5.2.5.2 Disturbance Effects

Winter Construction

The ringed seal is the principal pinniped species present in the region and the only one that would be expected in Lions Lagoon during the winter. Polar bears are known to den on land during the winter months in the project area. Cetaceans, including bowhead, beluga, and gray whales, will not be within the proposed project area during winter and, consequently, will not be affected by the winter construction efforts.

Disturbance to marine mammals present in Lions Lagoon and adjacent onshore areas (polar bears) during winter construction periods will likely occur due to noise from construction activities, drilling, aircraft and helicopter over-flights, and vehicle movement along sea ice roads. Construction activities that will generate noise include gravel extraction at the preferred gravel mine site, placement of gravel to construct roads, pads, and the airstrip, and placement of gravel fill in the nearshore area to build the Point Thomson dock. Increased suspended sediments under the ice from the dock construction probably will not affect marine mammals, which commonly inhabit turbid waters (Richardson et al. 1989). Therefore, the main concern is disturbance due to construction-related noise and activities.

Winter construction will occur from January to April for two seasons, with up to 450 people working with heavy equipment at any given time during this period (see Section 3.0). During winter construction and drilling efforts, numerous vehicle trips per day could take place on the sea ice road from Prudhoe/Endicott to the Point Thomson area. In addition, several helicopter and other aircraft trips could be required each day to support construction activities.

Pinnipeds

In winter and spring, ringed seals frequent land-fast ice and offshore pack ice. The highest densities of seals are usually found on stable shore-fast ice. Ringed seals maintain breathing holes throughout the winter in ice up to 6 ft (1.8 m) thick and dig multiple haul-out shelters and nursery lairs beneath the snow (Kelly 1988). It is possible that construction activities could impact individual seals using the area at the dock construction site. Pupping occurs in the spring, and it is unlikely that birthing lairs would be established by the time construction begins. The most likely impact to seals in the area would be displacement to other areas of shore-fast ice. Inupiat hunters continually stress that all marine mammals are sensitive to noise, and are careful to make as little extraneous noise as possible when hunting. Seals are also said to be cautious of any unusual visual stimulus, especially if the stimulus is in motion. At the same time, seals are said to be curious and will sometimes investigate unusual objects, and can be attracted by imitating the normal, non-vocal sounds that seals make on the ice. In short, seals are sensitive to their surroundings, especially responsive to sound, and tend to avoid unusual sounds. Industry and peer review findings are consistent with these traditional and local observations, and provide a qualified measure of this sensitivity to noise and other disturbance.

Seal reactions to construction activities are related to the noise of construction activities. Greene (1983) studied the underwater noise produced during construction of Seal Island. The island was built in 40-ft (12-m) of water compared to 0 to 12 ft (0 to 4 m) of water for the Point Thomson dock. He found that at 2.2 mi (3.6 km) from the Seal Island construction site, there was no evidence of propagation of noise components above 1000 Hertz (Hz), and little propagation of components below 1000 Hz (Greene 1983). Sea ice road construction in waters over 40 ft (12

m) deep produced potentially detectable low-frequency (<200 Hz) underwater noise as far as 2,624 ft (800 m) from the source (Greene 1983). Others have found that sound, especially at low frequencies, attenuates rapidly in shallow nearshore waters (Mi et al. 1987; Section 4.4 in Richardson et al. 1985). Thus, winter construction sounds only propagate a short distance waters as shallow as those at Seal Island (40 ft [12 m]), and would propagate even less well in the nearshore zone at the proposed site of the Point Thomson dock.

The ability of seals and other marine mammals to detect anthropogenic noise is influenced by natural background (ambient) noise levels. Ambient noise is influenced by sea surface noise associated with waves (Fairbridge 1966). Some limited measurements of ambient noise under the ice near the Liberty Development were obtained during February 1997 (Greene 1997). Noise levels as measured were well below the reference values for zero sea state at all frequencies between 25 Hz and 5000 Hz. This is typical for an area of stable fast ice. As one would expect, background noise, as influenced by sea state, is minimal under the ice.

The hearing abilities of these mammals are another factor affecting their potential responses to anthropogenic noise. The hearing abilities of ringed seals have not been measured at frequencies below 1 kiloHertz (kHz) (Terhune and Ronald 1975). Based on data from harbor seals, hearing sensitivity is expected to deteriorate with decreasing frequency to a threshold of about 96 decibels (dB) re 1 micro Pascal (μPa) at 100 Hz (Kastak and Schusterman 1995 and Richardson et al. 1995b). This means that the radius of audibility of low-frequency construction sounds to seals will be smaller than the radii within which they are detectable by sensitive hydrophones under low ambient noise conditions.

Green and Johnson (1983) found that seals apparently were displaced from the area within a few mi of Seal Island during the island construction in the winter of 1981-1982. Frost and Lowry (1988) similarly found seals avoiding areas within 2.3 mi (3.7 km) of artificial islands, and that avoidance was stronger, a 50 to 70 percent reduction in seal density, when island activity was high. However, more recent data described in LGL and Greeneridge (2001) showed that the construction of Northstar Island pipeline corridor and ice roads in late 19991 and early 2000 did not significantly affected the distribution or abundance of ringed seals. Seal densities in areas close to the Northstar development were similar to those found in non-construction impacted areas.

Since most of the Point Thomson construction effort is located on shore, there should be even less disturbance to seals from this project. Any minor displacements that occur as the dock is being constructed and dredged localized and short term. Overall effects on ringed seals from dock construction will likely be minor.

Polar Bears

Polar bear dens have been identified in the project area in the past (see Section 4.10.3). Females are occasionally found on land during the winter denning season. Construction and drilling activities can cause short-duration (one-or two seasons), but intense disturbances for polar bears denning near the center of activity. However, Amstrup (1993) found that 10 of 12 polar bears tolerated exposure to a variety of disturbance activities with no apparent effect on productivity. Polar bears may be more apt to abandon dens in response to disturbance early in the denning period (Amstrup 1993). Abandonment late in the denning period could have a greater impact. Amstrup and Gardner (1994) found that survival was poor for cubs that left dens prematurely due to movement of sea ice. It is apparently less costly for a bear seeking a den site to find an alternate location than for the bear to abandon a den and establish a new one elsewhere. Amstrup (1993) suggested that initiation of intense human activities during the period when polar bears seek den sites (October– November) could give bears the opportunity to choose less disturbed locations. All known areas of specific denning activity by polar bears have been avoided during design and siting of the project facilities and planned ice road routes.

Polar bears are thought to avoid loud noise sources, although there is no evidence that noise associated with construction or operations disturbs polar bears. Stirling (1988) reports that polar bears have commonly approached industrial sites in the Canadian Beaufort Sea region. Human/polar bear encounters have the potential to cause injury to both sides. Polar bears are curious and opportunistic hunters that have been known to approach facilities in search of food. As with grizzly bears and foxes, all operations in the project area will be conducted to minimize the attractiveness of the construction sites to polar bears and to prevent their access to garbage, food, or other potentially edible or harmful materials. All activities associated with polar bears in the region will be coordinated with the U.S. Fish and Wildlife Service (USFWS) and the ADF&G. Upon issuance of a Letter of Authorization from the USFWS, trained personnel have authority under Section 112(c) of the Marine Mammal Protection Act to haze/take polar bears under certain circumstances involving the protection of life.

Summer Construction

As described for winter construction, disturbance to marine mammals present in Lions Lagoon during summer construction periods will likely occur due to noise from construction activities, helicopter and fixed-wing aircraft overflights, and vessel movement in the nearshore and offshore areas. During summer, daily helicopter and other aircraft trips may be employed each day for personnel and equipment transport. Marine vessels will also be used to support summer construction throughout the open water construction season from Prudhoe Bay or Endicott. One sealift (two to three barges) will transport production and other modules to the Point Thomson area. Vehicle traffic will take place on the infield roads as construction on the roads is completed. During summer facilities construction and installation activities, daily vehicle trips can be expected on the infield gravel roads between the pads.

An open water dredging operation to create a 1,000 ft by 400 ft by up to 2 ft deep channel will take place off of the end of the marine dock. The dredging will be conducted using one or two 10 to 12 inch (25 to 30 cm) suction dredges. Barges will be used to transport spoils to an offshore permitted location. The dredging activity will likely begin as early as mid-July and could last until mid-August. The dredging and dumping of spoils must be completed by late summer to avoid any impacts to the fall bowhead whale migration.

Cetaceans

Spring migration of bowhead and beluga whales through the Western Beaufort Sea occurs from April to June at a considerable distance north of the barrier islands. Fall migration for bowheads begins in early to mid September, and a few bowheads could be expected to be offshore of Point Thomson as early as late August. Beluga whales are rarely seen offshore of Point Thomson in the summer. During their fall migration, small numbers of beluga whales could move into waters offshore of the project area. Details concerning the presence of these whales in the area can be found in Section 4.10.1 of this ER.

Whales are particularly sensitive to noise. Hunters stalking these mammals avoid making any sort of extraneous noise, and the loud and relatively constant noises associated with boat and air transport can cause whales (and other marine mammals) to avoid areas where such noise is audible to them. Dredging and re-grading of the dock and onshore summer construction activities (see Section 3.0) will generate noise during one season, but the sounds should not propagate far offshore due to the shallow waters of Lions Lagoon (see Section 5.2.5.2.1). The barrier islands that lie between the lagoon and the migration corridor used by the great majority of whales will also serve to block noise. In addition, LGL Greeneridge (2001) found that airborne sounds were not consistently detectable as far away as underwater sounds. The presence of boats near Northstar Island had the largest impact on the level of man-made underwater noise potentially perceivable to whales (LGL and Greeneridge 2001). For example, sounds from self-propelled barges were limited in frequency range but were faintly detected as far as 15 nautical miles (28 km) north of the island.

Therefore, while whales are sensitive to noise, they are either not expected to be found in the area during the majority of the summer construction and transportation efforts, or the majority of noise from these efforts is not likely to propagate to the whales' offshore migration corridor. Dredging activities and vessel movements outside of the barrier islands will be curtailed after September 1 so as not to impact the fall migration.

Pinnipeds

Disturbance to seals during summer construction will be similar to that discussed above for winter construction activities. However, other species of seal such as spotted and bearded seals could be present in Lions Lagoon during the summer months, and at higher densities. The nearshore dredging operation, along with vessel and air traffic does have the potential to disturb seals in the lagoon. Mitigation measures for vessels such as avoiding haul-out areas and limiting helicopter flights to routes over land can be enacted during summer construction. However, mitigation may not be possible for the dredging operations, and localized displacement of the seals is possible. Since this operation is short-term (about 1 month), population impacts are not expected. Additional mitigation measures are described below for operations and in Section 6.0.

Polar Bears

In the summer, polar bears will be casual visitors to the study area. Females with cubs and subadult males may come ashore for short periods of time. In the fall while open water is still found in the lagoon, polar bears moving along the barrier islands from the Canadian Arctic could be encountered on or near Flaxman Island. These bears could swim to onshore areas at Point Thomson, particularly if attracted by cooking odors or other human activities. As the pack ice recedes from coastal areas, polar bears for the most part move north with the ice where they remain offshore with the drifting ice during the summer months. Therefore, no impacts from summer construction are expected.

Operations

The majority of effects from Point Thomson operations and production activities on marine mammals will be in response to underwater and airborne noise. Operation of the facility will require transportation to the area by vessel and aircraft. In addition, the compressors, flares, and other equipment associated with condensate production will produce noise that could disturb marine mammals in the area.

Operation of the Point Thomson Gas Cycling facility could require a few helicopter trips per week and daily trips by other aircraft, from Prudhoe Bay. At present, an annual sea ice road to the facility is not planned once construction is completed. There will be daily trips by vehicles on the infield roads to each of the well pads during operations. During the open water season, annual barge trips can be expected. Levels and duration of noise from operations equipment (such as compressors, generators, and flares) would be expected to be similar to levels currently experience at Endicott where similar facilities are in operation. Impacts to deeper water should be even less then Endicott since Point Thomson facilities are located on shore and inland behind a barrier island and lagoon system.

Effects of operations of the proposed project and associated transportation on seals are expected to be limited to short-term and localized behavioral reactions by a small number of seals. Aircraft will avoid flying within 2 mi (3.2 km) of any identified spotted seal haul-out sites in or near the proposed project to mitigate potential effects of aircraft on these highly sensitive species. Overall, operations effects on individual seals or their populations will not be significant.

Polar bears are extremely curious and opportunistic hunters, and they have been known to approach facilities in search of food. All operations in the project area will be conducted to minimize the attractiveness of the construction sites to polar bears and to prevent their access to garbage, food, or other potentially edible or harmful materials. A polar bear interaction plan using the MMS guidelines for operation within polar bear habitats can be implemented if necessary (Truett 1993 and BPXA 1993a). All activities associated with polar bears in the region will be coordinated with the USFWS and the ADF&G. Trained personnel have authority under Section 112(c) of the Marine Mammal Protection Act to haze/take polar bears under certain circumstances involving the protection of life. This requires project-specific authorization from the USFWS.

The project will be operated in compliance with all applicable permits and regulations, which will further assure that the likelihood that impacts will occur to the species, stocks, and subsistence users of the species or stocks is minimized. During the summer, all helicopter operations will be conducted over land, to the extent practicable. If any spotted seal haul-out sites are identified, air traffic will be instructed to avoid these sites. As appropriate, activities will be coordinated with the relevant federal and state agencies (particularly the National Marine Fisheries Service, USFWS, National Biological Service, and ADF&G), local authorities (North Slope Borough), communities (Barrow, Nuiqsut, and Kaktovik), and whaling captains and their representatives (Alaska Eskimo Whaling Commission; Barrow, Nuiqsut, and Kaktovik Whaling Captains Associations).

Potential non-acoustic project related effects on marine mammals include exposure to spilled oil and NPDES-permitted wastewater effluent. Since the effluent will be regulated by permit limitations, no deleterious effects on marine mammal populations are expected. Impacts from large spills are considered in detail in Section 5.4.

Effects of the proposed project operations and associated transportation on bowhead whales are expected to be minimal. Additional information concerning bowheads is provided in Section 5.2.7, Threatened and Endangered Species.

5.2.5.3 Mortality Effects

Mortality effects on marine mammals could be either direct due to construction or operations activities, or indirect due to attraction to predators that could then reduce populations of resident marine mammals. For the marine mammals expected in the Point Thomson area, only direct mortality of polar bears is possible. Hunting of seals, polar bear, and whales by project personnel will not be permitted. Vessels will avoid the presence of seals in the water; therefore, mortality due to collisions will be negligible.

Should a polar bear encounter occur, it may become necessary to kill a threatening bear. This is most feasible during winter construction and operations since polar bears are not likely to be in the area during the summer. Mitigation measures such as avoidance of known polar bear denning areas and managing wastes will help to reduce the possibility of this effect.

Regardless of the mitigation efforts, mortality to marine mammals may occur during project operation. Operations will be conducted under small take provisions, including either (1) Incidental Harassment Authorizations (IHA) or (2) regulations and Letters of Authorization, or both, which will allow the take by harassment of small numbers of whales, pinnipeds and polar bears.

5.2.6 Terrestrial Mammals

Table 5-2 summarizes the potential impacts of the project on terrestrial mammals. Impacts due to habitat loss and alteration, disturbance, and mortality have been identified and are discussed in the following sections.

5.2.6.1 Habitat Loss and Alteration

Impacts to habitats used by terrestrial mammals can be either long-term (i.e., burial by gravel placed for roads, pads, and airstrip) or temporary. Temporary loss and alteration of terrestrial mammal habitats could result from ice roads, dust fallout, snow dumps, persistent snowdrifts, thermokarst, impoundments, and contaminants.

Gravel Mining and Placement

Gravel mine development and pad and road construction will occur during winter. Gravel placement and gravel mine development will cause long-term alteration of 9,404,666 ft^2 (873,693 m^2) of habitats used by terrestrial mammals, excluding open water (Table 5-3). Vegetation types that will be most affected by construction are moist sedge, dwarf shrub tundra/wet sedge tundra complex, and moist sedge, dwarf shrub tundra (together comprising 79% of the project footprint). Although these are important habitats for some mammal species (including caribou and lemmings), they are also the most abundant habitats in the Point Thomson area. Riparian habitats that are used particularly by moose, muskox, and grizzly bears comprise less than 1% of the project footprint (dry barren /dwarf shrub, forb grass complex; dry barren/forb complex; and river gravels; see Table 5-3). Dry upland sites that are important to ground squirrels and denning Arctic foxes comprise less than 4% of the project footprint (dry dwarf shrub, crustose lichen tundra; dry dwarf shrub, fruticose lichen tundra; dry barren/dwarf shrub, forb grass complex; dry barren/ forb complex; dry barren/dwarf shrub, grass complex; and river gravels). In general, for all vegetation types affected the amount of habitat loss would be small relative to abundance in the Point Thomson area. In addition, the displacement of terrestrial mammals, such as caribou, due to loss of habitat does not coincide with any negative impact on population/growth rates and it does not appear to be absolute, as is evidenced by the sustained use of even the most heavily developed oil field areas (Maki 1992). Therefore, effects of long-term habitat loss due to gravel mine development and gravel road and pad construction for terrestrial mammals are anticipated to be minor.

Ice Roads

Onshore ice roads will be used during winter pipeline construction. Effects of ice roads on vegetation could include broken and abraded willows and mortality of lichens, both of which may have adverse consequences for terrestrial mammals. Shrub habitats are important for collared lemmings, voles, and large mammals such as moose, muskoxen, and caribou. However, the use of ice roads during winter pipeline construction is anticipated to have minimal impacts on terrestrial mammals because of the small area affected.

Obstruction of Flow

Impoundments can occur when drainage is impeded adjacent to roads or pads. Impoundments can be temporary, disappearing by mid-June, or persist through summer. Depending on the duration of seasonal impoundments, effects on terrestrial mammal habitats range from minor to substantial. Water impounded by gravel roads and pads can displace resident small mammals and inhibit grazing by large herbivores. For the Point Thomson project, culverts will be placed during construction to prevent the formation of long-term impoundments adjacent to roads or pads. Additional culverts or other drainage structures could be installed after construction to drain any long-term impoundments that might form following initial gravel placement. Therefore, potential effects due to the formation of impoundments associated with gravel roads and pads is anticipated to be minimal.

Thermokarst

As described previously, thermokarst is a natural effect as well as a potential project effect that can change the tundra landscape by creating changes in microrelief and soil moisture. Changes due to thermokarst can result in increased diversity of wet, moist, and dry habitats or, if severe, can result in the creation of large, deep waterbodies. Many of the ecological changes associated with thermokarst may benefit plant productivity and wildlife use (Truett and Kertell 1992). Thermokarst has been shown to result in increased nutrient concentrations in plant tissue (Challinor and Gersper 1975; Chapin and Shaver 1981; Ebersole and Webber 1983; Emers et al. 1995). Lemmings and caribou are the most abundant herbivorous mammals in the Point Thomson area, and both species groups may benefit from the availability of grazing plants with higher nutritional value (McKendrick 1981). However, the effects of tundra disturbance on secondary production are uncertain, and data are insufficient to assess the net effect of thermokarst on wildlife populations (Truett and Kertell 1992).

Dust Fallout

Advanced snowmelt due to dust fallout can have both positive and negative effects on terrestrial mammals. Advanced snowmelt along gravel roads often impounds runoff and causes early "green-up" of plant species (Makihara 1983 and Walker and Everett 1987), attracting caribou prior to calving (Lawhead and Cameron 1988).

Gravel roads, pads, and the airport runway will be regraded and compacted during the first summer construction phase. Regrading and compacting activities will occur after spring thaw has begun; therefore, associated dust fallout will not affect snowmelt.

During operations, early snowmelt due to dust fallout could attract some terrestrial mammals in the spring. Low anticipated traffic volumes during operations and dust control measures (e.g., watering of roads) and enforced traffic speed limits should minimize the effects of early snowmelt due to dust fallout.

Snow Dumps and Snowdrifts

Snow dumps and snowdrifts adjacent to pads or roads could displace small mammals and have localized effects on vegetation due to delayed snow melting. Areas affected by snow dumps and snowdrifts associated with the Point Thomson Gas Cycling Project are anticipated to be minimal due to the minimal footprint of the project. Potential effects on terrestrial mammal habitats due to snow dumps and snowdrifts are anticipated to be minimal.

Spills and Leaks

Contaminant spills and cleanup efforts can alter mammal habitats in various ways. However, the most common spills in the oil fields are relatively small and affect small areas of tundra. Small spills occurring during construction and/or operations at the Point Thomson facility are not anticipated to result in population-level effects attributable to habitat alteration. Impacts from large spills are considered in detail in Section 5.4.

5.2.6.2 Disturbance Effects

Potential behavioral disturbance includes immediate responses of affected animals (including energetic or other costs associated with startle or fleeing responses), loss of habitat or degradation of habitat quality (by causing avoidance), and attraction of some species to areas of human activity (particularly predator/scavengers). Point Thomson Gas Cycling Project activities could cause either behavioral disturbance or attraction of wildlife during construction and main operations. The potential impacts are discussed under the context of winter construction, summer construction, and operations activities.

Winter Construction

Winter construction activities will occur from January to April for two seasons and will include ice road construction, gravel mining, gravel placement for roads, pads, airstrip and dock, drilling, and pipeline installation. Few caribou, muskoxen, grizzly bears, moose, and wolves are likely to be present in the Point Thomson area during the winter. Grizzly bears are also unlikely to be denning in the vicinity of the proposed project. Arctic fox and Arctic ground squirrels could be disturbed by construction activities if they were present in the area. It has not been determined to what extent these species make use of habitat in the project area (Section 4.10.4 and 4.10.6). It is anticipated that any disturbance of small mammals present in the Point Thomson area during the winter will be minimal.

Summer Construction and Year-Round Operations

Noise generated due to onshore construction activities, the physical presence of equipment, and vehicle traffic during construction and operations has the potential to disturb terrestrial mammals in the area. Disturbance of muskoxen, grizzly bears, moose, wolves, and wolverines is anticipated to be minimal due to their infrequent use of the area (Section 4.10).

Disturbance by traffic, structures, and human activities can produce several effects on caribou behavior and movement. During and immediately after the calving season, female caribou with calves tend to avoid areas near active pads and roads. During and immediately after the calving season, female caribou with calves (up to 3 to 4 weeks old) tend to avoid areas within at least 1,500 to 3,300 ft (457 to 1006 m) of active pads and roads (Johnson and Lawhead 1989) and as far as 1 to 3 mi (1.6 to 4.8 km) (Dau and Cameron 1986; Lawhead 1988; Cameron et al. 1992; Cronin et al. 1994). The Central Arctic Herd has shifted its most concentrated calving areas several times over the last 20 years, with the most recent shift to an inland area southwest of the point Thomson area (Section 4.10.1.1). The Porcupine Caribou Herd does not calve near the Point Thomson area (Section 4.10.1.1).

During the insect season, harassment by insects overwhelms the avoidance response, and caribou of all ages and both sexes regularly approach and cross pipeline/road corridors while moving to and from insect-relief habitat located near the coast. The clearest behavioral impact of road traffic during insect season is reduced crossing success when caribou groups attempt to cross pipelines that are within 300 ft (91 m) of roads with high traffic rates (15 or more vehicles per hour) (Curatolo and Murphy 1986 and Cronin et al. 1994). Deflected movement and delays of up to several hours are common under these circumstances (Johnson and Lawhead 1989, Lawhead et al. 1993). Energetic stress during the insect season has been identified as a potential pathway by which human disturbance could affect caribou populations by decreasing body condition of females and reducing reproductive success in subsequent years (Cameron 1995, Cameron and Ver Hoef 1996, Murphy et al. 2000, and Murphy and Lawhead 2000).

To reduce disturbance impacts, research has focused on ways to facilitate free passage of caribou through the oil fields and standard mitigation measures have been developed (Cronin et al. 1994). The principal mitigative measure is to elevate pipelines to a minimum height of 5 ft (1.5 m). This often results in substantial lengths of pipe situated higher than 5 ft (1.5 m) as it crosses irregularities in the tundra surface. A pipeline constructed to the standard minimum height of 5 ft (1.5 m) above the ground surface (measured at the bottom of the pipe or vibration dampers, whichever is lower) does not impede caribou movements as long as a road with a high traffic rate is not located nearby (Curatolo and Murphy 1986, Cronin et al. 1994). Therefore, another standard mitigative measure is to assure adequate separation of elevated pipelines from adjacent gravel roads. A distance of 300 ft (91 m) has been identified as the minimum separation necessary to ensure that crossing success is not reduced (Curatolo and Reges 1986), but a greater distance (400 to 500 ft [122 to 152 m]) has been recommended to provide extra assurance of mitigation (Cronin et al. 1994). Elevated pipelines at or above 5 ft (1.5 m) and pipeline/road separations of 500 ft (152 m) at the Point Thomson Project will minimize the impacts of behavioral disturbance of caribou. Behavioral reactions to road traffic could occur for caribou groups encountering the Point Thomson access roads during the construction phase, but it anticipated to diminish to low levels during project operation as traffic rates decline. Disturbances have not resulted in population level changes for caribou due to the location of facilities and the availability of other suitable habitat in the Prudhoe Bay region. Similarly, no population level effects are expected in the Pt. Thomson region.

Foxes and bears are attracted to areas of human activity where they readily feed on garbage and handouts (Eberhardt et al. 1982, Follmann 1989, Follmann and Hechtel 1990, Shideler and

Hechtel 1993, and Truett 1993). Opportunistic predator/scavengers such as Arctic foxes and grizzly bears appear to benefit from increased food resources in the oil fields (Burgess 2000 and Shideler and Hechtel 2000). When organic refuse is abundant, attracted foxes experience increased survivorship and higher reproduction rates (Eberhardt et al. 1982 and Burgess et al. 1993), leading to long-term increases in population size. The density of active Arctic fox dens and fox numbers are greater in oil fields than in undeveloped areas (Eberhardt et al. 1982 and 1983, Burgess et al. 1993, and Burgess 2000). Grizzly bears in and near the oil fields also show better nutrition, greater adult weights, lower cub mortality, and are present in higher concentrations than elsewhere on the North Slope, presumably due to the accessibility of human refuse (Shideler and Hechtel 2000).

The potential for scavengers to be attracted to the Point Thomson area is greatest during construction, when human activity would be most intensive and wide-ranging. Lower levels of human activity during operations would have less potential to attract scavengers. Tight controls on the availability of organic refuse will also reduce the potential impacts on foxes and bears. Nonetheless, the Point Thomson Gas Cycling Project could attract numbers of foxes and bears throughout the year since artificial food sources are powerful attractants. It is anticipated that refuse control efforts, employee environmental sensitivity training, and enforced rules against animal feeding will minimize population level effects on Arctic foxes and grizzly bears.

5.2.6.3 Direct and Indirect Mortality

Strikes by vehicles could cause mortality of terrestrial mammals at the Point Thomson project facilities. Risks of vehicle strikes will be greatest during summer when large numbers of caribou and other mammals may move into the area. Arctic foxes could be present year-round and subject to vehicle strikes during all seasons. Although vehicle-caused mortality is poorly documented for the Kuparuk and Prudhoe Bay oil fields, the number of animals injured or killed by vehicles is thought to be low.

Under certain seasonal conditions, caribou are attracted to developed areas. During early spring, caribou may be attracted to roadside areas where dust fallout has caused vegetation to "green up" earlier. Although these animals gain access to nutritious forage, their exposure to traffic-related disturbance and risk of vehicle strikes increases. Caribou also may be attracted to developed areas where they seek relief from insect harassment (mid-July to mid-August) on elevated gravel roads and pads and in shaded areas under pipelines and buildings (Roby 1978 and Johnson and Lawhead 1989). The number of caribou engaging in this behavior at a specific location can range from one or a few individuals to several thousand. Thus, the risk of vehicles striking caribou is greatest during this period. At such times, caribou often are less cautious around vehicles than at other times of the year. The likelihood of vehicle strikes can be minimized through driver education and reduced speeds.

The habituation of Arctic foxes and grizzly bears to human activity not only increases the potential for animals to be struck by vehicles, but also increases the potential for animals to infect humans and other animals with rabies or other diseases, harm humans through aggressive behavior, and be killed as a control measure to protect human life and property. Fox control measures, such as trapping, have occasionally been undertaken in the Prudhoe Bay and Kuparuk oil fields to reduce the abundance of Arctic foxes.

Increased predator populations around oil field developments may increase predation on prey populations (Martin 1997). This impact is inferred from the higher numbers and productivity of foxes (Eberhardt et al. 1982 and Burgess et al. 1993, Burgess 2000), grizzly bears (Shideler and Hechtel 1995b and Shideler and Hechtel 2000), and gulls and ravens (Truett et al. 1997 and Day 1998) in the North Slope oil fields. There is little information on lemming and vole populations in oil fields adjacent to where Arctic foxes have increased in abundance. Arctic fox could also cause impacts on birds, their primary prey during periods of lemming scarcity (Section 5.2.4.3). Terrestrial mammalian prey of grizzly bears includes ground squirrels and ungulates (caribou, moose, and muskoxen), particularly ungulate calves. Although grizzly bears are known to prey on caribou in the region (Shideler and Hechtel 2000), the magnitude of mortality is difficult to quantify. Impacts to colonial bird populations from increased grizzly predation are also a concern (Section 5.2.4.3). It is anticipated that refuse control efforts, employee environmental sensitivity training, and enforced rules against animal feeding would minimize population-level effects on predators and scavengers and avoid the potential for these animals to negatively affect populations of lemmings or ungulates in the Point Thomson region.

Contaminant spills also have the potential to result in mortality of terrestrial mammals. Contaminants can negatively affect mammals through dermal contact, dermal absorption, ingestion, and inhalation. Dermal contact can include impacts on the ability of hair to insulate or to shed water. The most common oil field spills (small volume spills of fuels and fluids necessary for vehicle/machinery operations) are unlikely to have population-level impacts on terrestrial mammals. Impacts from large spills are considered in detail in Section 5.4.

5.2.7 Threatened and Endangered Species

As described in Section 4.14, one threatened species of birds (spectacled eiders) and one endangered whale (bowhead) may be found seasonally in the vicinity of Point Thomson. Steller's eiders, also a threatened species, are unlikely to make use of the Point Thomson area. Table 5-2 summarizes the potential impacts of the proposed facilities on these species.

5.2.7.1 Spectacled Eiders

The effects of the Point Thomson Gas Cycling Project on threatened birds is restricted primarily to the possible effects on the spectacled eider.

Spectacled eiders are subject to the same types of concerns generally afforded other species of birds on the North Slope. These concerns include the potential for decreased populations (or impediment to recovery) due to habitat loss, disturbance of birds, and decreased productivity. Decreased productivity is generally a secondary effect arising from increased predator populations reducing nest success, including such factors as nest abandonment and predation on eggs or chicks. Protection measures are expected to be applied more conservatively in areas supporting spectacled eiders versus other tundra-breeding birds in general, because spectacled eiders are currently listed as threatened under the Endangered Species Act. The USFWS has developed preliminary protection guidelines for new developments within the breeding range of the spectacled eider. These measures include:

- Prohibiting high-noise facilities, such as gathering centers and airports, within 0.6 mile of nest sites.

- Prohibiting facilities within 0.1 mile (0.16 km) of nest sites.
- Maintaining adequate access for birds to move from nest sites to brood-rearing areas.

Habitat Loss and Alteration

The proposed Point Thomson project will result in the long-term alteration of 915,781 ft^2 (0.8 km^2) of the more important spectacled eider habitats. These habitats include water (primarily lakes and ponds) and the following vegetation types: salt marsh, aquatic graminoid tundra, water/tundra complex, wet sedge tundra, and wet sedge tundra/water complex. The direct loss of habitat due to gravel placement for the airstrip, roads, and pads could have a potential impact on these eiders, since spectacled eiders prefer habitats in drained lake basins and wet coastal tundra for nesting and brood rearing. Spectacled eiders have been shown to readily use impoundments (Warnock and Troy 1992) and are not expected to suffer adverse impacts should small areas of surface hydrology be changed due to ponding. Similarly, impacts on spectacled eider habitat from snowdrifts, and other temporary changes to habitats resulting from Point Thomson construction or operation are expected to be minimal. Spectacled eiders could also occasionally use some other vegetation types in the Point Thomson project area, but the water and aquatic types are those most important to eiders during the breeding season.

Disturbance Effects

Behavioral disturbance of birds using habitats near the roads and pads and the types of potential effects are discussed in detail in Section 5.2.4.1. Similar responses are likely for any spectacled eiders that use habitats near facilities in the Point Thomson area during construction or operations. Indirect loss of habitat due to disturbance may occur near facilities generating noise in the Point Thomson area. Spectacled eiders did shift their distribution away from the Central Compressor Plant in the Prudhoe Bay oil field, presumably due to increased noise output when the facility was expanded (Anderson et al. 1992).

Some disturbance of spectacled eiders may result from helicopter and fixed wing flights during both summer construction and operations activities. However, aerial surveys of spectacled eiders indicate that they are tolerant of low altitude helicopter overflights (i.e., they exhibit low incidence of flushing) during regular census surveys (LGL et al. 1998). In general, the relative scarcity of spectacled eiders in the area will potentially limit population-level impacts due to disturbance or indirect habitat loss.

Direct and Indirect Mortality

Some potential for increased mortality of spectacled eiders may result during poor weather conditions from collisions of low-flying spectacled eiders with elevated structures. The potential for such impacts is likely to be limited because the Point Thomson area is at the eastern end of the species range on the Arctic Coastal Plain and movements of large numbers of spectacled eiders past Point Thomson are unlikely.

Increased predation levels from attraction of predators to the Point Thomson area may affect small numbers of breeding spectacled eiders. The number of breeding pairs observed in June is low (5 pairs) and only one brood of spectacled eiders has been reported in the area, near Point Sweeny located about 2 mi (3.2 km) east of the West Pad (see Section 4.14.3). Therefore, increased predation is unlikely to have a population-level effect on spectacled eiders.

As with other birds, the impacts of contaminants on spectacled eiders are dependent on the type of contaminant, season (i.e., when the spill occurs), and the number of birds that could be affected. Because the distribution of most spectacled eiders is located to the west of the main production area at Point Thomson, effects on spectacled eiders related to possible spills are most likely from the pipeline rather than from contaminants found on the drilling and production pads. Impacts from large spills are considered in detail in Section 5.4.

In conclusion, the direct and indirect effects of the Point Thomson project will be limited for spectacled eiders because of their relatively low numbers and limited distribution (primarily away from the road, airstrip, and pad locations) in the Point Thomson project area.

5.2.7.2 Bowhead Whales

Effects of operation of the proposed project and associated transportation on bowhead whales are expected to be minimal. Vessel movements during the construction phase, especially in waters north of the barrier islands, will be completed before 1 September as ice and other conditions allow. Aircraft overflights of waters north of Flaxman Island will be avoided after 31 August until migration is complete, except for emergency situations. Dock construction and all major onshore construction and drilling will be conducted in winter, avoiding disturbance to whales. The details of these mitigation measures will be defined during the IHA and rulemaking processes.

5.3 SOCIOECONOMIC AND CULTURAL RESOURCES

Impacts of the project on the socioeconomic characteristics and cultural resources of the area can occur through a reduction or enhancement population, economy and income, land use and management, subsistence and recreational and visual resources. The consequences of disruption or displacement, restriction, and destruction are applicable to the land use and management, subsistence, recreation and visual and cultural resources.

5.3.1 Population

The Point Thomson Gas Cycling project is unlikely to significantly alter the population base of the local communities of the North Slope Borough (NSB) or the state of Alaska. The project is relatively small, requiring 75 personnel for operations, and during the temporary construction phase, 450 personnel. Workers will be housed on site at Point Thomson facilities for both construction and operations phases, avoiding the potential for significant impact to the relatively small village communities in the area. Additionally, this physical disassociation of workers from established local communities would also render it unlikely that incoming construction workers will settle in the NSB.

Addition of non-Alaskan Point Thomson personnel and their families would be a relatively minor factor in the NSB population of 7,345 (preliminary 2000 census count), and even more so within the population of the State of Alaska, diminishing the overall population impact.

5.3.2 Employment and Income

5.3.2.1 Local Communities

A direct positive economic effect should result from the Point Thomson project, with the creation of new jobs for construction and operations. It is expected that the benefit will take place mostly on the North Slope and in southcentral Alaska. In the short-term, the activity is projected to generate approximately 450 construction jobs and 75 long-term positions (for operating and maintaining the facility). The North Slope owners have historically made a commitment to hire Alaskan resident workers on the North Slope and within Alaska. Regarding long-term jobs in operations, local residents' need for seasonal flexibility to pursue subsistence activities and other factors may reduce the attractiveness of oilfield operations employment when other jobs (NSB) with greater flexibility are available. Relatively few village residents on the North Slope are currently employed by the oil industry for this reason, even though recruitment efforts are made and training programs are available. The Point Thomson Gas Cycling Project is not expected to change this pattern.

The short-term construction positions, however, are more seasonal in nature, and thus more likely to fit into a subsistence calendar, in particular those that take place during the winter phase of construction. There are local firms specializing in the construction of ice roads which could benefit from the project. In addition, many of the contractors hired for the Point Thomson project (design, construction, drilling, and operations) could be either Native Corporations, subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures or other relationships. This would thus provide indirect benefit to the wider Native community, as well as to individual workers.

5.3.2.2 State of Alaska

The Oil and Gas Policy Council report estimated that $1 in direct oil industry expenditures can result in $1.9 to $2.9 in total output, when state revenues, Permanent Fund dividends, and all other factors are considered (Northern Economics, 1995). The range of values reflects different facility types. Of the sites described in the report, the Point Thomson Gas Cycling project resembles most closely the marginal and remote sites, and should have an output multiplier of 1.9 to 2.1. The owners estimate that total expenses will be in excess of $1 billion for the Base Case. In addition, the State of Alaska will benefit directly from capital expenditures (associated with purchase of services and materials) in the economy, leading to the creation of indirect employment.

5.3.3 Public Revenue and Expenditures

Oil and gas revenues support a variety of expenditures and have allowed the NSB to pursue significant capital improvement plans and health and social services. The increase in the NSB tax base through the addition of the Point Thomson facility will also indirectly benefit on employment in the region, as the NSB employs about 62% of the Borough's working population.

Over the estimated life of the project, additional benefits will accrue to the State of Alaska through the State of Alaska's share of the Federal royalty, income tax, and *ad valorem* tax, some of which will also accrue to the NSB. This benefit will occur at a time when State of Alaska and NSB revenue, heavily dependent on production from the large North Slope oil fields, could be declining. The Point Thomson project by itself will not offset these declines, but it could help mitigate the severity of any decline. The Point Thomson Project will add approximately $1 billion to the NSB and State of Alaska taxable property.

5.3.4 Subsistence and Traditional Land Use

The proposed action includes construction and maintenance activities that have the potential to affect local residents' patterns of subsistence use. However, in order for there to be a potential impact on subsistence activities, two conditions must be met: 1) the resource has to be present or expected in the area during the period of impact, and 2) subsistence use of the resource has to occur in the impact area.

Impacts on subsistence can be produced by direct or indirect actions on biological resources that result in a displacement or reduction in the animals important for subsistence. Other impacts that could potentially occur are:

- Changes in human behavior, which can include restricting access to a subsistence resource.
- Disruption of subsistence activities, resulting in a reduced harvest.
- Limited subsistence resource use due to the perception that the subsistence experience has been affected or that the resource has been tainted.

5.3.4.1 Winter Construction

The majority of winter construction activities at the Point Thomson project area will take place during February through May. The preparation for these activities, during November to January, will include the construction of an ice road to access the Point Thomson site from Prudhoe Bay. Polar bears and ringed seals are the only marine mammals expected to be within the proposed project area during winter construction. Winter construction activities occur during a season in which subsistence use of the project area is low to non-existent. Nuiqsut and Kaktovik hunters do not venture as far afield as the Point Thomson area in order to pursue their traditional subsistence activities.

Polar bear denning habitat could be encroached upon by onshore pipeline construction and associated ice roads, although a one-mile (1.6 km) avoidance stipulation protects the dens to a large extent (Section 5.2.5). Any subsistence hunting of polar bear in and near the project area would be primarily opportunistic and associated with fall whaling activities. Given the infrequency of polar bear harvest during the winter, potential effects on subsistence use will likely be negligible.

Some localized disturbance of seals is possible due to noise associated with winter construction activities, but overall population effects are not anticipated. Similarly, some localized displacement of seal hunting activities may also occur, but would be minimal in terms of the overall pattern of Nuiqsut seal hunting. As discussed in Sections 4.13.3.1 and 4.13.3.2, seal hunters from Nuiqsut have reported using the area offshore of Point Thomson in the past, but current harvest rates from the area are relatively low.

Subsistence hunters in the area tend to rely on caribou hunted closer to the village for their winter protein (see Sections 4.13.3.1 and 4.13.3.2). As indicated in previous reports (USACE 1999), the area around the Point Thomson project is not currently used as a winter harvest area for caribou for the local villages.

Whales will not be present in the proposed project area during winter construction. Similarly, potential winter construction effects on fish are judged to be negligible (see Section 5.2.3), and subsistence use of the area for fishing is infrequent and limited to summer.

Effects of winter construction efforts, including gravel extraction, on terrestrial subsistence resources and their use for subsistence would also be minimal. Use of the project area by subsistence hunters in general is low and is practically non-existent in winter, when trapping and hunting of fur bearers occurs closer to the communities (see Sections 4.13.3.1 and 4.13.3.2). As a result, onshore gravel extraction, placement of fill, and pipeline construction efforts in the winter would not be expected to reduce, restrict, or disrupt subsistence activities.

5.3.4.2 Summer Construction

Summer construction activities both on land and offshore have the potential to impact subsistence resources. Subsistence resources are likely to be present in the area during the summer and fall construction period (i.e., seals, whales, anadromous and freshwater fish, terrestrial mammals, and birds). However, use of the area by residents of Nuiqsut and Kaktovik is low (see Section 4.13.3.1 and 4.13.3.2). Most area use occurs in conjunction with the fall whale hunt, when hunters travel through or near the area in pursuit of whales, and hunt other resources on an opportunistic basis.

Whales are not expected to be directly affected by shore-generated noise, as their normal migration route (seaward of the barrier islands) is beyond the transmission range of the noise expected to be generated. The open-water offshore construction activities are all associated with dock construction (e.g., compaction, shaping armoring, and dredging). Offshore construction activities are scheduled to be finished by mid-summer, which should avoid impacting the fall whaling hunt. Because of the offshore distribution of most fall migrating whales, few, if any, are expected to encounter vessels within the project area. However, it is possible that supply vessels travelling between Prudhoe Bay and Point Thomson could encounter whales. If any such approaches do occur, a small number of whales may show short-term avoidance reactions that will be of no long-term significance. Encounters during the fall whale-hunting season would be most likely to affect subsistence activities; mitigation measures (see Section 6.0) should reduce any potential adverse impacts. Potential impacts to whaling could be mitigated through the establishment of restrictions to boat and air traffic during sensitive whaling periods.

It should also be noted that although the Point Thomson area falls within the extent of Nuiqsut and Kaktovik whaling areas, it is by no means the most important stretch of coastline for this activity. In the case of the Nuiqsut whalers, the core bowhead harvest areas centers on Cross Island, to the west (USACE 1999). The Kaktovik core area falls between Camden Bay and Griffin Point, to the east of the project area (Figures 4.19 and 4.20).

Summer construction activities are not anticipated to have any significant effects on diadromous, freshwater, or marine fish (Section 5.2.3). Fish species in the Point Thomson area were historically used by Native residents, but currently are not used much due to the area's distance from local communities. Therefore, overall subsistence use effects on fish resources are anticipated to be minimal (LGL et al. 1998).

The subsistence use of terrestrial mammals in the project area is minimal, primarily due to its distance from Nuiqsut and Kaktovik. There is a historical summer caribou hunting site for the Kaktovik village adjacent to the Point Thomson project area (USACE 1999), but it is currently seldom used. The potential for impact of the project on terrestrial mammals is also limited to the immediate vicinity of the project area, as the project is not planning to build overland transportation routes. During the summer, transportation will be via marine vessels or aircraft. Thus any potential disturbance of terrestrial mammals due to summer and fall construction should be strictly limited to the immediate locale of the Point Thomson project, and given the present use pattern of local Inupiat hunters, should not be significant.

5.3.4.3 Operations

Noise generated during operations is anticipated to be less than that produced during the construction phases. Disturbance effects on local wildlife are anticipated to be minimal and should not affect subsistence resource population levels. In order to mitigate the potential for adverse effects on wildlife in the area due to attraction of wildlife, personnel will be trained in measures to avoid attracting wildlife, and how to deal with human/wildlife interaction.

Another potential long-term effect of the project is competition for local subsistence resources due project personnel sport hunting and fishing. In order to mitigate the potential for project personnel to interfere with subsistence activities, hunting by personnel in the vicinity of the project will be prohibited. All personnel will be required to comply with applicable ADF&G sport fishing regulations.

A significant concern is the potential impact of a pipeline spill or well blowout on biological resources and related effects on subsistence activities in the Point Thomson area. The risks and impacts on biological resources associated with a large spill are discussed in Section 5.4. The impacts of a spill on subsistence activities may cause displacement or mortality of a wildlife resource, or restrict access of subsistence users to the resource. While direct effects of a product spill on terrestrial and/or marine subsistence resources could occur (see Section 5.4), the use of the area by subsistence hunters is low, so that any subsistence use effects are anticipated to be minimal.

The perception of contamination can also occur even if resources are not actually affected. One of the most persistent effects of the *Exxon Valdez* oil spill was the reduced harvest and consumption of subsistence resources due to the local perception that they had been tainted by oil (Fall and Utermohle 1995). Even though extensive testing programs were instituted and no such contamination of fish or marine mammals was established (some localized shellfish were contaminated), this pattern of reduced consumption persisted for at least a year. The cultural context of subsistence on the North Slope differs markedly from the *Exxon Valdez* area (in the Alutiiq cultural region), making it difficult to make specific comparisons. Direct, indirect, and perceived subsistence impacts can be expected after a spill on the North Slope, with the extent of the decline in harvest and use and the temporal duration of the effect dependent on the size and location of the spill. Mitigation measures could include contamination testing in coordination with local residents to dispel such perceptions.

Oil-spill cleanup activities could also have effects on subsistence resources from vessel and aircraft traffic by causing temporary disturbance and possible displacement. The Final Environmental Impact Statement for Lease Sale 144 states that in the event of a large spill contacting and extensively oiling coastal habitats, the presence of several thousand humans, hundreds of boats, and the many aircraft involved with cleanup activities could (depending on the time of the spill and the cleanup) potentially displace seals, polar bears, and other marine mammals, increase stress, and reduce pup survival of ringed seals if operations occurred in the spring (MMS 1996). The potential impacts of large oil spill is discussed in Section 5.4.

5.3.5 Land Ownership, Use, and Management

5.3.5.1 Ownership

As described in Section 4.13.4.1 most of the land in the Point Thomson Gas Cycling Project area is patented to the State of Alaska. All project development will occur on these State Lands under the terms of existing State oil and gas leases. Most leases within the Point Thomson Unit are currently being held through Plans of Development that have been submitted and approved by the state on an annual basis.

Federal lands within the Arctic national Wildlife Refuge (ANWR) are located adjacent to the east of the development unit. A Native allotment application has been made on Flaxman Island and a location near Brownlow Point. However, the proposed project facilities will not be constructed in either of these areas and will not affect land ownership.

5.3.5.2 Land Use

As described in Section 4.13.4.2, historic and current land and water use of the Point Thomson area is primarily threefold. It includes oil and gas exploration, occasional traditional and subsistence use by Alaskan Natives, and occasional summer recreation uses along the Canning River within the ANWR border.

The proposed project is consistent with existing oil and gas exploration and production activities in and adjacent to the project area. In terms of the subsistence use of the area, impacts will be minimal (see Section 5.3.4), primarily due to the fact that the area is minimally used at present by the Kaktovik and Nuiqsut villages for subsistence. The greatest potential for disruption of subsistence habits would be to the annual fall whale hunt, and would consist of disruption to the whale migration pattern through noise or transportation interactions. The likelihood that these impacts would be significant is low (see section 5.2.5) and will be mitigated to some extent through project controls (see Section 6.0). There will be negligible competition for subsistence resources through additional access to the area for sports fishing and hunting. Project personnel will not be permitted to hunt in the area.

Recreational use in the area mainly occurs in the adjacent ANWR. Development of the Point Thomson facilities would affect use of surrounding areas for recreation activities to the extent that the presence of an industrial facility would interfere with that experience. See Section 5.3.7 for further discussion of recreation impacts. The project may distract from the visual aesthetics of the region in the eyes of residents and visitors. Mitigation measures, such as using natural coloring for facilities, will provide some amelioration of this effect.

5.3.5.3 Land Management

Section 4.13.4.3 describes the land management aspects of the Point Thomson area. The area has been unitized and is subject to specific agreements and state regulations governing activities within unitized areas. The unit is located within the boundaries of the NSB coastal zone. All development within the unit will adhere to the NSB Title 19 LMRs and the Alaska Coastal Management Program (ACMP). The Point Thomson unit is zoned as a Resource Development District, but any existing Master Development Plans for the area will require revisions.

The construction of the pipeline to connect the Point Thomson Unit with the Badami Unit requires rezoning of the area from a Conservation to a Resource Development District, as designated by the NSB LMRs. This requires the development of a Master Plan for the area, which must demonstrate that the project will not permanently and seriously impair the surrounding ecosystem, nor significantly affect subsistence resources and activities.

The project will be consistent with the existing policies and requirements specified in the various governing ordinances. Mitigation measures proposed in Section 6.0 will assist with compliance.

Development plans should receive approval, with likely conditions and stipulations for complying with responsible practices as directed under NSB and ACMP management.

5.3.6 Transportation

Impacts to transportation systems will occur since the project requires the movement of personnel, equipment, materials, and supplies by marine, highway, air, and overland routes for construction and operation. Although the project is not large in size, there will be an increase in movement, particularly during parts of the construction phase.

A one-time construction impact in the form of increased vessel traffic will affect annual sealifts, since project modules will be transported either to Prudhoe Bay and on to Point Thomson by barge, or directly to Point Thomson without a stop in Prudhoe Bay. However, this should create only minor effects on transportation systems and can be mitigated by planning.

Traffic on the Dalton Highway and within the Prudhoe Bay road system is not expected to see a large increase due to the Point Thomson project. A dock is proposed at the project site, so that major modules can be sealifted directly into the area and not have to be transported via ice or gravel roads from Deadhorse. The suction dredges needed to create a channel to the dock, smaller modules, and piping will be trucked to Prudhoe Bay, and then transported by ice road or barge to Point Thomson. A seasonal ice road will connect the project during the construction phase and potentially during operations; however the expected traffic from Point Thomson activities is unlikely to be significant.

Air and boat traffic in the immediate vicinity of the project, associated with the transport of supplies and personnel between the project site and Prudhoe Bay, will increase during the construction and operations phases. Impacts associated with disturbance of marine and terrestrial animals have been discussed in previous sections 5.2.5 and 5.2.6 of this ER. Due to Prudhoe Bay access restrictions, and lack of existing overland access to the site, an increase in public and charter service into Deadhorse related this project would be unlikely.

5.3.7 Recreation

As described in Section 4.13.6, recreational opportunities in the area include floating the Canning River and camping in ANWR. As the possibility of oil drilling in ANWR receives more public attention, the perceived impairment to recreational opportunities in the area may become an issue raised concerning the Point Thomson project development.

Currently, the US Fish and Wildlife Service estimates that 591 visitors are expected in ANWR during 2001. This figure represents visitors arriving with guided tours, but does not include individuals traveling to ANWR. Recreation activities occur during the summer, and would only be impacted by summer construction activities and regular operations. The project would provide no actual impediment to the recreational activities as currently practiced; however it may affect the quality of the recreation experience. During construction in particular, the Point Thomson area will be subject to a large number of transportation vehicles, including airplanes and boats, which may create visual and aural impacts, distracting from the recreational experience. Drilling may create a noticeable increase in noise for a limited time period; however, due to current restrictions, drilling is planned to take place during winter when recreation activities will be less likely to occur. Construction effects would last for one to two seasons, with the majority of impact occurring during dark and cold winter months. Noise associated with facility operation may be heard in the immediate vicinity throughout the life of the project. The Canning River takeout airstrip for guided float trips is located approximately 11 mi (18 km) south of the Point Thomson project area. Depending on activities and wind direction and speed, the noise associated with operations may not be audible by visitors at the Canning River takeout.

5.3.8 Visual Aesthetics

The long-term visual and aesthetic characteristics of the project during operation have the potential to affect both the local residents and visiting recreational users. Since the visual and aesthetic characteristics of the area (see Section 4.13.7) consist of a low relief, treeless landscape, oil field facilities, particularly those located at the East Well Pad, could be visible from within ANWR, or to people partaking in recreational activities on the Staines and Canning Rivers. While it is unlikely to be visible from the Kaktovik or Nuiqsut, the villagers could be affected by the project during subsistence activities conducted in the area and in particular during the whale-hunting season. Since the facilities will also have flares and lights, a glow could be visible in the area. Noise from the compressors and vehicles may be heard. These impacts may be perceived as intrusive to local residents who pass through the area, or as a reduction in the quality of the recreational experience for visitors for whom the visual and aesthetic value may be a key component. The presence of the oil field facilities and the accompanying limits to area access may be considered as a disruption to recreational use of the area. Tower-like structures such as flare stacks (100 ft [30 m]) and the microwave tower (300 ft [91 m]) will be part of the facility design. More massive structures such as modules and processing facilities are likely to be approximately 100 ft (30 m) tall. However, any impacts can be at least partially mitigated by choosing colors that are consistent with the natural landscape, reducing noise emissions, and reducing or redirecting light from the facilities.

5.3.9 Cultural Resources

The results of the cultural resources reconnaissance survey of the proposed Point Thomson development identified seventeen sites that are listed on the Alaska Heritage Resource Survey (AHRS) archaeological database. Five of these sites are also listed on the NSB's Traditional Land Use Information (TLUI) database (see Section 4.12 of this ER). The known sites in the project area are all located along the Beaufort Sea coastline.

Lobdell and Lobdell (2000) described the status of cultural resources in relation to proposed development of the Point Thomson Unit:

> *Given the extensive research that has taken place from early in this century through concentrated impact-related research beginning in the 1980s and intensifying in the 1990s, it is herein recommended that the Point Thomson Unit receive an area or unit clearance. There is no need for conducting additional cultural resources examinations. Unit operations should buffer and remove areas of all known cultural resources from any potential development or exploration activities. Additional protective measures and unit operating personnel education about the importance of the preservation of these historic sites should be included*

in HSE certification and personnel training. The sites may require periodic visitation to insure their integrity and the effectiveness of protective measures.

As Lobdell and Lobdell noted, the nature of the project area's landscape, specifically, the dynamic nature of Point Thomson area shorelines, and the expansive areas of low-lying wet tundra, reduces the archaeological sensitivity of the project area. Impacts to any identified or unidentified cultural resources of the area would be either through destruction and/or disruption of the site during construction activities, or through disruption of the artifacts by unauthorized visitors. Destruction could be defined as the physical obliteration of the site, while disruption could involve removal of the artifacts or other impacts to the integrity of site features or artifact locations. With effective protective measures in place, disruption and/or destruction of known cultural resources due to either winter or summer construction efforts are unlikely.

No surface sites or indications of buried cultural sites are identified within the project footprint. However, the previous citation notwithstanding, the proposed airstrip and mine site have not been systematically surveyed for cultural resources. It would be prudent to do so, particularly since the proposed airstrip footprint is located on a 25 ft (7.6 m) elevation contour, a geomorphological feature that should be examined for archaeological resources prior to construction.

If there are any unknown archaeological sites yet to be discovered, they may be inadvertently impacted through excavation at the proposed gravel mine site(s) or airstrip construction. However, given the environs elsewhere within the project area, direct impact to cultural resource sites is regarded as highly unlikely. The known archaeological sites are limited in area and well known. There should be no direct adverse effect to the physical remains present at these sites since they can easily be avoided. Mitigation measures of avoidance and sensitivity training of personnel would adequately counter any potential impacts during winter and summer construction activities (see Section 6.0 of this ER).

Systematic surveys including subsurface testing for deeply buried cultural resource sites in the Point Thomson area are not likely to produce any archaeological resources but may create unintended impacts to fragile permafrost. With the exception of the proposed airstrip and mine site area, further surveys are unlikely to produce cultural resources because of the reduced archaeological sensitivity of the project area. Similarly, the likelihood of submerged cultural resources being located in the area to be impacted by planned dock construction is a low. No shipwrecks are known from the locale (Tornfelt and Burwell, 1992), and no geomorphological features are present to indicate potential ancient buried sites.

However, should cultural resources be discovered during construction gravel mining activities, airstrip construction, any work that may damage these resources will be halted, and the State Historic Preservation Officer and the North Slope Inupiaq History, Language, and Culture Commission will be contacted. Following consultation, a decision will be made to avoid, protect, or remove the resource, utilizing appropriate scientific excavation, recording, or testing.

Secondary impacts to cultural resources include destruction or damage to cultural resources and the heritage resource record from unauthorized visitation to, increased pedestrian traffic upon, looting of, or contamination of cultural resources sites. Secondary impacts may occur to sites not directly in the path or footprint of a project, but in close enough proximity to be damaged by the aforementioned activities. The impacts could occur either during construction or operations activities. To mitigate any potential secondary impact, all project personnel will receive training on the importance of cultural resources and will be instructed to avoid these sites. The training will include a discussion of the penalties for disruption of any cultural site. The lack of a permanent access road along the pipeline route thereby restricting year-round access to the Point Thomson area will aid in mitigating secondary impacts.

5.4 PRODUCT SPILL RISK ANALYSIS

This section assesses product spills and their relative impact to environmental, cultural and socioeconomic resource areas that could result from development at Point Thomson. Spills, leaks, or blowouts at the Point Thomson facility could consist of mostly gas at the wellheads and gathering lines, and liquid condensate from the sales lines connecting to Badami. In addition, produced water which will be removed from the product stream at the CPF could also be spilled.

Predicting a spill is a matter of probability with uncertainty in the areas of spill volume, extent, location, and quantity as well as environmental conditions (i.e. season, wind, ice, water currents) at the time of a spill. A lack of substantial experimental data regarding the spill behavior of the Point Thomson gas/condensate product under the extreme conditions expected and its effects on the affected environment contribute to this uncertainty.

Assumptions must be made to analyze the effects of oil spills, including estimating information regarding the type of oil, the location, size, and distribution of a spill, the chemistry of the oil, how the oil will weather, how long it will remain, and where it will move. These assumptions are made based on project-specific engineering calculations, modeling results, statistical analyses, and professional judgement. After analyzing the effects of an oil spill, we must take into consideration the chance of an oil spill ever occurring. This section also discusses this probability based on historical oil spill records and prevention and response planning strategies.

An *Oil Discharge Prevention and Contingency Plan* (C-Plan), demonstrating effective oil discharge prevention, control, containment, cleanup, and disposal of a spill of any size, including the greatest possible discharge that could occur, is required by 18 AAC 75.425 (subject to AS46.04.020 and 09.020). In accordance with ADEC requirements, the C-Plan for Point Thomson will address specific conditions that might reasonably be expected to increase the risk of discharge, and actions taken to eliminate or minimize them.

5.4.1 Probability of an Oil Spill

Although much smaller, BP Exploration-Alaska's (BPXA) Badami facility has similar facilities as the proposed Point Thomson development. The history of spills at Badami reveals that most spills are small (in the 1 to 20 gallons [4 to 76 liters] category) and involve hydrocarbons (crude, glycols, motor oil, diesel, hydraulic fluid, etc.). Most spills are caused by leaking valves, failures of automatic shutoffs, and leaks from vehicles.

In its exploration and production history, Badami had three spills that were 55 gallons (gal) (209 liters) or more. These include one 150-gal (570-liter) turbine oil spill within a turbine enclosure, and two crude oil spills of 55 gal (209 liters) and 125 gal (475 liters) that were contained on a snow covered gravel pad.

Large spills, such as those associated with pipelines and well blowouts, tend to be more significant and of greater public concern. Fortunately, the rare occurrence of such spills can be attributed to the operators' implementation of comprehensive spill prevention procedures. ExxonMobil's policy is to prevent spills at the outset, through facility design and personnel training, including proper fuel transfer procedures, secondary containment, pipeline corrosion protection plan, remote or manually operated valves, and pipeline leak detection systems. Additionally, regular ground inspection or over-flights of the pipeline route will be conducted to inspect for potential pipeline spills. If a spill occurs, there are several resources at hand including qualified on-site personnel, the Mutual Aid organization of North Slope operators, and Alaska Clean Seas.

Spill data associated with ANS exploration and production (E&P) activites, including all North Slope oil wells, facilities, crude stabilization, and feeder pipelines (flowlines) available in Atlantic Richfield Corporation BPXA, and ADEC databases from 1977 until 1999 were analyzed as part of the Trans Atlantic Pipeline System (TAPS) Right Of Way renewal ER draft report (2001). This analysis found that there have been no large oil spills (using the typical MMS definition of a large spill as 1,000 barrels [bbl] or more) related to ANS E&P activities on record. The largest spill events associated with E&P activities include leaks on pads, well workover/maintenance spills, and loading/unloading spills at crude oil topping units. Most spills are relatively small; about 84% of crude spills and 92% of product spills are less than 2 bbl. The total volumetric spill rate was calculated at 0.86 bbl per million barrels throughput. Using a projected future (2004-2034) TAPS throughput estimate of 7.02 billion barrels, the total projected volume of E&P crude and product spills on the North Slope averages 202 bbl per year.

In a major pipeline leak, the full volume of the product contained between adjacent automated valves or high points in piping could be released. Theoretical spill volumes from a gas condense pipeline between Point Thomson and Badami have been studied using a 100% flow rate sized failure at the elevated throughput rates of the three-train case. For this worst-case scenario, the largest condensate spill volume from the pipeline is estimated at approximately 3,300 bbl, resulting from a significant rupture at the most critical location that is furthest from known valve locations (i.e. mainline valves only on each side of East Badami Creek and at the midpoint between there and the CPF were assumed). A significant rupture at any other point on the pipeline could result in a spill of 1,500 bbl. These worst-case spill volumes can be reduced as additional valves are considered and optimal valve locations are further examined.

For the Badami Pipeline, the reliable detection limit for a leak was estimated at 24 bbl. The minimum valve closure time is estimated at 20 seconds, with a conservative valve closure time of 30 seconds. Assuming a 75,000 barrels per day flow for 30 seconds provides a release volume estimate of about 26 barrels, for Pt. Thomson pipelines.

The risk of a worst-case spill event, such as that from a well blowout, actually occurring during the proposed activities at Point Thomson is extremely small. Worldwide, the chance of a blowout from development drilling is about one in 400. On the North Slope of Alaska, there is an even smaller chance of well control loss with about one blowout in 560 wells drilled (includes exploration and development drilling) (Mallory 1998). These statistics include "shallow gas" blowouts, which do not involve oil. Based on historical records from the U.S. Offshore Continental Shelf, there is a 95% or greater probability that future blowouts will not contain oil (S.L. Ross 1998). Several reports exemplify these probability calculations.

Mallory (1998) found that of the approximately 3,336 wells that were drilled on Alaska's North Slope between 1974 and 1997, there are six documented cases of secondary well control loss with a drilling rig on the well; two surface blowouts and four subsurface blowouts. No oil spills occurred in any of the events. This suggests a blowout probability of 0.0018 (1.8 blowouts in 1,000 wells drilled) on the North Slope.

S.L. Ross (1998) specifies blowout frequency from various operations: Blowout probability from offshore development drilling is 0.0025, blowouts from land based development drilling is 0.0011, and blowouts from production operations/workovers is 0.000065.

Fairweather (2000) differentiates between a well control incident and a blowout. A blowout was defined as an uncontrolled flow at the surface of liquids and/or gas from the wellbore resulting from human error and/or equipment failure. Fairweather found 10 blowouts, six that Mallory had previously identified and four that occurred prior to 1974. Of the 10 blowouts, nine consisted of gas and one was oil. The blowout of oil occurred in 1950, prior to the availability of blowout preventers (Fairweather 2000). The blowout prevention program and well control plan for the Point Thomson development will be consistent with the programs currently used at other facilities on the North Slope. These detailed procedures will be included in the Point Thomson C-Plan.

Worldwide, the chances of an extremely large (>150,000 bbl) and large (>10,000 bbl) well blowout from development drilling are about 0.0008 and 0.014 respectively. Over a 16-year production period, similar blowouts from production activities and workovers, the chances are 0.0017 and 0.0043 respectively. This is equivalent to one extremely large well blowout for every 9400 years of production and one large well blowout for every 3700 years of production. These predictions are based on worldwide oil well blowout data including blowouts that occurred in Mexico, Africa, and the Middle East, where drilling and production regulations tend to be less rigorous (S.L. Ross 1998). Even lower frequencies are expected for the Point Thomson project given that little oil would be expected to spill during a blowout from this natural gas field. Additionally, because of technology improvements, there have been no development drilling blowout spills larger than 10,000 barrels since 1980.

Despite the low risk, a blowout at Point Thomson is a significant concern to the public due to its proximity to the ANWR. For this reason, the behavior of a response-planning standard sized spill for a well blowout will be analyzed in the C-Plan. Additionally, the behavior and environmental effects of a low probability, large spill are addressed in the following sections.

5.4.2 Behavior of Spilled Oil

The chemical and physical characteristics and toxicity of oil spilled on water or on land undergo a progressive series of changes. Collectively, these processes are referred to as weathering or aging of the oil and, along with the physical oceanography and meteorology, the weathering processes determine the oil's fate. The major oil-weathering processes are spreading, evaporation, dispersion, dissolution, emulsification, microbial degradation, photochemical oxidation and sedimentation to the seafloor (Payne et al., 1987; Boehm, 1987). Weathering rates are usually higher in the first few hours of a spill and are highly dependent on the type of oil spilled. The lighter and more volatile components of the spilled oil are lost most rapidly. Consequently, the Point Thomson condensate product is expected to weather much faster than most crudes, which contain a smaller proportion of light fractions.

5.4.2.1 Characteristics of Point Thomson Condensate

The Point Thomson condensate is the hydrocarbon liquid that condenses from the natural gas stream as the stream is expanded from the high pressure, high temperature reservoir conditions to the lower pressure, cooler conditions in the surface production, gathering and processing facilities. It is a low-density, low-viscosity hydrocarbon liquid at standard conditions (i.e. atmospheric pressure and 60° F) with a tendency to emit hydrocarbon vapors similar to the volatility of kerosene. The export condensate is expected to be a cloudy to light brown liquid that contains a small amount of sediment and water (combined total volume less than 0.35%) and small amounts of other liquid hydrocarbon constituents.

The predicted compositions of the gas stream are in Table 5-5. The predicted chemical and physical properties of the Point Thomson export condensate (i.e. the sales quality condensate that will exist downstream) are listed in Table 5-6. The three-phase product in the gathering pipelines, prior to production and processing, contains gas, condensate (similar in composition to the export condensate) and produced water. As the pressure is dropped in the CPF, additional condensate condenses from the gas phase. The produced water may contain heavy metals, salts, and other constituents as listed in Table 5-7. The concentrations of sodium, chloride, and total dissolved solids (TDS) may exceed Alaska's water quality standards if spilled into the aquatic environment. Therefore, cleanup of any spilled produced water would be performed according to the applicable regulations.

The Point Thomson condensate has physical characteristics that are more similar to refined petroleum products like gasoline and kerosene than the crude oil produced at most other Alaska North Slope assets. Table 5-8 compares typical standard physical characteristics of the condensate with crude oils and other selected refined petroleum products.

Table 5-5 Expected gas stream compositions (Typical Mole Fraction)

CHEMICAL	PRODUCED GAS/CONDENSATE	INJECTED GAS	EXPORT CONDENSATE
Nitrogen, N_2	0.6231	0.650	0.000
Carbon Dioxide, CO_2	4.385	4.490	0.080
Methane, C_1	83.5878	86.940	0.120
Ethane, C_2	4.2057	4.270	0.300
Propane, C_3	1.7229	1.630	0.990
i-Butane, iC_4	0.3578	0.320	0.680
n-Butane, nC_4	0.6254	0.530	1.900
i-Pentane, iC_5	0.2476	0.200	1.510
n-Pentane, nC_5	0.2672	0.200	1.950
C_6	0.4699	0.240	6.810
n-Heptane, C_7	0.4478	0.170	8.040
Octane, C_8	0.474	0.130	9.880
Nonane, C_9	0.3561	0.070	8.040
Dodecane, C_{12}	1.2247	0.100	31.610
Heptadecane, C_{17}	0.6758	0.010	18.620
C_{27}	0.2807	0.000	7.810
C_{42}	0.0409	0.000	1.140
C_{65}	0.0069	0.000	0.190
C_{86}+	0.0007	0.000	0.020
Water, H_2O	0.000	0.050	0.310
Total:	100.000	100.000	100.000

Table 5-6 Export Condensate Physical and Chemical Properties (60 °F)

Vapor/Phase Fraction		0.0000
Molecular Weight		169.0
Molar Density	(lbmole/ft3)	0.3009
Mass Density	(lb/ft3)	50.86
Std Liquid Mass Density	(lb/ft3)	52.83
Molar Heat Capacity	(Btu/lbmole-F)	82.44
Mass Heat Capacity	(Btu/lb-F)	0.4878
Thermal Conductivity	(Btu/hr-ft-F)	0.07329
Viscosity	(cP)	1.400
Surface Tension	(dyne/cm)	19.69
Z Factor		0.6985
Molar Volume	(ft3/lbmole)	3.323
Watson K		11.54
Kinematic Viscosity	(cSt)	1.718
CP/Cv		1.115

Table 5-7 Composition of Produced Water (mg/l).

CHEMICAL	CONCENTRATION (mg/l)
Sodium	23,181
Potassium	230
Calcium	1620
Magnesium	225
Iron	0
Sulfate	0
Chloride	39,000*
Carbonate	0
Bicarbonate	842
Hydroxide	0
TDS	64,671

*Point Thomson sands contain 30,000 to 45,000 mg/l Chloride.

Table 5-8 Comparison of Typical Physical Characteristics of Condensate, Crude Oil, and Selected Refined Petroleum Products.

	SPECIFIC GRAVITY 15 °C	VISCOSITY cs (38 °C)	POUR POINT (°C)
Condensate	0.78 to 0.80	4 to 10	unknown
Crude Oil	0.8 to 0.95	20 to 1,000	-35 to 10
Gasoline	0.65 to 0.75	4 to 10	na
No. 2 Fuel Oil (diesel)	0.85	15	-20
Kerosene	0.8	1.5	na

5.4.2.2 Weathering

The physical properties of a hydrocarbon liquid (hereafter referred to as "oil"), the environment in which it is spilled, and the source and rate of the spill will affect how an oil spill behaves and weathers. The spreading of a slick, as well as the rates and extent of emulsification, evaporation, and biodegradation processes, are intimately related to the physical and chemical properties of the spilled liquid. These properties include specific gravity, surface tension, viscosity, pour point, and changes in these parameters with time. By convention, these properties are measured at a standard temperature and atmospheric pressure. However, the physical properties of an oil will vary depending on local environmental conditions and may deviate considerably from values reported for "standard" conditions.

The following is a general description of the significant physical properties that affect oil spills to provide a comparison between the known behaviors of crude and other oils with the Point Thomson condensate (Fingas et. al., 1979). The fate of a hypothetical worst-case spill, or well blowout scenario, at Point Thomson will be described in detail in the C-Plan.

- *Specific gravity*, or the ratio of the mass of the oil to the mass of an equivalent volume of water, affects its dispersion in water. Since the specific gravity of virtually all oil products is less than 1.0, they will float on water. Generally speaking, the condensate and other oils with low specific gravities, have low viscosities, low adhesion properties, and high emulsification tendencies.
- *Surface tension*, in conjunction with viscosity, affects the rate at which an oil spill spreads over the water or land surface, or into the ground. The lower the surface tension of an oil, the greater its potential spreading rate. Low surface tensions are characteristic of low specific gravity oils such as the predicted condensate at Point Thomson. As temperature decreases, surface tension increases, and consequently the rate of spreading of a slick will decrease.
- *Viscosity* is a measure of the flow resistance of a fluid; the lower the viscosity the easier it flows. Like other physical properties of oils, viscosity is also affected by temperature, such that viscosity is greater at cooler temperatures. The condensate is expected to have low viscosity and the spreading rate on water and penetration into unfrozen soil of a spill from Point Thomson will be similar to that of diesel fuel at low temperatures.
- *Pour point* of oil is the temperature at which it becomes a semi-solid or "plastic" and will not flow. This effect is the result of the formation of an internal microcrystalline structure and overrides the effects of viscosity and surface tension. Although the pour point for Pt. Thomson condensate had not yet been tested, lighter oils with low viscosites, such as the expected condensate, tend to have low pour points. If the pour point is lower than the coldest temperatures expected on the North Slope, the condensate is expected to remain a liquid and rapidly penetrate most unfrozen granular beach substrates and soils. If the pour point is higher than ambient temperatures, the condensate may become a semi-solid consistency and stay on top of the ground when spilled.

In summary, a large portion of the gas/condensate produced at Point Thomson is expected to rapidly volatilize under most conditions. The remaining spilled liquid is expected to have weathering characteristics more like light fuel oils than crude oil when spilled. When compared to crude oil, it is expected to have relatively low specific gravity, low surface tension, low viscosity, and low adhesion. These properties indicate that spilled condensate should volatize faster than crude oil and prior to volatilization, it may spread and emulsify more rapidly on water.

5.4.2.3 Environmental Fate

The Point Thomson project's focus is the recovery of hydrocarbon condensate from a high-pressure retrograde gas reservoir. To provide a better idea of the effects of a large spill (i.e. for a well blowout) of the Point Thomson product, this section describes the environmental fates of the produced gas/condensate's major constituents (Refer to Table 5-5).

Approximately 61% of the produced gas/condensate's mass (90% of the mole fraction) consists of light-end hydrocarbons (C_1 to C_3 and C_6), while about 23.6% of the mass (3% of the mole fraction) consists of the heavy-end hydrocarbons (C_8 and above) with carbon dioxide making up most of the remaining fraction. This section summarizes a risk assessment performed by Zelenka and Steinberg (2001) where exposures to maximum one-hour concentrations of the major constituents provide conservative estimates of acute effects from exposure to them. This analysis assumes there is no snow or ice cover and that methane, ethane, and propane do not persist in the environment and do not exhibit chronic effects on humans, animals, or vegetation.

Light-End Fraction (C_1 to C_3 and C_6)

The largest fraction of the produced gas/condensate's composition consists of methane, ethane, and propane (C_1 to C_3). A conservative risk of benzene was used, where 100% of the C_6 portion of the condensate is considered benzene. Zelenka and Steinberg (2001) provide a summary of relevant physical/chemical properties for methane, ethane, propane, and benzene that are included in Table 5-9.

The environmental fates of these hydrocarbon gases were reported by Zelenka and Steinberg (2001) as fates in atmospheric, terrestrial, and aquatic environments and summarized here. In the ambient atmosphere, all four of these hydrocarbon gases are expected to exist entirely in the vapor phase, based on their calculated vapor pressures at 25 °C (77 °F). Methane, ethane, and propane are not expected to undergo direct photolysis in the atmosphere. And, direct photolysis should not be an important degradation process of benzene. Methane is expected to be unreactive towards ozone molecules. Vapor phase reactions with photochemically produced hydroxyl radicals in the atmosphere have been shown to occur for ethane and propane. Vapor-phase benzene is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals in air, the half life for which is about 13 days at 25 °C (77 °F).

In soils, photolysis or hydrolysis of methane, ethane, and propane is not expected to be important. Biodegredation and, to a lesser extent, adsorption of methane, ethane, and propane may occur in soil, but volatilization is expected to be the dominant fate process. Methane is calculated to have low mobility in soils and its high vapor pressure suggests that this gas may permeate through soil; however, under ambient conditions methane is a gas and therefore is expected to rapidly volatize from surface soils. Ethane and propane are characterized as having medium mobility in soils and should rapidly volatilize from most surface soils. Benzene has high mobility in soil. Significant volatilization of benzene from moist soil surfaces and also potential volatilization from dry soil is predicted. Based on a study in a base-rich para-brownish soil, benzene is expected to biodegrade. However, anaerobic degradation of benzene in soil is not expected to be an important loss process based on various studies (Zelenka and Steinberg 2001).

Table 5-9 Relevant Physical/Chemical Properties for Methane, Ethane, Propane, and Benzene

CHEMICAL NAME	METHANE	ETHANE	PROPANE	BENZENE
CAS RN	74-82-8	74-84-0	74-98-6	71-43-2
Molecular Formula	CH_4	C_2H_6	C_3H_8	C_6H_6
Appearance/State (760mmHg & 25°C)	Odorless, Colorless gas	Odorless, colorless gas	Odorless, Colorless gas	Colorless to light-yellow liquid
Molecular Weight	16.042	30.069	44.096	78.11
Boiling Point (°C)	-161.49	-88.63	-42.07	80.1
Melting Point (°C)	N/A	N/A	N/A	5.5
Flash Point (°C)	-187.78	-135.0	-183.27	-11
Flammability Limits (lower %)	5	3	2.1	1.2
Vapor Pressure (mm Hg)	30,400 @ -80.3°C	31,459 (calc.) @ 25°C	7,162 @ 25°C	94.8 @ 25°C
Vapor Density @ 25°C (Air = 1)	0.55	1.04	1.56	2.77 (@ 20°C)
Water Solubility	Very slight	Insoluble	Slight	Slight
Odor Threshold	303 mg/m^3	185-1106 mg/m^3	1800-36,000 mg/m^3	4.8 - 38.4 mg/m^3
Conversion Factors	1 ppm=0.66 mg/m^3 1 mg/m^3=1.515 ppm	1 ppm=1.23 mg/m^3 1 mg/m^3=0.813 ppm	1 ppm=1.80 mg/m^3 1 mg/m^3=0.555 ppm	1 ppm=3.25mg/m^3 1 mg/m^3=0.31ppm

In aquatic environments, methane, ethane, and propane are not expected to undergo significant photolysis or hydrolysis. Methane and propane are only slightly soluble and ethane is insoluble in water. Methane may permeate through organic matter contained in sediments and suspended materials, while ethane and propane may partition from the water column to these materials. Benzene is not expected to adsorb to sediment and suspended solids in water.

Biodegradation of these hydrocarbon gases may occur in aquatic environments to a limited degree, but volatilization is expected to be more significant. Rapid volatilization from environmental waters is predicted. A volatilization half-life from a model river is estimated to be 1.17 hours for methane, 1.5 hours for ethane, 1.9 hours for propane, and 1 hour for benzene. The half-life from a model environmental pond, which considered the effect of adsorption, was estimated to be about 14 hours for methane, 1.9 days for ethane, 2.3 days for propane, and 3.5 days for benzene. The half-life of benzene in seawater was reported to be about 5 hours.

Heavy-End Fraction (C_8 and above)

The assessment of a blowout at the Point Thomson gas condensate field indicates that octane and higher molecular weight paraffin droplets are likely to settle on the ground before evaporating. Therefore the environmental fate and effects of the heavy-end fraction (C_8 and above) are provided. Table 5-10 summarizes relevant physical/chemical properties for the C_8 to C_{27} hydrocarbons (EPIWIN model, USEPA version 3.04).

In the atmosphere, rapid oxidation (half-life 15.5 hours or less) is expected for paraffins C_8 and above. Based on Log K_{oc} values, moderate adsorption to soil or sediment is expected for C_8 to

C_{12} paraffins and high adsorption to soil or sediment is expected for C_{17} to C_{27} paraffins. Low water solubility is estimated for paraffins C_{12} and above. Based on Henry's Law Constant, rapid volatilization from water is expected for paraffins C_8 and above. In general, the heavy-end hydrocarbons (C_9 to C_{27}) have a low potential for bioconcentration (BCF < 1000), with the exception of octane (C_8), which has high bioconcentration potential.

Table 5-10 Relevant Physical/Chemical Properties for Paraffins $\geq C_8$.

PROPERTY	OCTANE C_8	NONANE C_9	DODECANE C_{12}	C_{17}	C_{27}
Log K_{ow}	5.18*	4.76	6.10*	8.69	13.60
Water Solubility (mg/L @ 25 °C)	1.152	2.329	0.1099	2.938e-4	2.834e-9
Henry's Law Constant (atm-m^3/mole)	3.21*	3.40*	8.24*	38.5	655
Atmospheric Oxidation, Hydroxyl Radicals Half-Life (hours)	15.493	13.236	9.210	6.111	3.653
Half-Life from Model River (hours)	1.091	1.156	1.332	1.582	1.991
Half-Life from Model Lake (hours)	101.5	107.6	124.0	147.3	185.3
Log K_{oc}	2.705	2.971	3.768	5.097	7.756
Bioconcentration Factor	1,944	92.51	314.1	9.876	3.162

*measured value; other values estimated (source EPIWIN model USEPA version 3.04).

Table 5-11 is based on the EQC model (version 1.01 May 1997) which is primarily the work of Mackay et al. (1996). This table shows that C_8 to C_{12} paraffins will partition largely to air. The C_8 to C_{12} paraffin droplets that settle on the ground will evaporate, for the most part. Table 5-10 shows that a C_{16} paraffin will partition predominantly to air and to soil. It is expected that paraffins partitioning to soil will biodegrade over time. Most experiments provide optimistic biodegredation rates (i.e. 83% of C_{13} in 28 days) that were performed at temperatures higher that those anticipated for most of the year at Point Thomson (EBSI 1996). While biodegradation is expected, it will occur at a slower rate.

Although half-lives of 1 to 2 hours are estimated for a river and half-lives of 101 to 147 hours are estimated for a lake (C_8 to C_{17}, Table 5-10), Table 5-11 shows that an insignificant amount of C_8 and above paraffins will enter water. Although octane has a high potential for bioconcentration, Table 5-10 shows that an insignificant amount of octane will partition into water or fish.

Table 5-11 EQC Level I Environmental Partitioning of Paraffins $\geq C_8$.

Compartment	Octane C_8	n-Nonane C_9	Dodecane C_{12}	Iso-Hexadecane C_{16}	n-Hexadecane C_{16}
% Air	99.8	99.2	93.3	68.4	24.5
% Water	0.012	0.015	4.37e-3	3.41e-4	5.26e-4
% Soil	0.0196	0.768	6.569	30.9	73.8
% Sediment	4.35e-3	0.017	0.146	0.687	1.639
% Suspended Sediment	1.36e-4	5.33e-4	4.56e-3	0.021	0.051
% Fish	1.11e-5	4.33e-5	3.71e-4	1.75e-3	4.16e-3

5.4.3 Spill Effects

There is considerable evidence that the nature of biological damage resulting from an oil spill is also directly related to the oil type. The capacity of an oil to smother and dislodge organisms is determined by its physical characteristics, while toxicity is more closely related to its chemical composition. For example, spills of heavy fuel oils and some crude oils may result in damage to intertidal organisms due to smothering or displacement from shoreline surfaces. On the other hand, light fuel oils have a higher proportion of aromatic hydrocarbons than heavy fuel oils and are generally more toxic to aquatic organisms (Fingas et al. 1979). Effects to organisms in a spill situation vary depending on a number of factors including

- time of year (species present),
- oil type (viscosity and composition),
- volume, extent, and location of the spill,
- local weathering conditions,
- sensitivity of species and life history stage present,
- exposure time of organisms,
- success of containment or cleanup, and
- time to detection.

This section describes the potential effects of a Point Thomson produced gas/condensate spill on organisms expected in the development area. Zelenka and Steinberg (2001) provided the information regarding the effects of methane, ethane, propane, and benzene that are summarized in this section. For this hazard assessment, it was assumed that there was no snow or ice cover. Due to the lack of sufficient experimental data regarding the effects of the condensate product on specific local species, the focus of this analysis is on known effects from exposure to the condensate's constituents. The estimated concentrations at which these various effects occur may vary somewhat. Since the light end, hydrocarbon gas fraction (C_1 to C_3 and C_6) do not persist in the environment, they do not exhibit chronic effects on humans, animals, or vegetation. Similarly, C_8 to C_{12} paraffins deposited on the ground will evaporate over time and C_{16} paraffins and above that adsorb to soil are expected to biodegrade over time. For this reason, acute effects are the focus of this discussion. Refer to Section 4 for a description of the potentially affected animal and plant species. Effects upon subsistence are discussed in Section 5.3.

5.4.3.1 Human Health Effects

Methane, ethane, and propane all present a flammable hazard, act as asphyxiates by displacing oxygen in air, and cause Central Nervous System (CNS) depression, or narcosis, at high concentrations. Each of these gases are considered asphyxiates at a concentration of 140,000 parts per million (ppm). Methane is predicted to induce CNS effects at 300,000 ppm, but since it displaces oxygen in air at 140,000 ppm it is considered to be a simple asphyxiant. Ethane and propane are thought to induce narcosis at 130,000 ppm and 47,000 ppm respectively, indicating these gases are fast-acting agents of narcosis, with symptoms of loss of judgment, disorientation, dizziness, and light-headedness. CNS effects are expected to occur in less than 15 minutes (min) following inhalation exposures to these gases. However, this occurs at concentrations above their lower explosive limits (LEL) of 50,000 ppm methane, 30,000 ppm ethane, and 21,200 ppm propane therefore these gases present a low hazard potential overall. Due to the normal physical state of methane, ethane, and propane it is unlikely that humans will experience oral or dermal exposure. However, contact with ethane and propane in compressed liquid from can cause frostbite injury to the skin or eyes (Cavender 1994).

Under the proposed revised Carcinogen Risk Assessment Guidelines, benzene is characterized as a known human carcinogen for all routes of exposure based upon convincing human evidence as well as supporting evidence from animal studies (USEPA 1998). Benzene toxicity is well studied and its effects are highlighted below. However, it should be noted that the benzene concentration in the Point Thomson condensate is highly unlikely to approach the levels assumed for this report.

Inhalation of benzene in concentrations of 300 ppm can be endured for up to an hour, after which it is thought that acute CNS effects including vertigo, drowsiness, headache, and nausea may occur. Exposure to concentrations of 20,000 ppm can be fatal in 5 to 10 min (Gerarde 1960). Unspecified high concentrations can also lead to cardiac arrhythmia and ventricular fibrillation. As a liquid, benzene may be ingested, and its oral toxicity is considered relatively low. It has been estimated that a concentration of 10 milliliters (ml) would be a lethal dose in humans (Thienes and Haley 1972). Although benzene is not thought to have acute dermal toxicity, caution should be considered since dermal contact with benzene could contribute to the total dose received.

Most research on the chronic toxicity of benzene has involved its propensity to cause leukemia in humans. Studies suggest that benzene exposures of 35 to 100 ppm can result in a 4 to 20 fold increase in the risk of leukemia. Benzene may have a unique effect on acute myelogenous leukemia and its variants, rather than all leukemias (EBSI 1996). In contrast, chronic lymphocytic leukemia is a predominant leukemia cell type in the population at large. There is conflicting data regarding the hematologic effects of benzene exposure. However, it appears that benzene exposure does show some effects on cytopenias, especially of white and red blood cells at exposures down to 35 ppm.

5.4.3.2 Effects on Animals

Available data regarding CNS effects from inhalation of methane, ethane, and propane on animals is limited to a study in rats exposed to high concentrations of propane (290,000 ppm) where rats exhibited severe CNS effects including ataxia and loss of righting within 10 min (Clark and Tinston, 1982). Methane and ethane are simple asphyxiants and can cause suffocation by displacement of oxygen from breathing atmosphere below the critical level of 16% oxygen required to maintain life. Ingestion and dermal exposure to methane, ethane, and propane is considered unlikely under normal conditions due to their gaseous states, hence no toxicity data for these exposure routes is readily available. Overall, the potential acute toxicity for these gases is considered low.

Acute exposure of animals to high levels of benzene by all routes produces CNS effects including loss of righting reflex, ataxia, tremors, coma and death. Table 5-12 summarizes the key toxicological effects on animals from inhalation of methane, ethane, propane, and benzene. The oral toxicity of benzene has been studied by (Cornish and Ryan 1965 and Wolf et al. 1956) and it was found that, in rats, the oral LD_{50} to benzene is between 930 to 5,600 milligrams per kilogram (mg/kg) (equivalent to ppm). The dermal LD_{50} (rabbits) to benzene is greater than 2,000 mg/kg (Roudabush et al. 1965).

Chronic effects of long-term exposure to benzene have been studied in rats and mice and found to produce cancer of the hematopoietic system, particularly lymphomas. Additionally, it is thought that significant effects from chronic exposure to benzene in animals includes bone marrow and immunological effects. Genotoxicity of benzene was reviewed and it was determined that, in the absence of metabolic activation, benzene did not produce mutations in most of the standard short-term tests.

Table 5-12 Summary of Acute Toxicity Of Methane, Ethane, Propane, And Benzene in Animals.

HC GAS	EFFECTS				
	CONCENTRATION (ppm)	SPECIES	DEFINITION	TIME OF ONSET	REFERENCE
Methane	870,000	Mouse	Asphyxiation		Hathaway et al., 1991; Low et al., 1987
	900,000	Mouse	Respiratory arrest		
Ethane	150,000-900,000	Dog	Cardiac arrhythmia		Krantz et al.,1948
Propane	LC_{50} = > 800,000	Rat		15 min.	Clark and Tinston, 1982
	100,000-200,000	Monkey	Respiratory depression	15 min.	Aviado, 1975
	24,000-29,000	Guinea pig	Irregular breathing	5 to 120 min.	Low et al., 1987
	47,000-55,000	Guinea pig	Tremors	5 to 120 min.	
	25,000	Dog	Changes in blood pressure		Aviado et al., 1977
	33,000	Dog	Changes is BP, heart stroke rate/volume, pulmonary vascular resistance		
	100,000-200,000	Dog	Cardiac arrhythmia (17% of the time) Multiple ventricular beats (58% of the time)	5 min.	Reinhardt et al., 1971
	EC_{50} = 180,000	Dog	Cardiac arrhythmia to epinephrine	5 min.	Kirwin and Thomas, 1980
	EC_{50} - 100,000	Mouse	Cardiac arrhythmia to epinephrine	5 min.	Aviado, 1975
	EC_{50} = 280,000	Rat	CNS depression	10 min.	Clark and Tinston, 1982
Benzene	LC_{50} = 13,700	Rat		4 hr.	Drew and Fouts, 1974
	LC_{50} = 9,980	Mouse			Lewis, 1996

Limited data is available regarding the environmental toxicity of the individual heavy-end hydrocarbons (C_8 and above), which is summarized in Table 5-12. Some of the toxicity values reported in this table are above the estimated water solubilities of the hydrocarbon. Octane (C_8) is shown to be toxic to aquatic organisms (LC_{50} or EC_{50} ranges from 0.001 to 0.9 milligrams per liter [mg/L] or ppm). However, since an insignificant amount of octane will partition into water (refer to Table 5-11), toxicity effects of octane on fish are considered insignificant.

Nonane had LC_{50} or EC_{50} values of 0.2 mg/L for two species of aquatic invertebrates. No acute toxicity was observed for another aquatic invertebrate (mysid) exposed to nonane. No acute toxicity was observed for three species of aquatic invertebrates exposed to C_{10} to C_{14} paraffins.

An insignificant amount of C_8 paraffins and above is expected to enter water. It is not anticipated that the exposure concentrations and durations that resulted in adverse effects in the laboratory will occur in receiving waters due to advection and dilution. For terrestrial animal exposure, C_8 to C_{12} paraffins deposited on the ground will evaporate over time and C_{16} and above paraffins that absorb into soil are expected to biodegrade over time. Therefore, long-term exposure to these hydrocarbons is not expected.

Table 5-13 Environmental Toxicity of Paraffins ≥ C_8

SPECIES	COMMON NAME	EXPOSURE	ENDPOINT	VALUE	REFERENCE
Daphnia magna	Water flea	48 hours	EC_{50} Immobilization	0.2 mg/L* n-nonane 0.3 to 0.4 mg/L* octane	Adema & Bakker 1987
Chaetogammarus marinus	Amphipod	96 hours	LC_{50} Mortality	0.2 mg/L* n-nonane 0.3 to 0.9 mg/L* octane	Adema & Bakker 1987
Mysidopsis bahia	Mysid	96 hours	LC_{50} Mortality	Acute toxicity > water solubility of n-nonane 0.3 to 0.4 mg/L* octane	Adema & Bakker 1987
Daphnia magna *Chaetogammarus marinus* *Mysidopsis bahia*	Water flea Amphipod Mysid	48 hours 96 hours 96 hours	EC_{50} Immobilization LC_{50} Mortality LC_{50} Mortality	Acute toxicity > water solubility of n-decane, n-dodecane, n-tetradecane	Adema & Bakker 1987
Daucus carota *Helianthus annuus*	Wild carrot Common sunflower	7 hours	Leaf damage indicated by change in conductance, when 2 ml n-nonane, n-dodecane, or n-hexadecane added to 5 g of excised leaves	No effect	Boyles 1976 (study on C9 + only)
Lactuca sativa	Lettuce	14 days	EC_{50} growth	> 1,000 μg/g soil decane	Hulzebos et al. 1993 (study on C9 + only)

Table 5-13 (Cont.) Environmental Toxicity of Paraffins ≥ C_8

SPECIES	COMMON NAME	EXPOSURE	ENDPOINT	VALUE	REFERENCE
Lycopersicon esculentum	Tomato	14 to 42 days	Leaf and bud damage following application of 0.05 to 0.10 M dodecane	No effect	Tucker 1975 (study on C9 + only)
Artemia salina	Brine shrimp	24 hours	LC_{50} mortality	3.5 mmol/m^3 octane	Abernethy et al. 1986 (study on octane only)
Mytilus edulis	Blue mussel	< 1.7 hours	EC_{50} feeding behavior	0.10 to 0.13 mg/L octane	Donkin et al. 1989 (study on octane only)
Skeletonema costatum	Diatom	9 hours	EC_{50} physiology	0.001 mg/L octane	Brooks et al. 1977 (study on octane only)
Crassostrea gigas	Pacific oyster	48 hours	mortality	3,500 mg/L octane	Legore 1974 (study on octane only)
Oncorhynchus kisutch	Coho salmon	96 hours	Mortality	100 mg/L octane	Morrow et al 1975 (study on octane only)
Tetrahymena pyriformis	Ciliate	24 hours	Mortality	3.9 mmol/m^3 octane	Rogerson et al. 1983 (study on octane only)
Squalus acanthias	Spiny dogfish	72 hours	Mortality	10 mg/kg octane	Guarino et al. 1976 (study on octane only)
Avena sativa Brassica rapa	Common oat Bird rape	14 days	EC_{50} Growth	> 1,000 mg/kg octane	Kordel 1984 (study on octane only)
Daucus carota Helianthus annuus	Wild carrot Common sunflower	7 hours	Leaf damage indicated by change in conductance, when 2 ml n-octane added to 5 g of excised leaves	No effect octane	Boyles 1976 (study on octane only)
Lactuca sativa	Lettuce	14 days	EC_{50} growth	> 1,000 µg/g soil octane	Hulzebos et al. 1993 (study on octane only)

*analytical verification

It should be pointed out that the toxicological experiments shown in Tables 5-12 and 5-13 were performed under laboratory conditions on laboratory animals. For this reason, the study results might not be considered applicable to the local species expected in the Point Thomson project area (Refer to Section 4 for a description biological resources). However, the range of species tested and the high exposures required to exert toxic effects on these species provide assurance that significant toxic effects on local species from a condensate spill would be minimal.

5.4.3.3 Effects on Vegetation

Based on available literature, no significant adverse effects due to a release of Point Thomson gas/condensate are expected for terrestrial vegetation unless volumes of material are sufficient to smother plants. The volume of gas/condensate required to smother vegetation has not been studied. Experiments on plant-growth dynamics containing a mixture of methane, ethane, and propane were performed to study the effect on the ultrastructure of the plant photosynthetic apparatus for maize (*Zea mays*) and ryegrass (*Arrhenetherum elarius*). The study concluded that only after high doses or prolonged exposure of the gases, irreversible damage of the plant cell ultrastructure and even plant death may occur and overall, maize and raygrass exhibited high resistance against the action of these substances (Buadze and Kvesitadze 1997). Environmental toxicity of paraffins C_8 and above is summarized in Table 5-13. No adverse effects were observed in five species of plants exposed to octane and four species of plants exposed to C_9 to C_{16} paraffins.

In summary, based on the known properties of the gas/condensate and limited experimental laboratory data available, the Point Thomson gas/condensate is expected to have a low hazard potential overall. This is due to the expected gaseous physical state of methane, ethane, and propane and the predicted rapid volatilization of the heavy-end hydrocarbons. Any liquid light-end fraction or heavy-end paraffins that do not immediately volatilize and are deposited on the ground are expected to evaporate and degrade in a relatively short amount of time, limiting the risk exposure of these components. The light-end hydrocarbons, as a gas, are considered a fire hazard and may cause asphyxia in humans and animals at high concentrations. Benzene is considered to be the component of primary concern and has been shown to have acute toxic effects in humans and animals via all exposure paths. These include CNS effects including vertigo, drowsiness, headache, and nausea as well as chronic effects such as cancer of the hematologic system (lymphoma) caused by long-term exposure.

Lacking sufficient data regarding the effects of natural gas/condensate on Arctic animal and plant species, it cannot be assumed that a large spill of Point Thomson gas/condensate would have the same or fewer effects as the relatively well known consequences caused by a crude oil spill. However, the range of species tested and the high exposures required to exert toxic effects on these species provide assurance that significant toxic effects on local species from a gas/condensate spill would be minimal. Furthermore, the probability of a large oil spill from a gas field such as Point Thomson is extremely low, which provides additional assurance that the hazard potential is low.

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6.0 MITIGATION MEASURES

Mitigation measures are specific controls integrated into the project design and operations. The measures are intended to alleviate potential impacts to the physical, biological or human environment that could occur due to the (project) construction and/or operations. This section describes potential mitigation measures that could be considered in the design of the proposed Point Thomson Gas Cycling Development Project. Potential mitigation measures organized by environmental issues are summarized in Table 6-1. The table also discusses the anticipated effect or benefit of each measure.

Primary construction mitigation measures include:

- Access to site by a local dock and airstrip eliminate construction of an access road from the existing road system (Endicott & Prudhoe Bay Unit) located 40 miles to the west
- Separation of roads and elevated pipelines by sufficient distances to minimize obstruction impacts on wildlife,
- Avoidance of high value wildlife habitats (salt marshes, lagoon, etc.) in siting of structures
- Reuse of existing gravel pads where practicable.

To minimize environmental impact, all construction involving on-tundra activities will take place during winter. These activities include pipeline construction from ice roads and ice pads, access to and development of the gravel mine site, and construction of the pads, airstrip, and in-field access roads. While placement of gravel for the dock is proposed for winter, associated dredging will occur in the summer.

By conducting major construction activities in winter, disturbance to wildlife will be minimized, and impacts to tundra, other than those specifically authorized by permit, will also be minimized. Minor displacement of some breeding birds is anticipated as a result of construction of the pads and roads. Noise and other disturbances associated with the drilling and production operations will occur at the production sites; however, these changes are not expected to influence either breeding success or population dynamics of the species involved (see Troy and Carpenter 1990).

Similarly, caribou may be displaced from some areas of the project site; however, experience from the North Slope oil fields indicates that caribou will use gravel pads and other facilities as insect relief habitat because insect abundance is often lower on gravel pads compared to undisturbed tundra (LGL 1993b and Pollard and Noel 1994).

Measures used for protecting air and water quality, and for managing wastes during construction, will be continued as appropriate through project operation. These measures are also summarized in Table 6-1.

Table 6-1 Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
General	1) Maintain continual on-site environmental presence during construction and operation following ExxonMobil Operation Integrity Management System (OIMS) guidelines 2) Strictly enforce speed limits within project areas; train personnel in interactions with wildlife 3) Establish an environmental/cultural awareness and training program 4) Conduct permit compliance training 5) Conduct periodic health, safety and environmental compliance audits	1) Assure compliance with permit requirements and all applicable federal, state, and local laws 2) Reduce potential for impacts on wildlife, reduce accidents and spill potential on tundra, sea ice, and marine environment 3) Both 1) and 2) above 4) Same as 1) 5) Independent performance assessment
Air Quality	1) a) Design uses natural gas fired turbines as drivers for compressors, and thus minimizes diesel-fired sources b) Reduce emissions of nitrous oxide (NO_x) through Best Available Control Technology (BACT) turbine selection c) Plan construction activities to stagger tasks and minimize concurrent sources d) Implement operational scenarios that minimize concurrent source operation e) Use of BACT (as per New Source Performance Standards) f) Design tanks with pressure/vacuum release devices and vapor recovery g) Water gravel surfaces to reduce dust generation h) Strictly enforce minimal speed limits 2) a) Minimize plume overlap by avoiding alignment of significant sources of NO_x in a NE/SW direction b) Where diesel fuel is necessary, use low sulfur grade where available c) Orient all equipment stacks vertically with no obstructions such as rain caps d) Design stacks 20 feet (6m) above rooftop and taller than tallest structure (may be incompatible with visual impacts mitigation). e) Utilize a halon-free fire suppression system	1) Reduce the volume of air emissions 2) Reduce the impact of air emissions

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Water Quality	1) a) Conduct gravel mining and construction during winter b) Locate pads, roads, and airstrip to minimize blockage of natural surface water drainage c) Locate gravel mine to minimize impacts to freshwater resources d) Use culverts and berm breaks to restore natural surface water drainage e) Limit water removal under ice in fish bearing water sources so as not to exacerbate low dissolved oxygen levels in winter	1) Minimize impacts due to construction/presence of facilities
	2) a) Eliminate operational discharges to the greatest extent possible by using injection wells as the primary disposal route b) Design facilities to minimize and control stormwater/snowmelt surface drainage c) Design and construct a wastewater treatment system for wastewater discharge should primary injection become unavailable d) Develop and implement treatment, and best management practices for all wastewater streams and stormwater discharges e) Manage snow removal	2) Minimize impacts due to permitted discharges
	3) a) Conduct continual-improvement employee training in proper refueling methods and use of authorized locations following ExxonMobil OIMS b) Provide proper storage locations for fuels and other fluids designed with appropriate secondary containment systems c) Limit refueling tasks to pre-defined locations that have appropriate secondary containment systems	3) Minimize impacts of spills and leaks

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Tundra/Wetlands	1) a) Minimize gravel pad footprints to meet operational needs b) Utilize Extended Reach Drilling directional drilling techniques (up to 20,000 ft [6,000 m]) c) Minimize infrastructure and infield road distances by selecting direct routes while minimizing encroachment to salt marsh d) Relocating East Well Pad to less optimal position to avoid impacts to salt march on point which would have been farther north e) Minimize infield access road crown width; use 2:1 slope f) Reuse Point Thomson #3 pad g) Do not build a gravel road connecting Point Thomson to oil fields located to the west h) Use ice roads for construction and seasonal access i) Reuse gravel from existing pads where possible	1) Reduce acres of tundra physically covered by gravel
	2) a) Conduct major construction efforts in winter for infield roads, pads, pipeline and airstrip b) Use of ice roads for seasonal access c) Based on hydrological studies, optimize siting of gravel mine, roads, stream crossings, and minor drainages to reduce alterations in surface water drainage patterns d) Design facilities to minimize impacts to drainage and permafrost e) Identify potential culvert requirements for infield roads to reduce alterations to surface water drainage patterns f) Prevent icing/blockage of culverts manual removal of ice when required; inspect to assure proper flow is occurring g) Utilize dust control measures such as applying water to roads and enforcing speed limits h) Institute and enforce environmental sensitivity training for construction and operations personnel i) Design emergency response and containment procedures in case of a spill j) Rehabilitate and re-seed any impacted areas and monitor restoration	2) Reduce tundra disturbance

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Fish and Fish Habitat (including anadromous, marine, and freshwater)	1) a) Do not use streams for water source in winter b) Limit work in streams in known spawning areas and prevent work during fish spawning runs, if any. c) Winter construction for gravel mining, infield roads, pads, pipeline, airstrip, and dock d) Prevent obstructions to fish migration due to roads e) Limit winter water withdrawal in fish bearing water sources, if any in area, to 15% of available water under ice.	1) Minimize direct impact/mortality of fish
	2) a) Based on hydrological studies, optimize siting of gravel mine, roads, and river crossings to reduce alterations to surface water drainage patterns b) Minimize stream crossings and construction activities in streams. c) Utilize arch or box culverts or bridges in larger streams d) Limit winter water withdrawal in any fish bearing water sources to 15% of available water under ice. e) Do not use streams for water source in winter f) Mine gravel for roads and pads during winter only and according to approved mining plan g) Conduct major construction efforts in winter for infield roads, pads, pipeline, airstrip and dock h) Do not cut stream banks for access, use ice or snow ramps i) Use appropriate means to stabilize banks j) Review and summarize existing data on nearshore oceanographic and hydrographic conditions and potential alterations due to construction of a dock in Lion's Lagoon (See Section 4.2 of this Environmental Report) k) Assure normal ice breakup by removing blockages in culverts and breaching ice roads as needed. l) Institute and enforce environmental sensitivity training for construction and operations personnel m) Only cross streams (tundra travel) where solidly frozen.	2) Maintain optimal fish habitat

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Wildlife and Habitat	1) Caribou and Muskoxen a) Use 5 ft (1.5m) high pipelines b) Design infield road and pipeline with a 500 ft (152.4m) separation c) Conduct major construction efforts in winter for infield roads, pads, pipeline and airstrip d) Route helicopters to minimize wildlife disturbance -- consultation with United States Fish and Wildlife Services (USFWS) e) Institute and enforce environmental sensitivity training for construction and operations personnel f) Strictly enforce speed limits within project area g) Institute a no hunting policy for site workers h) Prepare wildlife interaction plan	1) Minimize disturbance to migrating caribou and musk oxen
	2) Birds a) Where practicable, locate and avoid flyways, molting, and nesting areas. b) Review historical data and conduct baseline studies of use within the project area to optimize project siting and design c) Properly manage wastes and garbage d) Prohibit feeding by personnel e) Strictly enforce speed limits within project area f) Proper siting of culverts to minimize creation of temporary impoundments g) Limit water removal from freshwater lakes h) Limit aircraft to specific routes i) Prepare wildlife interaction plan	2) Minimize impacts to tundra nesting, waterfowl and predatory birds
	3) Other mammals including grizzly bear and fox a) Properly manage wastes b) Prohibit feeding by personnel c) Institute and enforce environmental sensitivity training for construction and operations personnel d) Strictly enforce speed limits within project area e) Use bear-proof dumpsters	3) Minimize impacts to these mammals

Table 6-1 (Cont.) Potential Mitigation Measures

Issue/Resource	Potential Mitigation Measure	Effect
Marine Mammals	1) Cetaceans a) Minimize construction noise especially during whale migration periods by using and maintaining high quality mufflers and sound proofing where available b) During fall and spring migration route vessel traffic inside the barrier islands and limit helicopter flights to overland routes to minimize disturbance to migrating whales c) Institute and enforce environmental resource sensitivity training for construction and operations personnel 2) Pinnipeds a) Minimize construction noise during all seasons by using and maintaining high quality mufflers and sound proofing where available b) Minimize offshore impacts by using the shortest possible dock, minimize barge trips by carrying full loads as much as possible c) Institute and enforce environmental resource sensitivity training for construction and operations personnel d) Avoid haul-out areas should any be identified in the transportation corridor e) Limit helicopter to overland flight routes f) Build sea-ice road on grounded ice (not seal habitat) g) Begin sea-ice road construction as early as possible 3) Polar Bears a) Develop and implement polar bear interaction plan b) Partner with USFWS in yearly polar bear surveys and studies c) Conduct major construction efforts in winter for infield roads, pads, pipeline and airstrip d) Utilize facility design that minimizes polar bear and human interactions e) Locate and avoid historic polar bear denning areas f) Avoid dens by 1 mile g) Use forward-looking infrared (FLIR) technology to locate densities along ice road routes h) Ensure appropriate set back from denning areas i) Report any den encountered j) Manage wastes to avoid attracting polar bears k) Institute and enforce environmental sensitivity training for construction and operations personnel l) Prepare polar bear interaction plan m) Use bear-proof dumpsters	1) Minimize disturbance to migrating whales 2) Minimize disturbance to pinnipeds, both long and short term residents in Lions lagoon 3) Minimize disturbance to denning polar bears in the project area.

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Threatened and Endangered Species	1) Spectacled and Steller's Eiders a) Coordinate with USFWS on Spectacled eider surveys b) Conduct major construction efforts in winter for infield roads, pads, pipeline and airstrip c) Institute and enforce environmental resource sensitivity training for construction and operations personnel 2) Bowhead whales a) Conduct major construction efforts in winter for the nearshore dock b) Minimize offshore impacts by using the shortest possible dock and efficient transportation methods c) During fall and spring migration route vessel traffic inside the barrier islands and limit helicopter flights to overland routes to minimize disturbance to migrating whales d) Institute and enforce environmental resource sensitivity training for construction and operations personnel	1) Protect these endangered/threatened species 2) (Same as 1)
Subsistence	1) a) Identify subsistence use and areas potentially affected by the project b) Conduct major construction efforts in winter for infield roads, pads, pipeline, and airstrip c) Prohibit hunting by construction and operations. Only allow fishing with required State license and following State regulations d) Route vessel traffic inside the barrier islands to minimize disturbance to subsistence activities. e) Institute and enforce subsistence resource sensitivity training for construction and operations personnel f) Obtain and respond to community input g) Coordinate offshore activities such as barge traffic with subsistence communities h) Develop conflict avoidance agreement for marine mammals, if needed	1) Minimize disturbance to subsistence resources and activities

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Cultural Resources	1) Archeological Sites a) Locate and avoid archeological sites b) Obtain and incorporate local information about important historical sites c) Maintain confidentiality of site locations d) Institute and enforce cultural resource sensitivity training for construction and operations personnel	1) Protect cultural resources in the Point Thomson area
Cultural Values	1) a) Obtain and respond to community input 2) a) Minimize visual impacts such as lights and structural profile b) Facility design to include no permanent road connecting project to state road system and other facilities and therefore no direct connection to other communities c) Institute and enforce cultural resource sensitivity training for construction and operations personnel d) Use local resources for construction and development labor	1) Ensure community input to project design and operations 2) Minimize impacts to local culture or ensure that impacts will be positive

Table 6-1 (Cont.) Potential Mitigation Measures

ISSUE/RESOURCE	POTENTIAL MITIGATION MEASURE	EFFECT
Spill Prevention	1) a) Design facility for zero discharge of drilling wastes b) Utilize corrosion resistant alloy for gathering lines c) Provide leak detection, monitoring and operating procedures for the gathering and sales lines. d) Use on-site fuel gas for power when it becomes available. Note: diesel will always be available for backup 2) a) Ensure adequate spill response equipment and personnel are available to respond b) Build spill controlling berm strategies into pad c) Locate pipeline route south of infield road so that road provides containment in case of a leak d) During construction, locate fuel storage and transfer locations away from river crossings and wetlands e) Use secondary containment at all fuel storage locations f) Train personnel in acceptable refueling procedures and allowed locations for refueling g) Use drip pans and liners during refueling and vehicle maintenance procedures	1) Reduce risk of spills/leaks 2) Reduce effect of spills; improve ability to respond/clean up spills
Recreational and Visual Effects	1) a) Utilize fuel gas for generator fuel, , energy efficiency , and emission controls b) Reduce indirect lighting as much as possible c) Reduce structural profile where practical. Highest structure is the microwave tower at approximately 300 feet. d) Use natural color schemes that blend with environment	1) Minimize emissions and visibility impacts

7.0 CUMULATIVE EFFECTS

A cumulative effect analysis is a requirement of the National Environmental Policy Act (NEPA). The Council on Environmental Quality (CEQ) regulations for implementing NEPA define cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

7.1 CUMULATIVE EFFECTS ANALYSIS OBJECTIVES

This Environmental Report (ER) is a pre-NEPA tool, following CEQ guidelines, with an objective of providing information to assist in determining the magnitude and significance of cumulative effects at a later date.

7.2 CUMULATIVE EFFECTS APPROACH

A well-designed cumulative effect analysis uses a procedure that is logical and reproducible. The cumulative effects procedure in this ER:

- Defines a spatial and temporal framework;
- Describes the potential direct and indirect effects of the Point Thomson Gas Cycling Project;
- Identifies external actions (e.g., human controlled activities and natural phenomena) that could have additive or synergistic effects;
- Uses a matrix process to screen effects that are potentially cumulative in nature;
- Identifies potential cumulative effects using criteria appropriate to the resource category in question; and
- Discusses the reasoning and assumptions used during the analyses.

The CEQ guidelines set forth 11 steps for analyzing cumulative effects that can be classified into four basic stages: scoping, organizing, screening, and evaluating (CEQ 1997). Table 7-1 summarizes how the Point Thomson Gas Cycling Project cumulative effects analysis was adapted to parallel the CEQ guidelines. The four stages are discussed below.

7.2.1 Scoping

Potential direct and indirect effects of the proposed project activities were identified using the project description (Section 3 of this ER) and affected environment information (Section 4 of this ER), Environmental Impact Statements (EIS) from other oil and gas projects, North Slope resource studies, and peer reviewed literature.

Two spatial or geographic areas were used in the cumulative effect analysis (Figure 7-1). The first is defined as a spatial area of interest from the Colville River east along the coastal plain to Kaktovik, from the coastal plain south to the Brooks Range, and seaward of the barrier islands to the north. This spatial area was used for the following resource categories:

- Fish
- Cetaceans (whales)
- Caribou (area modified, western boundary moved east to the Sagavanirktok River)
- Subsistence Issues
- Socioeconomic Issues (includes some North Slope Borough and statewide effects)

Table 7-1 Point Thomson Gas Cycling Project Cumulative Effects Analysis

RECOMMENDATIONS FROM CEQ (1997)	APPROACH USED IN POINT THOMSON ANALYSIS
A. Scoping: Identify Issues, Actions, and Boundaries	
1. Identify the significant cumulative effects issues associated with the proposed action [and alternatives], and define the assessment goals.	1. Review information provided in Sections 3.0 and 4.0 of the ER. Summarize predicted direct and indirect effects of the Point Thomson Gas Cycling.
2. Establish the geographic scope for the analysis.	2. Geographic scopes are defined in Section 7.2.1 of the ER.
3. Establish the time frame for the analysis.	3. The time frame is established as 1980 through 2020.
4. Identify other actions affecting the resources, ecosystems, and human communities of concern.	4. Review environmental impact statements, reports, resource studies, and peer-reviewed literature. Confer with expert contributors to the ER to identify other actions and issues of concern.
B. Organizing: Characterize and Consolidate Issues	
5. Characterize the resources, ecosystems, and human communities identified during scoping in terms of their response to change and capacity to withstand stresses.	5. Identify and characterize potentially affected resources and delineate the component parts/species of each resource category (organized into resource categories in Section 4 of the ER).
6. Characterize the stresses affecting the resources, ecosystems, and human communities and their relation to regulatory thresholds.	6. Evaluate all of the potential direct and indirect effects of the Point Thomson project on the specified resource categories (Section 5 of the ER).
7. Define a baseline condition for the resources, ecosystems, and human communities.	7. The baseline condition is defined as current Y2001 conditions.
C. Screening: Identify Potential Cumulative Effects	
8. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities.	8. Screening and matrix analyses for identified resource categories.
D. Evaluating: Rank by Magnitude and Probability	
9. Determine the magnitude and significance of cumulative effects.	9. A qualitative determination of identified cumulative effects was conducted.
10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.	10. The Point Thomson project could incorporate appropriate additional mitigation measures following NEPA review.
11. Monitor the cumulative effects of the selected alternative and adaptive management.	11. Monitoring and adaptive management would be conducted as needed.

The second spatial area of interest is from the Badami Facility east to the Canning River, north to the barrier islands, and to the southern boundary of the Point Thomson Unit. This spatial area was used for the following resource categories:

- Physical and Chemical Resources
- Marine Benthos
- Vegetation and Wetlands
- Birds
- Pinnipeds (seals)
- Polar Bears
- Moose, Grizzly Bear, Muskoxen, and Arctic Fox
- Threatened & Endangered Species
- Cultural Resources

The temporal timeframe for the cumulative effect analysis is established as 1980 through 2020. This timeframe allows for the incorporation of potential effects from previous exploratory oil and gas activities in the Point Thomson Unit and reasonably foreseeable future oil and gas development in the Point Thomson, Sourdough, Badami, and Slugger Units.

Potential external actions were identified using EISs from other oil and gas projects, North Slope environmental assessments, North Slope resource studies, and peer-reviewed literature. Expert contributors to this ER also assisted in identifying potential external actions. Potential external actions for physical, chemical, biological, cultural, and socioeconomic resources were identified. The external actions were placed into past, present, and reasonably foreseeable categories.

7.2.2 Organizing

Potentially affected resources were identified and characterized in Section 4 of this ER. Resource categories were defined and component parts of each resource category were described. For example, under the biological resources, fish were identified as a resource category with the component parts being freshwater, diadromous, and marine fish species. Potential direct and indirect effects of the proposed project on identified resources were evaluated in Section 5 of this ER. The baseline condition for the cumulative effect analyses was defined as the current (2001) physical/chemical, population, and socioeconomic conditions in the defined geographic areas and current (2001) subsistence use areas.

7.2.3 Screening

The screening process for the cumulative effect analyses consists of the following steps.

- Using Section 5 analyses, bring forward project actions with the potential to affect a given resource.
- Identify potential effects on a given resource from past external actions remain. Determine if there are lingering effects on the resource.

- Identify potential effects on a given resource from present and reasonably foreseeable actions.
- Analyze collectively project actions, lingering effects from past actions, and present and reasonably foreseeable actions to determine if a cumulative effect exists.
- Use matrices as the organizational structure in the cumulative effect analyses. The matrices provide a visual representation of the analytic process and help assure that the analysis is methodical.

7.2.4 Evaluating

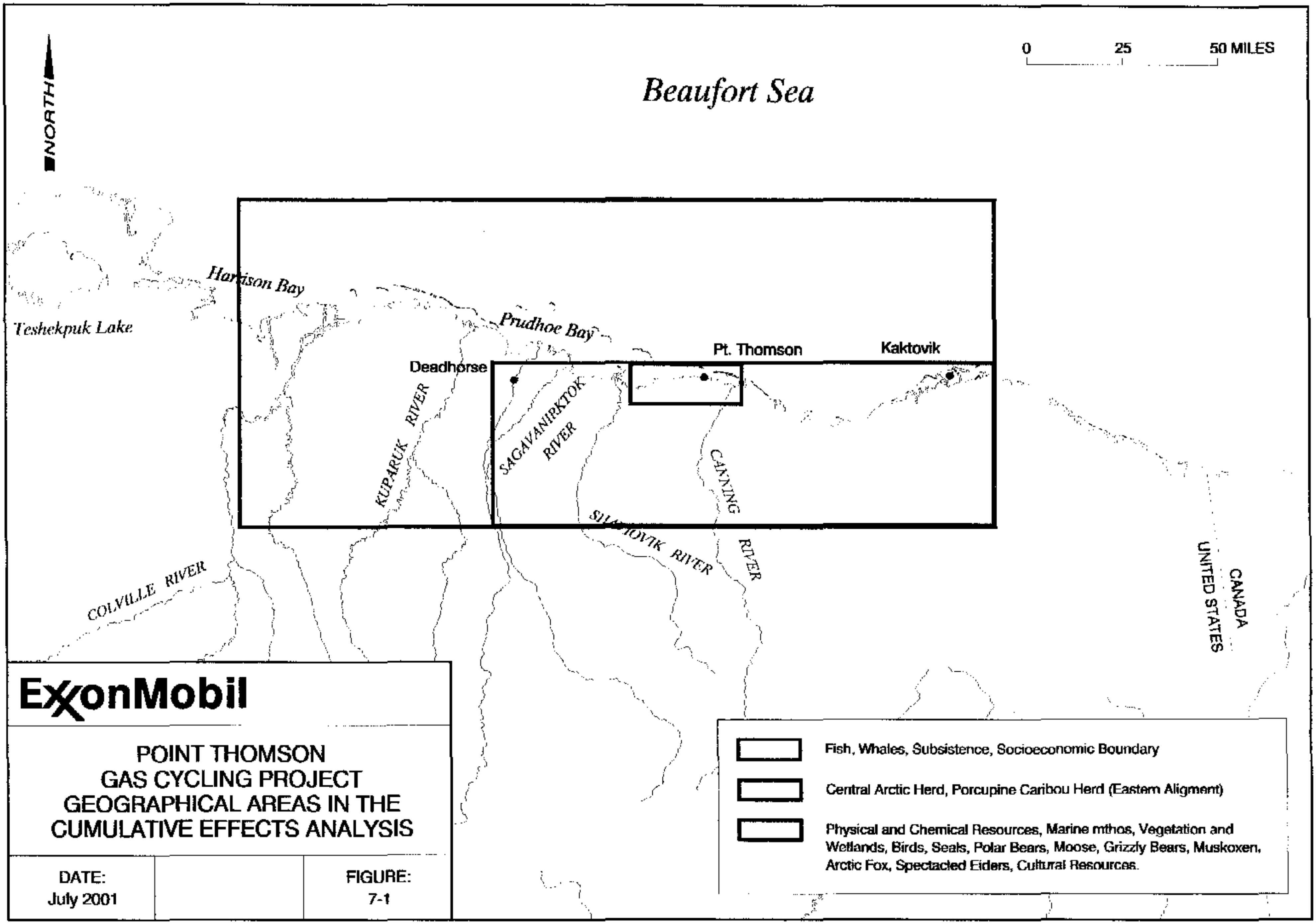
Physical/chemical resources were evaluated to determine if potential project and external effects would be long-term despite mitigation. For biological resources, the evaluation considered whether population level effects would occur. For socioeconomic characteristics, the evaluation criteria varied by resource as follows:

- Population and employment: potentials for a moderate increase in regional and state levels.
- Contribution to Borough and State revenues: particularly as they offset currently decreasing levels from order facilities.
- Potential effects on subsistence resources, disruption of harvest activities, and decreases in harvest levels: particularly with regard to culturally important species such as the bowhead whale.
- Major changes in land use and potential for creating land use conflicts.
- Transportation facilities and traffic levels: demands on facility capacity and changes in traffic levels.
- Recreation: level of recreational use and quality of recreation experience.
- Potential visual and noise effects from project activities and facilities were evaluated from the perspective of visitors and residents.

For all resource categories potential project effects were identified and qualitatively rate as follows:

- NS – not significant, assigned when it was determined that potential effects would not exceed evaluation criteria for a given resource.
- S – significant, assigned when it was determined that potential effects would exceed evaluation criteria for a given resource.

Lingering influences from past actions, and from present and reasonably foreseeable external actions were identified, but not rated for significance. Cumulative effects were identified and the likelihood that a cumulative effect could have significant impact on the resource was rated as low or high.



NORTH
0
25
50 MILES
Beaufort Sea
Harrison Bay
Teshekpuk Lake
Prudhoe Bay
Deadhorse
Pt. Thomson
Kaktovik
KUPARUK RIVER
SAGAVANIRKTOK RIVER
CANNING RIVER
COLVILLE RIVER
UNITED STATES
CANADA
Fish, Whales, Subsistence, Socioeconomic Boundary
Central Arctic Herd, Porcupine Caribou Herd (Eastern Aligment)
Physical and Chemical Resources, Marine mthos, Vegetation and Wetlands, Birds, Seals, Polar Bears, Moose, Grizzly Bears, Muskoxen, Arctic Fox, Spectacled Eiders, Cultural Resources.
ExxonMobil
POINT THOMSON
GAS CYCLING PROJECT
GEOGRAPHICAL AREAS IN THE
CUMULATIVE EFFECTS ANALYSIS
DATE:
July 2001
FIGURE:
7-1

fig7_1.dgn

7.3 CUMULATIVE EFFECTS ANALYSES

As discussed in Section 7.0, a cumulative effect analysis takes into account the impact of the proposed action when added to other past, present, and reasonably foreseeable future actions external actions. It should be noted that development of the Point Thomson Gas Cycling Project could facilitate the development of other oil and gas resources in the immediate area, including several Brookian formation accumulations (i.e., Sourdough, Slugger, Flaxman). These accumulations are in the same Brookian formation from which Badami produces, and are believed to underlie portions of both the Point Thomson and Slugger Units. Construction of the Point Thomson dock, airstrip, and export pipeline could be used to support future development of these Brookian prospects and improve their development feasibility by reducing costs through shared facilities. For the purpose of this analysis, it is assumed that the proposed location of the Point Thomson dock, airstrip, and export pipeline are suitable to provide support to development in the Point Thomson Unit area.

Potential external actions identified during the cumulative effects scoping process are presented in Table 7-2. The external actions in Table 7-2 are first categorized by type, either "Human Controlled External Actions" or "Natural Events," and then as occurring in the past, present, or reasonably foreseeable future. A brief description of the external actions presented in Table 7-2 is as follows:

<u>Human Controlled Actions</u>

- <u>Oil and Gas Exploration and Development</u>: Includes past exploratory and Badami development, Badami operations, and reasonably foreseeable future exploration and development. Reasonably foreseeable includes exploration and/or development for which technical work is currently in progress or where Point Thomson Gas Cycling development might improve development feasibility. These foreseeable future projects are not part of the proposed action and would require authorization under a separate local, state, and federal permit process.
- <u>Scientific Research and Surveys</u>: past, present, and future oceanographic and biological and cultural survey work conducted within the geographic scope of the analysis having the potential to impact identified biological resources.
- <u>Industrial Pollutants</u>: past, present, and future global industrial air pollutants (including North Slope) and global industrial pollutants with the potential to affect North Slope resources.
- <u>Subsistence Activities</u>: past, present, and future potential impacts to identified resources.
- <u>Borough and State Tax and Royalty Revenues Generated by the Petroleum Industry</u>: Past, present, and future potential North Slope Borough (NSB) and State of Alaska tax and royalty revenues generated by petroleum industry projects
- <u>Commercial Fishing</u>: past, present, and future potential impacts to identified resources.
- <u>Tourism and Recreation</u>: past, present, and future potential impacts to identified resources.
- <u>Military</u>: past, present, and future potential impacts from the Bullen Point Distant Early Warning (DEW) Line Station.

Natural Events

- Disease: present and future viral infections affecting long-tailed ducks.
- Weather/Seasonal: past, present, and future ice scour; increased turbidity due to breakup, storms, and wave actions; and foggy weather.

Table 7-2. Potential External Actions

POTENTIAL EXTERNAL ACTIONS	PAST	PRESENT	REASONABLY FORESEEABLE
Human Controlled External Actions			
Oil and Gas Exploration and Development	• West Dock Causeway • Endicott Causeway • Endicott Onshore Road • Badami • Exploratory drilling pads • Seismic exploration	• West Dock Causeway • Endicott Causeway • Endicott Onshore Road • Badami • Flaxman Island Remediation	• Far West Pad • Sourdough • Slugger • Gas Sales Point Thomson • Seismic Exploration
Scientific Research and Surveys	• Oceanographic • Biological	• Oceanographic • Biological	• Oceanographic • Biological
Global Industrial Pollutants	• Bioaccumulation • Air Quality	• Bioaccumulation • Air Quality	• Bioaccumulation • Air Quality
Subsistence Activities	• Hunting • Trapping • Fishing • Whaling • Sealing • Traveling	• Hunting • Trapping • Fishing • Whaling • Sealing • Traveling	• Hunting • Trapping • Fishing • Whaling • Sealing • Traveling
Sport Hunting and Fishing	• Brooks Range • Kaktovik • ANWR	• Brooks Range • Kaktovik • ANWR	• Brooks Range • Kaktovik • ANWR
Commercial Fishing	• Colville River • Whaling	• Colville River	• Colville River
Tourism and Recreation	• Flight Seeing • Floating the Canning River • Arctic National Wildlife Refuge (ANWR)	• Flight Seeing • Floating the Canning River • ANWR	• Flight Seeing • Floating the Canning River • ANWR
Military	• Distant Early Warning Line Station	• None	• None
Tax Revenues Generated by the Petroleum Industry	• North Slope Borough (NSB) • State	• NSB • State	• NSB • State
Natural Events			
Disease	• None documented	• Viral infection in long-tailed ducks	• Viral infection in long-tailed ducks
Weather/Seasonal	• ice scour • increased turbidity due to breakup, storms, and wave actions foggy weather	• ice scour • increased turbidity due to breakup, storms, and wave actions foggy weather	• ice scour • increased turbidity due to breakup, storms, and wave actions foggy weather

Table 7-3 is an example of a cumulative effect matrix for a biological resource (bimos). Proceeding from left to right across the table, the screening procedure is as follows.

- Columns ❶ and ❷. This information is based on the discussions presented in Section 5 of the ER.
- Column ❸ asks if there is any lingering effect from a past external influence. This information is based on the results of the past external action screening (see Section 7.2.3).
- Columns ❹, "Human Controlled, and ❺, "Natural Events", are combined under the present and potential future external effects heading. In these columns, each external effect is screens to determine if it has a potential contribution to the project actions listed.
- Column ❻ asks if there is a cumulative effect. The determination of a cumulative effect result from identifying an additive or synergistic effect between a project impact (in this case, the Point Thomson Gas Cycling Project) and one or several external actions (in this case, actions associated with external human controlled activities and/or natural events).
- Column ❼ rates the likelihood that an identified cumulative effect could be significant.
- Column ❽ presents the assumptions and rationale used when rating the potential likelihood of a given cumulative effect in Column ❼.

The following sub-sections present the results of the cumulative effects analyses for each of the ER resource categories. Tables within each sub-section summarize the results of the cumulative effect analyses.

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Table 7-3 Example Cumulative Effect Analysis Matrix

❶ POTENTIAL IMPACT	❷ Potential Project Effects?	❸ Lingering Influence From Past External Action?	PRESENT and POTENTIAL FUTURE EXTERNAL ACTIONS										❻ Cumulative Effect?	❼ Likelihood That CE Could Be Significant	❽ Assumptions/Rationale
			❹ Human Controlled								❺ Natural Events				
			Badami[3]	Far West Pad	Flaxman Island Rem.	Sourdough Dev.	Slugger Dev.	Gas Sales PTU[4]	Global Pollution	Scientific Research & Surveys	Foggy Conditions	Disease			
HABITAT LOSS AND ALTERATION	Y(NS)[1]	N[3]	Y	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	Y	LOW	• Pt. Thomson project has minimal contribution to CE • Nesting habitat not limiting • Any new developments will minimize footprint and mitigate impacts to birds
DISTURBANCE	Y(NS)[2]	N	Y	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	Y	LOW	• Pt. Thomson project has minimal contribution to CE • Any new developments will minimize and mitigate impacts to birds • Disturbance severe enough to create population level effects is not expected
MORTALITY	Y(NS)	N	Y	Y	Y	Y	Y	Y	Y[5]	Y	Y[6]	Y[7]	Y	LOW	• Mortality from Pt. Thomson project and other oil/gas development activities expected to have minimal contribution • Mortality from subsistence hunting and scientific surveys is controlled to minimize population level impacts • Disease not expected to have population level impacts in non-threatened species.

NOTES:
Y = Yes
N = No
NS = Not significant
N/A = Not applicable
Dev. = Development
Rem. - Remediation
CE = Cumulative Effect

Footnotes:
[1] Onshore nesting habitat not limited.
[2] Short-term impacts could occur due to construction noise; however, noise would be greatest during winter construction when most birds are not present.
[3] Potential effects if existing Badami facilities are expanded.
[4] If larger pads/roads are needed for gas sales equipment.
[5] Documentation of contaminants in Alaskan birds is poor; however contaminants could adversely affect bird populations.
[6] Foggy conditions contribute to incidence of bird strikes.
[7] Long-tailed ducks in waters found off of Flaxman Island suspected to have succumbed to a virus (ADN, June 27, 2001).

7.3.1 Physical/Chemical Resources

The cumulative impact analysis for physical and chemical resources of the Point Thomson area is summarized on Table 7-4 and described in the following sections.

7.3.1.1 Internal Project Effects

The physical and chemical resources of the Point Thomson area include air, freshwater, and marine water quality, marine circulation, surface hydrology, and permafrost/soils. As described in Section 5.1, project actions such as the placement and/or removal of gravel, emissions, discharges, and spills of materials to the environment, the removal of water from area lakes, and offshore dredging operations have the potential to impact these resources.

Air Quality

As described in Section 5.1, effects on local air quality will occur during project construction and operations. The project will produce emissions from vehicles, aircraft, machinery, generators, and compressors. Impacts may also include effects of minimal generation of dust during gravel mining and placement. Dust will also be generated by vehicles using gravel roads.

While air quality impacts will occur, construction and operations emissions will be regulated and monitored. In addition, long-term impacts due to dust generated during construction and operations are not anticipated (see Section 5.1.1.1 and 5.1.1.2). There fore, it is expected that the Point Thomson project will not significantly degrade air quality in region. This conclusion is depicted as Y (NS) [Yes, Not Significant] on Table 7-4.

Surface Hydrology

Impacts to drainage patterns and surface hydrology can occur when placement of gravel for roads, pads, or the airstrip diverts, impedes, or obstructs flow in stream channels or wetlands (see Section 5.1.2). As described in Section 5.1.2.1, impacts can be minimized with the proper siting of roads, pads, and the airstrip. In addition, the use of culverts and berm breaks can further minimize any blockage effects.

Surface hydrology can also be impacted by water removal for ice road construction and project operations (see Section 5.1.2.3). Impacts can be temporary if recharge is sufficient or longer term if areas are drained. Therefore, lakes used for this purpose will be carefully chosen and removal volumes in fish-bearing waters will likely be limited by permit. Melting ice roads during breakup could cause obstructions to typical water flow patterns or provide additional water in normally drier areas.

Therefore, while impacts can occur due to project actions, proper mitigation will decrease their significance. Table 7-4 indicates a Y (NS) under potential project effects related to surface hydrology changes.

Freshwater Quality

Water quality impacts to freshwater lakes and streams can occur due to obstruction of flow (see Section 5.1.2.1), and discharges and spills, water removal, and gravel removal (see Section 5.1.2.2 through 5.1.2.4). It is likely that direct project impacts such as increased turbidity during construction and discharges of wastewater during project operations will be mitigated. Also, in the case of small spills, proper mitigation will decrease their significance. While water withdrawal issues and their impact on freshwater quality could occur due to inadequate recharge, withdrawal volumes will be likely limited by permit requirements in fish-bearing water bodies. Any construction-related turbidity increases will be due to the timing of construction (most occurring during winter) or short-term. Therefore, while a potential project effect is identified for impacts to freshwater quality, any effects are expected to be not significant. The conclusion is depicted as Y (NS) on Table 7-4.

Marine Water Quality

Impacts to marine water quality could occur due to increased turbidity during dock construction and dredging, or due to the long-term presence of the dock itself. Sections 5.1.3.1 and 5.1.3.2 describe the potential impacts on water quality. Winter placement of gravel for dock construction is expected to create a minimal and short-term impact. A suspended sediment plume will be generated during summer dredging activities related to the 1,000-foot (ft) (305 meters [m]) channel. However, the effects will be temporary and generally restricted to lagoon waters within the project area. It may be necessary to transport dredge spoils to a location seaward of the 20-ft (6-m) isobath. It is anticipated that the affects related to ocean dumping would be similar to dredging effects (i.e., increased short-term turbidity).

Hydrographic effects due to the presence of the dock itself are anticipated to be minimal compared to naturally occurring, wind-driven upwelling. Therefore, while impacts to marine water quality can occur due to project actions, they are expected to be short-term and in the case of small spills, proper mitigation will decrease their significance. Table 7-4 indicates a Y (NS) under potential project effects related to marine water quality degradation.

Marine Circulation

Solid-filled structures, including marine docks, influence the alongshore movement of water immediately adjacent to the structure, resulting in variations in the current velocity (i.e., speed and direction), and introduce local vorticity (i.e., wake effects such as eddies and secondary flows). The Point Thomson dock would provide an alternative mechanism by which upwellings could occur, but would not enhance naturally occurring upwellings. Because the water column within Lions Lagoon in the area of the proposed dock tends to be uniform (URS 2000), both horizontally and vertically, formation of a wake eddy would mix waters with similar temperature and salinity characteristics, and thus have no perceptible effect on hydrography (see Section 5.1.3.1). Accordingly, the impact of the dock on marine circulation is rated as not significant, and this is depicted on Table 7-4 under potential project effects as Y (NS).

Permafrost and Soils

As described in Section 5.1.4, the dominant ice-rich permafrost soils in the project area, if allowed to thaw, will slump and release melt water that could then pond. In addition, there could be loclaized degredation of permafrost in the area of the gravel mine. The placement of 5 ft (1.5 m) of gravel on the tundra surface for roads, pads, and airstrip provides adequate insulation to prevent the degradation of the permafrost. Therefore, impacts of the Point Thomson facility of permafrost in the area will be minimal. The conclusion is depicted as Y (NS) on Table 7-4.

7.3.1.2 Past External Impacts

Past activities in the Point Thomson area could have had impacts on physical and chemical resources. Past external actions in the area include:

- Military operations, particularly at the Bullen Point DEW line station
- Oil and gas exploration, seismic investigations and drilling in the Badami and Point Thomson Units
- Construction and operation of the Badami facility
- Global pollutants/Arctic haze – contaminants that reach the Arctic through long-range atmospheric transport
- Natural Events - spring flooding and storms and wave action could have caused impacts to marine and freshwater quality.

The following sections describe the potential for lingering impacts from these past external actions on the physical and chemical resources of the Point Thomson area. As discussed in Section 7.2.4, lingering influences from past actions were identified but not rated for significance.

Air Quality

The incidence of arctic haze can be considered as a lingering influence from past external actions either on the North Slope or due to global pollution. This is depicted as Y on Table 7-4 under the "Lingering influence from past external actions?" column.

Surface Hydrology and Freshwater Quality

Past oil and gas exploration and development and military actions in the area that have included placement of gravel, removal of water, and gravel mining, could have impacted surface hydrology and/or water quality in localized areas. For example, the former gravel mine sites at Badami and Point Thomson have accumulated freshwater and could be used as water sources. While significant lingering impacts are unlikely on a large scale, localized areas (such as in the vicinity the old exploration pads or the DEW line station) may exhibit changes in surface hydrology conditions or degraded freshwater quality. Therefore, a remaining effect from past external actions for these impact categories is identified. Table 7-4 depicts these conclusions as Y in the lingering influence from past external actions column for both changes in surface hydrology and degradation of freshwater quality.

Marine Water Quality and Marine Circulation

There have been no industrial actions that could have contributed to lingering impacts on marine water quality and circulation in Lions Lagoon. Boats and barges passing through the area might have had accidental discharges of fuels or other materials. These contaminants, along with increased turbidity due to wind and wave action or spring river flooding, would likely be short-term and not have a lingering influence on marine water quality. Table 7-4 depicts these conclusions as N in the lingering influence from past external actions column for both changes in marine circulation and degradation of marine water quality.

Permafrost and Soils

Past oil and gas exploration and development, and the Bullen Point DEW line facility in the area that have included placement of gravel for construction of facilities on the tundra and gravel mining. These activities are likely to have impacted permafrost and soils in localized areas. While significant lingering impacts such as slumping, thermokarsting or tundra scars are unlikely on a large scale, localized areas may exhibit these impacts. Therefore, a remaining effect from past external actions is identified, and Table 7-4 depicts this conclusion as Y in the lingering influence from past external actions column.

7.3.1.3 Present and Potential Future External Actions

The following external actions, both human controlled and natural phenomena, have been identified as potentially contributing to impacts on physical and chemical resources of the Point Thomson area:

- Badami – future expansion of onshore facilities could be required to support development in the Slugger Unit. Impacts to surface hydrology, freshwater quality, and permafrost could be realized due to additional gravel placement or gravel mining.
- Far West Pad, Slugger Exploration and Development, and Sourdough Exploration and Development – impacts to surface hydrology, freshwater quality, and permafrost could be realized due to placement of gravel for development of these areas. Exploration activities could impact freshwater resources due to water withdrawal for ice roads and pads. Effects on the marine environment could occur if it became necessary to dredge offshore of either the Badami or proposed Point Thomson dock. Potential marine impacts include increased short-term turbidity and changes to hydrography.
- Gas Sales at Point Thomson - impacts could occur to surface hydrology, freshwater quality, and permafrost if additional or enlarged gravel pads are required or to the marine environment if the proposed Point Thomson dock would be dredged.
- Spring Flooding and Storms and Wave Action - could cause impacts to marine and freshwater quality.

Individually, many of these external factors could cause impacts to physical and chemical resources of the area. They are shown as Y, N, or N/A Table 7-4. However, while the potential for an impact from these actions is identified, the significance of an impact from any given action is not rated (see Section 7.2.4).

7.3.1.4 Cumulative Effects

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Facility, in conjunction with impacts from present and potential future external actions, it has been determined that cumulative effects on the physical and chemical resources of the area could occur. This is shown in the "Cumulative Effects?" column for each potential impact. However, the likelihood that any of the potential cumulative effects could be significant is low (see Table 7-4 "Likelihood that CE Could be Significant" column). The rationale for determining that the likelihood of significance will be low is based on the following assumptions (see "Assumption/ Rational" column):

Air Quality

- Other projects in the area will fall under New Source Performance standards protecting the air quality of the region.
- Impacts could occur, but mitigation will decrease their overall significance.
- Point Thomson project construction and operation is not expected to significantly contribute to arctic haze.

Surface Hydrology

- Other projects in area will be constructed with minimal footprint.
- Impacts could occur, but mitigation will decrease significance.
- Point Thomson contribution to cumulative effects is expected to be minimal.

Freshwater Quality

- Other projects in area will also be held to water withdrawal limitations as per permit requirements.
- Impacts could occur, but mitigation will decrease the significance.
- Turbidity impacts due to natural causes are expected to be short-term .
- Turbidity impacts will be minimized by winter construction efforts.
- Point Thomson contribution to cumulative effects is expected to be minimal.

Marine Water Quality and Circulation

- Point Thomson contribution to cumulative effects is expected to be minimal.
- Short-term increases in nearshore turbidity are not expected to be significant and are likely to be within range of natural perturbations.
- Region-wide climatic processes drive currents; development of other reasonable foreseeable facilities is unlikely to affect marine circulation in Lions Lagoon.

Permafrost

- Point Thomson contribution to cumulative effects is expected to be minimal.
- Other projects will be constructed to minimize impacts to permafrost.
- Majority of construction impacts on permafrost will be minimized due to timing (winter construction).
- Degradation of permafrost in the area of the gravel mine will be localized and minimal.

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Table 7-4. Physical and Chemical Resources Cumulative Effects Analysis Summary

POTENTIAL IMPACT	Potential Project Effects?	Lingering Influence From Past External Action?	PRESENT and POTENTIAL FUTURE EXTERNAL ACTIONS								Cumulative Effect?	Likelihood That CE Could Be Significant	Assumptions/Rationale
			Human Controlled						Natural Events				
			Badami[1]	Far West Pad	Sourdough Exp. & Dev.[1]	Slugger Exp. & Dev.[1]	Global Pollutants/ Arctic Haze	Gas Sales PTU[2]	Breakup Spring Flooding	Storms Wave Action			
DEGRADATION OF AIR QUALITY	Y(NS)[3]	Y[5]	Y	Y	Y	Y	Y	Y	N/A	N/A	Y	LOW	• Other projects in area will also fall under NSP standards • Impacts could occur, but mitigation will decrease significance • Pt. Thomson not expected to contribute significantly to arctic haze
CHANGES IN SURFACE HYDROLOGY	Y(NS)[5,7]	Y[8,9]	Y[5]	Y[5]	Y[5]	Y[5]	N/A	Y[5]	Y	N/A	Y	LOW	• Pt. Thomson contribution to CE expected to be minimal • Other projects in area will be constructed with minimal footprint • Impacts could occur, but mitigation will decrease significance
DEGRADATION OF FRESHWATER QUALITY	Y(NS)[5,6,7]	Y[8]	Y[5,6]	Y[5,6]	Y[5,6]	Y[5,6]	N/A	Y[5,6]	Y[7]	N/A	Y	LOW	• Pt. Thomson contribution to CE expected to be minimal • Other projects in area will also be held to water withdrawal limitations as per permit requirements • Turbidity impacts due to natural events will be short term • Majority of construction impacts on turbidity minimized due to timing (winter) • Impacts could occur, but mitigation will decrease significance
DEGRADATION OF MARINE WATER QUALITY	Y(NS)[7]	N	Y[1]	Y[1]	Y[1]	Y[1]	N/A	Y[1]	Y[7]	Y[7]	Y	LOW	• Pt. Thomson contribution to CE expected to be minimal • Short-term increases in turbidity not expected to be significant and likely within range of natural perturbations
CHANGES IN MARINE CIRCULATION	Y(NS)[10]	N	N	N	N	N	N/A	Y	Y	Y	Y	LOW	• Pt. Thomson contribution to CE expected to be minimal • Region- wide climatic processes drive currents; development of other facilities unlikely to affect marine circulation in Lions Lagoon
CHANGES IN PERMAFROST/ SOILS	Y(NS)[5]	Y[8]	Y[5]	Y[5]	Y[5]	Y[5]	N/A	Y[5]	N	N/A	Y	LOW	• Pt. Thomson contribution to CE expected to be minimal • Majority of construction impacts on permafrost minimized due to timing (winter) • Degredation in the area of the gravel mine will be localized and minimal • Other projects will be constructed to minimize impacts

NOTES:

Y = Yes NS = Not significant

N = No CE = Cumulative Effect

N/A = Not applicable

Dev. = Development

EXP = Exploration

Footnotes:

[1] If existing Badami or proposed Pt Thomson facilities are expanded or area offshore of docks is dredged

[2] If larger pads/roads and additional equipment are needed for gas sales

[3] Construction and operations emissions will be regulated and monitored, dust from construction not expected to be significant

[4] Arctic Haze

[5] Impacts could occur, but mitigation should decrease significance of impact;

[6] Includes potential impacts due to water withdrawal for ice roads and other project needs; will be mitigated by water use permit limits

[7] Potential short-term increases in turbidity

[8] Potential for localized impacts in vicinity of old exploratory pads or within the Badami facility; likely to be small scale

[9] Former gravel mine sites at Badami and Pt. Thomson have created new freshwater sources

[10] Wake eddy could be present, but effects will not be significant

7.3.2 Biological Resources

The following sections describe the analysis of cumulative impacts on biological resource. The resources considered are marine benthos, vegetation and wetlands, birds, marine mammals, terrestrial mammals, and threatened and endangered species.

7.3.2.1 Marine Benthos

The cumulative effect analysis for marine benthos is summarized on Table 7-5 and described in the following paragraphs.

Internal Project Effects

As described in Section 5.2.1, the development actions associated with the Point Thomson Gas Cycling Project can impact the benthic community of Lions Lagoon. The impacts can be seen as causing habitat loss and mortality and/or habitat alteration and disturbance. The following project actions have been identified as potentially contributing to these impacts:

Habitat Loss and Mortality

- Placement of gravel to construct the 750-ft (230-m) dock.
- Dredging operations to create a 1,000-ft (305-m) by 400-ft (122-m) channel from the end of the dock.
- Disposal of approximately 30,000 cubic yards (cy) (23,000 cubic meters [m^3]) of spoils outside of the barrier islands.

Habitat Alteration and Disturbance

- Creation of temporary turbidity plumes associated with dock construction and maintenance, dredging operations, and spoils disposal.
- Alteration of local circulation patterns, and thus the deposition (or erosion) of sediment and organic material in the vicinity of the dock.
- Tug and barge movement that could disrupt bottom sediments, thereby increasing turbidity.

Section 5.2.1 determined that impacts on marine benthos due to habitat loss and mortality and/or habitat alteration and disturbance associated with these project actions would be minimal. Habitat is not considered to be a limiting factor for benthic organisms in the grounded or land-fast ice zones. The area is characterized by regular disturbance and recolonization. Further offshore the community is considered to be more stable (see Section 4.5) and the disposal of the spoils could impact an as yet undetermined area of this community depending on disposal location. However, while numbers of non-motile organisms may be subject to burial, recolonization is likely to occur after a short period.

Two areas of kelp beds have been identified offshore of Lions Lagoon (see Section 4.5). Turbidity impacts associated with dredging and dredge spoils are not expected to impact the kelp since the dredge and disposal areas would be located away from known kelp beds. For these reasons, project impacts on the benthic community of Lions Lagoon are rated as not significant.

These determinations are depicted as Y (NS) on Table 7-5 under the "Potential Project Effects" column.

Past External Impacts

There have not been any previous offshore projects in Lions Lagoon or in the immediate vicinity of the Point Thomson Project. The Badami dock extends about 1,000 ft (305 m) into the nearshore zone of Mikkelsen Bay. The nearshore zone is subject to natural disturbance and recolonization events and habitat is not a limiting factor for these benthic organisms. Therefore, it has been determined that there are no lingering influences on the benthic community within the defined geographic area (Lion Lagoon). These conclusions are depicted as N in the "Lingering Influences from Past External Actions" column in Table 7-5.

Present and Potential Future External Actions

The following external actions, both human controlled and natural events have been identified as potentially contributing to marine benthic habitat loss and mortality and/or habitat alteration and disturbance in the vicinity of the Point Thomson project:

- Far West Pad, Slugger Development, Sourdough Development, and/or Gas Sales at Point Thomson – effects on the benthic environment could occur if it became necessary to dredge offshore of either the Badami or proposed Point Thomson dock to support development of these facilities. Potential impacts include benthic habitat loss and/or alteration and mortality of benthic organisms.
- Ice Scour – annual scoring of the nearshore benthic habitat by grounded sea ice or land-fast ice ridges prevents most species from overwintering in this zone. The area is characterized by opportunistic species that quickly recolonize the disturbed habitat

Individually, these external factors could impact the Benthic community. They are shown as Y on Table 7.5. However, due to the opportunistic nature of the benthic community, and the community's ability to adapt to natural disturbance and quickly recolonize new or previously disturbed areas, the significance of an impact for any given external action is likely to be not significant.

Cumulative Effects

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Facility, in conjunction with impacts from present and potential future external actions, it has been determined that cumulative impacts on the benthic community in Lions Lagoon and westward to Badami could occur (shown as Y in "Cumulative Effect?" column in Table 7-4). However, the likelihood that any of the potential cumulative effects could be significant is low (see Table 7-4). The rationale for determining that the likelihood of significance will be low is based on the following assumptions:

- Availability of benthic habitat is not limiting in Lions Lagoon.
- The area is characterized by opportunistic species that are regularly impacted by natural events.

Table 7-5. Marine Benthos Cumulative Effects Analysis Summary

POTENTIAL IMPACT	Potential Project Effects?	Lingering Influence From Past External Action?	PRESENT and POTENTIAL FUTURE EXTERNAL ACTIONS					Cumulative Effect?	Likelihood that CE could be Significant	Assumptions/Rationale
			Human Controlled				Natural Events			
			Far West Pad [1]	Sourdough Dev.[1]	Slugger Dev.[1]	Gas Sales PTU[1]	Ice Scour			
HABITAT LOSS AND MORTALITY HABITAT ALTERATION AND DISTURBANCE	Y(NS)[2]	N[2]	Y	Y	Y	Y	Y	Y	LOW	• Availability of benthic habitat is not limiting in Lions Lagoon • The area is characterized by opportunistic species regularly impacted by natural events • Kelp beds found in the offshore zone would not be impacted by increased turbidity; these organisms are likely adapted to turbidity from natural sources such as river input • Increased opacity of sea ice due to turbidity from dredge spoils disposal would not likely impact kelp since dredging will occur in summer. • Organisms are expected to quickly recolonize disturbed areas • Population/community effects not expected

NOTES:
Y = Yes
N = No

N/A = Not applicable
NS = Not significant
Dev. = Development
CE = Cumulative Effect

Footnotes: [1]Only if existing dock at Badami or proposed dock at Point Thomson is dredged for use by one of these other projects.
[2]Habitat not limiting to these opportunistic species which are affected by natural events such as ice scour each winter.

- Kelp beds found in the offshore zone would not be affected by increased turbidity; these organisms are likely adapted to changes in turbidity from natural sources such as river input.
- Increased opacity of sea ice due to turbidity from dredge spoils disposal would not likely impact kelp since dredging will occur in summer and resulting turbidity plumes from dredging and disposal will have dispersed prior to freeze-up.
- Organisms are expected to quickly recolonize any disturbed areas.
- Population/community effects are not expected for marine benthos.

7.3.2.2 Vegetation and Wetlands

The cumulative impact analysis for vegetation in the Point Thomson area is summarized on Table 7-6 and described in the following sections.

Internal Project Effects

As discussed in Section 5.2.2, potential effects of the Point Thomson Gas Cycling Project on vegetation and wetlands are primarily from habitat loss and alteration. While mortality and disturbance of plants including wetland species will occur as gravel is placed on the tundra, these direct impacts are considered in the context of habitat effects. The following project actions have been identified as potentially contributing to habitat effects:

Habitat Loss and Alteration

- Removal of vegetation at the gravel mine site, and burial of vegetation due to placement of gravel to construct facility roads, pads and airstrip. About 9,832,545 square feet (ft^2) (nearly 1 square kilometer [km^2]) of vegetation habitats would be impacted due to gravel mining and placement (see Section 5.2.2.1)
- Potential obstruction of surface flow due to improper or unmitigated placement of gravel, thereby creating impoundments, or conversely, unnaturally drier areas of tundra.
- Establishment of ice roads to support winter construction efforts; effects include areas of persistent ice and delayed "green-up" in those areas.
- Water removal from tundra lakes for ice road construction, dust control, and camp operations, potentially altering wetland community structure.
- Facilities-induced thermokarst areas can provide preferred habitat for certain plant species or conversely less attractive habitat for others.
- Dust fallout due to construction and operations along roadways, and near pads and the airstrip, which can cause earlier snowmelt and subsequent earlier green-up, reduce photosynthesis, increase soil pH, lower nutrient levels, and promote changes in plant community structure.
- Snow dumps and snow drifts that can result in delayed snowmelt and soil compaction. Impacts on vegetation may be long-term, because of the chronically reduced growing season, soil compaction, altered moisture regime, and gravel fallout.

Section 5.2.2 determined that the impacts of gravel cover are long term and vegetation recovery is slow following remediation. However, only about 8 percent (%) of total acreage affected by gravel coverage and/or removal consists of high value bird habitat and less than 2% of the area covered would alter high value salt marsh (see Section 5.2.4.1). In general, for all vegetation types affected, the amount of habitat loss would be small relative to regional abundance.

Impacts to vegetation from dust fallout, snow dumps and drifts, rare emergency flaring events, and small operational spills are also anticipated to be minimal and can be further minimized by mitigation measures. For these reasons, project impacts on vegetation due to habitat loss or alteration are considered to be not significant. This determination is depicted as Y (NS) under the "Potential Project Impact" column on Table 7-6.

Past External Effects

Past activities in the area of consideration for vegetation and wetlands could have had impacts on the habitat or created additional disturbance or mortality (see Table 7-2 for a list of potential external actions). Past external actions in the area that have had the potential to impact vegetation and wetlands include:

- Military operations particularly at the Bullen Point DEW line station – impacts to habitat due to gravel placement.
- Oil and gas exploration, seismic investigations, and drilling in the Badami and Point Thomson Units - impacts to habitat due to gravel placement, dust fallout, impoundments, snow accumulations, and thermokarst associated with existing facilities.
- Construction and operation of the Badami facility – loss and alteration of habitat due to gravel placement, disturbance and mortality due to construction and operations activities and presence of facility buildings.

Previous oil and gas exploration and development and military activities in the region contributed to loss of habitat due to mining and placement of gravel to support the developments. Gilders and Cronin (2000) report that approximately 10,900 acres (4400 hectares [ha]) of habitat have already been lost to gravel placement and mine sites on the North Slope. This impact is shown as a Y on Table 7.6 under the "Lingering Influence from Past External Actions" column since the vegetation impacts associated with gravel placement and removal can be considered permanent. However, the relative area of impact is small relative to the habitat available in the defined geographic scope of this analysis (exploration pads, small footprint for the Badami facility and only one military site at Bullen Point about 14 miles (mi) [23 km] to the west of the proposed Central Processing Facility (CPF). In addition, habitat is not considered to be a limiting factor for the bird and mammal populations present in the area, and any lingering impacts on habitat are likely to be not significant.

Present and Potential Future External Effects

The following external actions, both human controlled and natural phenomena have been identified as potentially contributing to loss or alteration of vegetation and wetlands in the vicinity of the Point Thomson project:

Table 7-6 Vegetation Cumulative Effects Analysis Summary

POTENTIAL IMPACT	Potential Project Effects?	Lingering Influence From Past External Action?	PRESENT and POTENTIAL FUTURE EXTERNAL ACTIONS					Cumulative Effect?	Likelihood that CE Will be significant	Assumptions/Rationale
			Badami[1]	Far West Pad	Sourdough Dev.	Slugger Dev.	Gas Sales PTU[2]			
HABITAT LOSS and/or ALTERATION	Y(NS)[3]	Y[4]	Y	Y	Y	Y	Y	Y	Low	• Pt. Thomson project has minimal contribution to CE • Habitats affected are not limiting for wildlife species in the area • Future development s will minimize footprints and mitigate impacts
DISTURBANCE[5]	NA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
MORTALITY[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTES:

Y = Yes NS = Not significant
N = No
N/A = Not applicable
Dev. = Development

Footnotes:
[1]Only if existing additional gravel were to be placed at Badami to support development in Slugger or other projects.
[2]Only if additional gravel were to be placed in the Point Thomson area to support gas sales.
[3]Total areas effected are small, rare habitat types and are not affected, habitats are not limiting for wildlife in the Point Thomson Development area.
[4]Former exploration drill sties and DEW line site
[5]Disturbance and mortality effects are considered as habitat loss

- Badami – future expansion of onshore facilities could be required to support development in the Slugger Unit. The effect would occur as vegetation habitat loss due to gravel placement.
- Far West Pad – if this pad is developed, an additional 968,054 ft^2 (less than 0.1 km^2) of vegetation would be covered.
- Slugger Development, Sourdough Development, and Gas Sales at Point Thomson – additional effects to vegetation would occur if additional gravel is needed for pad and road construction or expansion.

Individually, any of these external factors could impact vegetation. They are shown as either Y or NA on Table 7-6. However, while the potential for an impact from these actions is identified, the significance of an impact from any given action is not rated (see Section 7.2.4).

Cumulative Effects

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Facility, in conjunction with impacts from past, present, and potential future external actions, it has been determined that cumulative impacts on the vegetation in the analysis area could occur. However, the likelihood that any of the potential cumulative effects could be significant is low (see Table 7-6). The rationale for determining that the likelihood of significance will be low is based on the following assumptions:

- Habitats likely to be affected by gravel placement are not limiting for wildlife species in the area.
- Any new developments will minimize footprint and mitigate impacts to vegetation.
- Habitat lost due to placement of gravel for the Point Thomson and other oil/gas development activities in the vicinity (Far west Pad, Slugger and Sourdough developments) expected to have minimal contribution to overall cumulative effects.

7.3.2.3 Fish

The geographic scope for fish ranges from the Colville River east to Kaktovik. Cumulative impact analysis for freshwater, diadromous, and marine fish is summarized in Table 7-7 and described in the following paragraphs.

Internal Project Effects

As described in Section 5.2.3, potential effects of the Point Thomson Gas Cycling Project are modified and/or decreased value of nearshore foraging habitat, disturbance, and mortality of freshwater, diadromous, and marine fish. The following project actions have been identified as potentially contributing to these effects:

Habitat

- Placement of gravel to construct the 750-ft (230 m) dock causes loss of nearshore foraging habitat.

Disturbance

- Wake eddy at the tip of the dock could disturb nearshore fish movements.
- Dredging operations to create a 1,000-ft (305 m) by 400-ft (122 m) channel at the end of the dock would cause a short-term increase in turbidity.
- Disposal of approximately 30,000 cy (23,000 m^3) of spoils outside of the barrier islands would also cause a short-term increase in turbidity.

Mortality

- Winter water withdrawal for ice road construction could affect freshwater fish overwintering habitats in deep water sources.
- Sport fishing conducted by project personnel in streams, rivers, and Lions Lagoon could cause direct mortality of fish.

Section 5.2.3.1 evaluations determined that the proposed project is not anticipated to have any effects on spawning or overwintering habitat of freshwater, diadromous, or marine fishes. Habitat loss due to construction of the proposed dock would eliminate a small area (2 acres [< 1 ha]) of nearshore summer foraging habitat compared to the total nearshore foraging habitat available in Lions Lagoon. In addition, the proposed dock would not block or alter natural marine upwelling processes that play a roll in the trophic richness of the nearshore waters (Section 5.2.3.1). Therefore, project impacts on nearshore fish foraging habitat are rated as not significant, and depicted as Y (NS) on Table 7-7 for habitat in the "Potential Project Effects?" column.

The project is not anticipated to disturb fish migration due to dock wake eddy effects (Section 5.2.3.2). The potential effects from project actions are limited to disturbance due to increased turbidity from dredging activities, and disposal of dredge spoils offshore. Increased turbidity from dredging and disposal of dredge spoils will be short term. Due to fish tolerance of naturally caused turbid conditions, it is anticipated that a short term, localized increase in nearshore and offshore turbidity will not disturb fish. Accordingly, these project actions are rated as not significant, and depicted as Y (NS) on Table 7-7 for disturbance in the "Potential Project Effects?" column.

Recent State permits for North Slope development limit winter water withdrawal in fish bearing water sources for ice road construction. It is assumed that State withdrawal rates are conservative and protective of fish populations. All sport fishing conducted by project personnel will be required to comply with applicable State sport fishing regulations. The project is anticipated to have minimal fish mortality effects (Section 5.2.3.3). Therefore, project actions with the potential to cause fish mortality are rated as not significant, and depicted as Y (NS) on Table 7-7 for mortality in the "Potential Project Effects?" column.

Past External Effects

Past external actions pertinent to identified potential habitat, disturbance, and mortality effects for fish were as follows:

Habitat

Section 5.2.3.1 evaluations determined that the proposed project is not anticipated to have any effects on spawning or overwintering habitat of freshwater, diadromous, or marine fishes; however there could be nearshore fish foraging habitat effects. Therefore, from the perspective of this ER, past external actions with the potential to impact only nearshore foraging habitat of freshwater, diadromous, and marine fish in the geographic area of concern were selected from the list presented in Table 7-2.

- West Dock Causeway – foraging habitat loss due to gravel placement.
- Endicott Causeway – foraging habitat loss due to gravel placement.
- Badami Dock – foraging habitat loss due to gravel placement.

Disturbance

- West Dock Causeway – wake eddy and associated upwelling of cold saline water during prevailing easterly winds.
- Endicott Causeway - wake eddy and associated upwelling of cold saline water during prevailing easterly winds.
- Badami Dock – wake eddy and assumed associated upwelling of cold saline water during prevailing easterly winds.

Mortality

- Badami - potential effect on overwintering freshwater from winter water withdrawal for ice road construction.
- Sourdough and Slugger Exploration and Development - potential effect on overwintering freshwater from winter water withdrawal for ice road/pad construction.
- Scientific Research and Surveys – fish killed during fish surveys.
- Subsistence Fishing – direct take of fish.
- Commercial Fishing – direct take of fish.
- Sport Fishing – direct take of fish.

There are no significant data indicating that nearshore foraging habitat loss due to the construction of West Dock and Endicott Causeways and Badami dock has affected freshwater, diadromous, or marine fish at the population level (Colonell and Gallaway 1990). Therefore, it is assumed that there are no lingering influences on nearshore foraging habitat for freshwater, diadromous, or marine fish in the ER fish geographic scope. This determination is depicted as N on Table 7-7 for habitat in the "Lingering Influence From Past External Action?" column.

Summer migration and foraging distribution of many diadromous fish in the North Slope coastal region are influenced by wind generated currents (Colonell and Gallaway 1990). Although wake eddies and associated upwellings are present at West Dock and Endicott Causeways and the Badami Dock, there is no significant evidence that fish migration and foraging patterns have been disturbed due to the presence of docks in the nearshore waters (see Section 5.2.3.2 of this ER for further discussion). Therefore, it is assumed that there are no lingering influences causing disturbance to freshwater, diadromous, or marine fish migration or summer movements. This determination is depicted as N on Table 7-7 for disturbance in the "Lingering Influence From Past External Action?" column.

It is assumed that winter water withdrawal for past ice road/pad construction was in accordance with habitat protection stipulations. It is inferred that the water withdrawal levels set in State permits are conservative and no impact occurred due to past winter water withdrawal in fish bearing lakes. Direct fish kills due to scientific research and surveys and subsistence, commercial, and sport fishing have occurred in the past. During the 1999 fish survey conducted at Point Thomson less than 1% of the total catch over the openwater season resulted in moralities (LGL 2000b). State and Federal agencies monitor subsistence, commercial, and sport fishing. Direct kills from scientific research and surveys and subsistence, commercial, and sport fishing are small relative to fish populations and are not thought to have caused lingering population level effects. Therefore, it is assumed that there are no lingering influences from freshwater, diadromous, or marine fish mortality at the population level. This determination is depicted as N on Table 7-7 for disturbance in the "Lingering Influence From Past External Action?" column.

Present and Potential Future External Actions

Present and potential future external actions pertinent to identified potential habitat, disturbance, and mortality effects for fish were as follows:

Habitat

No known expansions of Badami or West Dock and Endicott Causeways are planned. Therefore, no present or reasonable foreseeable fish foraging habitat loss was identified due to gravel placement in the nearshore environment..

Disturbance

- Badami – potential effects of maintenance dredging for support of Badami facility.
- West Dock Causeway - potential effects of maintenance dredging for support of current and potential future development.
- Endicott Causeway - potential effects of maintenance dredging for support of Endicott facility.
- Sourdough and Slugger Exploration and Development - potential effects of dredging if Badami dock or proposed Point Thomson docks are used during development.

Mortality

- Badami – potential effect from winter water withdrawal for ice road construction.
- Sourdough and Slugger Exploration and Development - potential effect from winter water withdrawal for ice road construction.
- Badami – potential effects of maintenance dredging for support of Badami facility.
- West Dock Causeway - potential effects of maintenance dredging for support of current and potential future development.

- Endicott Causeway - potential effects of maintenance dredging for support of Endicott facility.

Short-term increases in turbidity due to dredging could cause minimal disturbance of fish nearshore movements. This is depicted as Y in Table 7-7 under the Badami, West Dock Causeway, Endicott Causeway, Sourdough and Slugger Exploration and Development columns for disturbance.

Excessive water withdrawal during the winter could adversely affect overwintering fish populations in deep tundra lakes. Overwintering habitat is a limiting factor for freshwater and diadromous fish on the North Slope (Craig 1989). Direct fish kills occur due to scientific research and surveys and subsistence, commercial, and sport fishing. Potential mortality due to these external actions is depicted as Y under the Badami, Sourdough and Slugger Exploration and Development, Scientific Research and Surveys, Subsistence Fishing, Commercial Fishing, and Sport Fishing columns in Table 7-7 for mortality.

Cumulative Effects

Habitat loss due to construction of the proposed dock would eliminate a small area (2 acres [< 1 ha]) of nearshore summer foraging habitat compared to the total nearshore foraging habitat available in Lions Lagoon. There are no significant data indicating a lingering influence from past nearshore foraging habitat loss due to the construction of West Dock and Endicott Causeways and the Badami dock. There are no external actions within the geographic scope that could cause present or reasonably foreseeable loss of nearshore fish foraging habitat. Therefore, a cumulative effect for fish nearshore foraging habitat was not identified. This is depicted as N under the "Cumulative Effect?" column in Table 7-7 for habitat.

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Project, in conjunction with potential impacts from past, present, and potential future external actions, it was determined that cumulative effects on fish populations in the analysis area due to disturbance and mortality could occur. This is depicted as Y in Table 7-7 under the "Cumulative Effect?" column for disturbance and mortality.

The likelihood that these cumulative effects could be significant is rated as low (Table 7-7). The rationale for determining the likelihood of significance is based on the following assumptions.

Disturbance

- Maintenance dredging activities are conducted on an as needed basis and are of short duration.
- Turbidity increases from maintenance dredging activities are short term.
- Fish in nearshore waters of the Beaufort Sea are tolerant of turbid waters.

Mortality

- State permit winter water withdrawal rates are thought to be conservative and protective of overwintering fish species in deep tundra water sources.

- Direct fish kills during scientific research and surveys are small. During the 1999 fish survey conducted at Point Thomson less than 1% of the total catch over the openwater season resulted in fish morality (LGL 2000b).
- Direct fish kills from fishing activities both commercial and subsistence are minimal compared to overall fish populations, and are monitored by State and Federal agencies.

Table 7-7 Fish Cumulative Effects Analysis Summary

POTENTIAL IMPACT	Potential Project Effects?	Lingering Influence From Past External Action?	PRESENT and POTENTIAL FUTURE EXTERNAL ACTIONS – Human Controlled: Badami	West Dock Causeway	Endicott Causeway	Sourdough Exp. & Dev.	Slugger Exp. & Dev.	Scientific Research & Surveys	Subsistence Fishing	Commercial Fishing	Sport Fishing	Cumulative Effect?	Likelihood That CE Could Be Significant	Assumptions/Rationale
HABITAT[1]	Y (NS)	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N/A	• No known expansions are planned for Badami dock or West Dock and Endicott Causeways.
DISTURBANCE[1]	Y (NS)	N	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	Y	LOW	• Limited to potential effects from maintenance dredging. • Turbidity increases short term. • Fish in nearshore waters are tolerant of turbid water.
MORTALITY	Y (NS)	N[2]	Y[2]	N/A	N/A	Y[2]	Y[2]	Y[3]	Y[3]	Y[3]	Y[3]	Y	LOW	• State permit water withdrawal rates are conservative and protective. • Fish mortality from fishing and scientific surveys is small relative to overall population levels. • Sport fishing is regulated by the State.

NOTES:

Y = Yes NS = Not significant
N = No CE = Cumulative Effect
N/A = Not applicable
Exp. = Exploration
Dev. = Development

Footnotes:

[1] = Effect is limited to nearshore foraging habitat for freshwater, diadromous, and marine fish.

[2] = Limited to potential effect on overwintering freshwater fish due to winter water withdrawal in fish bearing lakes for ice road/pad construction.

[3] = Adds to potential mortality from project actions.

7.3.2.4 Birds

The cumulative impact analysis for birds is depicted on Table 7-8 and described in the following paragraphs.

Internal Project Effects

As described in Section 5.2.4, development actions associated with the Point Thomson Gas Cycling project can impact waterfowl, tundra-nesting birds, and predatory birds that use the Point Thomson area for feeding, breeding, molting and/or nesting. Nearly all bird use of the area occurs in the summer months when snow free nesting habitats, forage, and open water are available (see Section 4.8). Only a few species remain in the area during the winter when food resources are scarce.

Potential project impacts on bird species in the area can occur due to habitat loss and alteration, behavioral disturbance, and/or mortality. The following project actions have been identified as potentially contributing to these impacts:

Habitat Loss and Alteration

- Burial due to placement of gravel to construct facility roads, pads, and airstrip.
- Potential obstruction of surface flow due to improper or unmitigated placement of gravel, thereby creating impoundments, or conversely, unnaturally drier areas of tundra. This could have positive or negative effects on bird habitat.
- Establishment of ice roads to support winter construction efforts; effects include areas of persistent ice and delayed breakup in those areas potentially causing temporary loss of habitat.
- Water removal from tundra lakes for ice road construction, dust control, and camp operations needs potentially causing loss of preferred habitat if recharge is inadequate.
- Facilities-induced thermokarst areas can provide preferred habitat for certain species or conversely less attractive habitat for others.
- Dust fallout due to construction and operations along roadways, and near pads and the airstrip which can cause earlier snowmelt and provide habitat for migrating birds that would normally not be available until later in the season.
- Snow dumps and snow drifts that persist into the breeding season rendering nesting habitat potentially unsuitable.

Section 5.2.4.1 determined that project impacts on bird habitat would be minimal since most habitats preferred by birds for nesting are not limited in the area. The amount of habitat anticipated to be lost due to gravel placement and gravel mine development will be small relative to regional habitat abundance. Habitat impacts from dust fallout, snow dumps and drifts, and small operational spills are also anticipated to be minimal and can be further minimized by mitigation measures. In addition, birds are known to regularly utilize abandoned gravel pads for resting and feeding. For these reasons, project impacts on bird habitat are considered to be not significant. This determination is depicted as Y (NS) under the "Potential Project Impacts" column on Table 7-8.

Disturbance

- Generation of noise and visual disturbance from activities associated with onshore and offshore construction during the summer when the majority of the birds are expected to use the area (i.e., construction equipment, vessels, airplanes, helicopters, and vehicles; drilling noise is not expected to create an impact on most birds since at present drilling is only allowed during the winter months).
- Longer-term, but likely of less magnitude, generation of noise associated with operation of the facility. This could consist of generators, compressors and other machinery, flaring events, and regular and maintenance-related vehicle traffic.

Section 5.2.4.2 concludes that a small percentage of birds could show short-term alterations in behavior due to noise associated with summer construction activities. However, the disturbance would be highest during winter construction efforts (gravel mine blasting, gravel hauling) when the majority of bird species are not present in the Point Thomson area. Vessel, air, and vehicle traffic effects during construction will be short-term. During operations, traffic and facility equipment noise could make areas adjacent to roads and pads less attractive to birds. However since habitat is not a limiting factor for birds, this displacement is expected to have minimal impacts. Therefore, project-related disturbance to area bird populations is considered to be not significant. This determination is depicted as Y (NS) on Table 7-8 under the "Potential Project Effects" column.

Mortality

- Strikes by vehicles and construction equipment.
- Collisions with structures and aircraft.
- Flare heat-related impacts, particularly for flightless or molting birds caught under the flare tower during flare events.
- Ingestion of spilled fuels and other operations-related materials.
- Increased predator populations (i.e., fox) due to attraction to oil field facilities (feeding by employees, or incorrectly handled garbage).

Section 5.2.4.3 discusses project-related mortality for birds in the Point Thomson area. While birds could be killed by vehicle strikes, collisions with aircraft and buildings, and/or by encountering the heat due to the flare, project-induced mortality is unlikely to have population level effects for birds migrating to the area for breeding, foraging, nesting, or molting. It is anticipated that waste control and enforced rules against personnel feeding wildlife will minimize artificial attraction of predators (i.e., grizzly bears and Arctic fox). Project-induced mortality is determined to be not significant, and is depicted as Y (NS) on Table 7-8.

Past External Impacts

Past activities in the area of consideration for bird species could have had effects on the habitat or created additional disturbance or mortality for these species (see Table 7-2 for a list of potential external actions). Past external actions in the area that had the potential to impact bird populations include:

- Military operations particularly at the Bullen Point DEW line station – impacts to habitat due to gravel placement, disturbance and mortality due to military operations
- Oil and gas exploration, seismic investigations and drilling in the Badami and Point Thomson Units - impacts to habitat due to gravel placement, disturbance and mortality due to exploration activities both onshore and offshore.
- Construction and operation of the Badami facility – loss and alteration of habitat due to gravel placement, disturbance and mortality due to construction and operations activities and presence of facility buildings.
- Scientific research and surveys conducted in the area (in particular a United States Geological Service [USGS] study on long-tailed ducks conducted from Flaxman Island in 1999 and 2000) could have caused disturbance and mortality, but are not likely to have caused habitat alteration or loss.
- Subsistence hunting - could add to any mortality or disturbance.
- Global pollutants - could also add to any mortality or disturbance from project actions. However, documentation of geographic coverage of contaminants in birds in Alaska is poor (ISER and ANSC 1999).

Previous oil and gas exploration and development and military activities in the region contributed to loss of bird habitat due to placement of gravel and gravel mining to support the developments. This is shown as a Y on Table 7-8 under "Lingering Influence from Past External Actions" since associated habitat impacts remain (i.e., the presence of the pads and roads and indirect impacts such as changes in surface hydrology and creation of thermokarsts). However, the relative area of impact is small compared to the total bird habitat available in the region (small exploration pads, small footprint for the Badami facility, only one military site at Bullen Point about 14 mi [23 km] to the west of the proposed CPF). In addition, habitat is not considered to be a limiting factor for the bird populations present in the area, and any lingering impacts on habitat are likely to be not significant.

The magnitude of past impacts on bird species due to disturbance from these external activities is unknown, but lingering population effects on non-threatened species are unlikely. The majority of the disturbance impacts were small scale, short-term, and, for the case of recent development at Badami and exploration drilling at Sourdough and Slugger, generally mitigated. Therefore, Table 7-8 shows an N for "Lingering Influence from Past External Effects" for disturbance.

Mortality due to past hunting and exposure to global pollutants is minimal relative to non-threatened bird species populations. Therefore, it is assumed there are no lingering influences from past mortality on on-threatened bird species. This is depicted as N for "Lingering Influences from Past External Effect" in Table 7-8.

Present and Potential Future External Actions

The following external actions, both human controlled and natural events have been identified as potentially contributing to bird habitat, disturbance, and mortality effects in the vicinity of the Point Thomson project:

- Badami – future expansion of onshore facilities could be required to support development in the Slugger Unit. Potential impacts to birds include habitat loss due to gravel placement, and disturbance and mortality due to project activities.
- Far West Pad, Slugger Development, and Sourdough Development – impacts to bird habitat, and disturbance and mortality impacts due to construction and operation of pad facilities could be realized due to development of these areas. Effects on the marine environment could occur if it became necessary to dredge offshore of either the Badami or proposed Point Thomson dock. Potential impacts to marine birds and waterfowl include disturbance and mortality.
- Gas Sales at Point Thomson - impacts could occur to the bird community if it became necessary to enlarge pads, or if dredging was required offshore of the proposed Point Thomson dock.
- Scientific Research and Surveys – annual bird surveys and other research efforts could cause disturbance and mortality.
- Subsistence hunting - could also add to any mortality or disturbance from project actions.
- Global pollutants – could cause increasing susceptibility to and bioaccumulation of contaminants such as mercury or other metals could cause a decrease in overall bird health eventually contributing to mortality impacts.
- Foggy Conditions – contribute to the incidence of bird strikes.
- Disease – a large number of long-tailed ducks is suspected to have succumbed to a virus in the past year (Anchorage Daily News June 27, 2001). Some of the dead ducks were found west of Flaxman Island during USGS surveys in the summer of 2000. USGS biologists believe that disease may be an important factor in population trends for these ducks.

Individually, any of these external factors could impact birds through habitat loss and alteration, disturbance, or mortality. They are shown as either Y or N/A on Table 7-8. However, while the potential for an impact from these actions is identified, the significance of an impact from any given action is not rated (see Section 7.2.4).

Cumulative Effects

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Facility, in conjunction with impacts from past, present, and potential future external actions, it has been determined that cumulative impacts on the bird populations in the analysis area could occur for habitat loss/alteration, disturbance, and mortality. However, the likelihood that any of the potential cumulative effects could be significant is low (see Table 7-8). The rationale for determining that the likelihood of significance will be low is based on the following assumptions:

- Nesting habitat is not limited in the region.
- Any new developments will minimize footprint and mitigate impacts to birds.
- Disturbance severe enough to create population level effects is not expected.

- Mortality from Point Thomson and other oil/gas development activities is expected to have minimal contribution.
- Mortality from subsistence hunting and scientific surveys is controlled to minimize population level impacts.
- Disease is not expected to have population level impacts in non-threatened species.

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Table 7-8. Bird Cumulative Effect Analysis Summary

POTENTIAL IMPACT	Potential Project Effects?	Lingering Influence From Past External Action?	PRESENT and POTENTIAL FUTURE EXTERNAL ACTIONS											Cumulative Effect?	Likelihood that CE could be Significant	Assumptions/Rationale
			Human Controlled									Natural Events				
			Badami[1]	Far West Pad	Flaxman Island Rem.	Sourdough Dev.	Slugger Dev.	Gas Sales PTU[4]	Global Pollution	Scientific Research & Surveys	Subsistence	Foggy Conditions	Disease			
HABITAT LOSS AND ALTER-ATION	Y(NS)[3]	N[3]	Y	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A	Y	LOW	• Nesting habitat not limiting • Pt. Thomson has minimal contribution to CE • Any new developments will minimize footprint and mitigate impacts to birds
DIS-TURBANCE	Y(NS)[4]	N	Y	Y	Y	Y	Y	Y	N/A	N/A	N/A	N/A	N/A	Y	LOW	• Pt. Thomson has minimal contribution to CE • Any new developments will minimize and mitigate impacts to birds • Disturbance severe enough to create population level effects is not expected
MORT-ALITY	Y(NS)	N	Y	Y	Y	Y	Y	Y	Y[5]	Y	Y	Y[6]	Y[7]	Y	LOW	• Mortality from Pt. Thomson and other oil/gas development activities expected to have minimal contribution • Mortality from subsistence hunting and scientific surveys is controlled to minimize population level impacts • Disease not expected to have population level impacts in non-threatened species.

NOTES:
Y = Yes NS = Not significant
N = No CE = Cumulative Effect
U = Unknown
N/A = Not applicable
Dev. = Development
Rem. – Remediation

Footnotes:
[1]Potential effects if Badami facilities are expanded to support other development
[2]If larger pads/roads are needed for gas sales equipment
[3]Onshore nesting habitat not limited
[4]Short-term impacts could occur due to construction noise; however, disturbance would be greatest in winter when most birds are not present
[5]Documentation of contaminants in Alaskan birds is poor; however contaminants can add to potential mortality from other actions
[6] Foggy conditions contribute to incidence of bird strikes
[7]Long-tailed ducks in waters found off of Flaxman Is. Suspected to have succumbed to a virus (ADN, June 27, 2001)

7.3.2.5 Marine Mammals

The cumulative impact analysis for marine mammal is divided into separate discussions considering cetaceans, pinnipeds, and polar bears.

Cetaceans

Section 5.2.5 of this ER concludes that no cetaceans are expected to be within the proposed project area during winter and consequently will not be affected by winter construction activities at Point Thomson. Beluga whales are rarely seen in the Point Thomson area during the summer and are absent from the Alaskan Beaufort Sea from November through March (see Section 4.9.1.2). In autumn, most belugas migrate well offshore of the Point Thomson area, and are unlikely to be impacted by noise associated with construction or operations activities. Therefore, the Point Thomson project will not contribute to any cumulative impacts on this species. Similarly bowhead whales migrate past the Point Thomson area, and a few individuals may be encountered offshore of the project as early as late August. While project-related impacts on this species are expected to be minimal, the overall cumulative impacts are considered due to the species' status as endangered. The cumulative effects analysis for bowhead whales is provided in Section 7.3.5.7 under Threatened and Endangered Species.

Pinnipeds

The cumulative impact analysis for pinnipeds is depicted on Table 7-9 and described in the following paragraphs.

Internal Project Effects

As described in Section 5.2.5, the construction and operations activities associated with the Point Thomson Gas Cycling project can impact pinnipeds that use Lions Lagoon and nearby areas for foraging and hauling-out. The ringed seal is main pinniped found throughout the region and the only one that could be expected in the area during the winter months (see Section 4.9.2). Bearded seals can be found near the project area in the spring and summer and spotted seals are occasionally observed during this time also.

Potential project impacts on pinniped species in the area can occur due to habitat loss and alteration, behavioral disturbance, and/or mortality:

Habitat Loss and Alteration

As described in Section 5.2.5.1, long-term habitat effects are not expected for pinnipeds due to winter or summer construction activities. Increased turbidity due to gravel placement in the winter and dredging and spoils disposal in the summer is expected to be short-term and have minimal direct impact on seals. There may be some displacement of pinnipeds from the immediate area of construction due to both noise and turbidity, but this impact is discussed under the context of disturbance (see below) rather than as a habitat effect. Therefore, Table 7.9 shows the potential project effects on habitat as N/A (not applicable), and the reader is referenced to a discussion on disturbance.

Disturbance

Behavioral disturbance to pinnipeds using the project area can be induced by:

- Generation of noise and activities associated with onshore and offshore construction during both winter and summer construction periods (i.e., construction equipment, blasting associated with the gravel mine, vessels, airplanes, helicopters, and vehicles).
- Longer-term, but likely of less magnitude, generation of noise associated with operation of the facility. This could consist of generators, compressors and other machinery, drill rigs, and regular and maintenance-related vehicle traffic.

Section 5.2.5.2 concluded that winter construction sounds do not propagate very far (<40 ft [12 m]) in shallow waters. In addition, LGL and Greeneridge (2001) determined that construction of the Northstar Island, pipeline corridor, and ice roads apparently did not impact ringed seal distribution or abundance. The same study concludes that during the open water construction period the behavior or number of ringed seals may have been slightly affected, but any effects from construction activities were minor, short-term, and localized with no consequences for the ringed seal population. Since much of the construction at Point Thomson will be land-based as compared to offshore, impacts or construction are likely to be even less than those reported at Northstar.

Section 5.2.5.2 of this ER also concludes that effects of operations-related noise and disturbance on pinnipeds will consist of short-term, localized behavioral reactions. In support of this conclusion, LGL and Greenridge (2001) found that a small minority of seals present in the Northstar area reacted to aircraft over-flights by diving or showing other disturbance-related actions. Most seals showed no apparent response to the aircraft. Effects on individual seals or their populations will not be significant. For these reasons, disturbance-related impacts on pinnipeds due to Point Thomson project actions are considered to be not significant. This determination is depicted as Y (NS) on Table 7-9.

Mortality

Direct pinniped mortality from project actions could occur through:

- Collisions with vessels or barges.
- Ingestion of spilled fuels and other operations-related materials.

Section 5.2.5.3 concludes that mortality impacts on pinnipeds due to project-related vessel traffic will not occur. For example, during the open water construction season for the Northstar project LGL and Greenridge (2001) found no evidence of seal injuries or fatalities. Also this study found that during the 1999-2000 ice covered season, seal injuries and/or fatalities were not expected, nor were they found. Operations-related mortality is also not expected due to the relatively small amount of vessel traffic expected for the project (see Section 5.2.5.3). Therefore, project-induced mortality is not anticipated to occur and is depicted as N on Table 7-9.

Past External Impacts

Past activities in the area of consideration for pinnipeds (see section 7.2) could have created additional disturbance or mortality for these species. Past external actions in the area include:

- Military operations particularly at the Bullen Point DEW line station.
- Oil and gas exploration, seismic investigations and drilling in the Badami and Point Thomson Units.
- Construction and operation of the Badami facility.
- Scientific research and surveys that have been conducted in the area (in particular a United States Geological Service (USGS) study on long-tailed ducks conducted from Flaxman Island in 1999 and 2000 could have caused disturbance to seals).
- Flaxman Island Remediation - cleanup of several old exploration drill pads on the island could have caused disturbance to seals due to increased air and vessel traffic and noise from heavy equipment.
- Subsistence hunting - could also have added to any mortality or disturbance.

The magnitude of past impacts on pinnipeds due to disturbance and mortality from many of these external activities is unknown, but lingering population effects on species are unlikely. Impacts of disturbance and mortality from oil-related construction activities can be inferred as having been minimal and short term (LGL and Greenridge 2001). Therefore, Table 7-9 shows an N for no lingering influence from past external effects for the potential impacts of disturbance and mortality.

Present and Potential Future External Actions

The following external actions, both human controlled and natural events, have been identified as potentially contributing to pinniped disturbance and mortality effects in the vicinity of the Point Thomson project:

- Far West Pad, Slugger Development, Sourdough Development and/or Gas Sales at Point Thomson – disturbance to pinnipeds could occur if it became necessary to dredge offshore of either the Badami or proposed Point Thomson dock to support development of these facilities.
- Flaxman Island Remediation – continued cleanup of several old exploration drill pads on the island could cause disturbance to seals due to increased air and vessel traffic and noise from heavy equipment.
- Scientific Research and Surveys – annual surveys by aircraft and possible collaring efforts could cause disturbance or mortality for seals either due to direct or indirect effects.
- Subsistence hunting – could also add to any mortality or disturbance from project actions.
- Offshore Seismic Exploration – could contribute to disturbance or mortality effects.

Individually, many of these external factors could cause behavioral disturbance or mortality for pinnipeds. They are shown as Y, N, or N/A on Table 7-9. However, due to the expected minimal amount of offshore activities that could be associated with the external actions, and the results of LGL and Greenridge (2001) which showed minimal impacts from a large offshore construction effort, the significance of an external impact for any given action is likely to be not significant.

Cumulative Effects

From the perspective of this project, a cumulative effect of mortality is not identified for pinniped species. This is shown as an N on Table 7-9 under the cumulative effect column.

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Facility, in conjunction with impacts from present and potential future external actions, it has been determined that cumulative effects due to disturbance impacts on the pinniped populations could occur. However, the likelihood that the potential cumulative effect could be significant is low (see Table 7-9). The rationale for determining that the likelihood of significance will be low is based on the following assumptions:

- While short term disturbance is possible during construction; population level effects are not expected.
- Minimal offshore or nearshore disturbance is expected during operations.

Polar Bear

The cumulative impact analysis for polar bear is depicted on Table 7-10 and described in the following paragraphs.

Internal Project Effects

As described in Section 5.2.5, the construction and operations activities associated with the Point Thomson Gas Cycling project can impact polar bears that use onshore areas for denning. In the proposed project area, polar bears are present near the coast during the ice-covered period and infrequently during the summer (see Section 4.9.3). Pregnant females enter dens in October or November and emerge with their cubs in late March or April. Therefore, potential project impacts on polar bears can occur due to habitat loss and alteration, behavioral disturbance, and/or mortality.

Habitat Loss and Alteration

Since non-denning polar bears generally prefer areas of heavy offshore pack ice, most potential project-related habitat effects would be to denning areas on shore. Traditionally, few dens are found on the mainland in the immediate project area (see Figure 4-6). While many dens have been historically found on Flaxman Island, project activities during the denning period (October to April) will not impact the immediate vicinity of the island. As described in Section 5.2.5.1, habitat or denning sites for polar bears will be avoided; however, it may not be possible to guarantee that no den sites or potential den sites will be impacted to any degree. Therefore on Table 7-10 potential project effects on habitat are identified, but are anticipated to be not significant. This is shown as Y (NS) on the table for the "potential project effects" column.

Disturbance

Behavioral disturbance to polar bears using the project area can be induced by:

- Generation of noise and activities associated with onshore and offshore construction during both winter and summer construction periods (i.e., construction equipment, blasting associated with the gravel mine, vessels, airplanes, helicopters and vehicles, and winter drilling activities).

- Longer-term, but likely of less magnitude, generation of noise associated with operation or the facility. This could consist of generators, compressors and other machinery, drill rigs, and operations and maintenance-related vehicle traffic.
- Hazing activities required to protect project personnel.

As discussed in Section 5.2.5.2, Amstrup (1993) found that polar bears tolerated exposure to a variety of disturbances with no apparent effect on productivity. If exposed to intense disturbance during the period when they are seeking den sites, polar bears could choose less disturbed locations. They are likely to be most sensitive to disturbance late in the denning period when abandonment of a den could impact cub survival. Section 5.2.5.2 concludes that polar bears are thought to avoid loud noise, but there is no evidence that noise associated with construction or operations at oil field facilities disturbs polar bears. The impacts of occasional hazing to protect life and property will be minimized by developing mitigation actions and following wildlife interaction plans. For these reasons, a potential project effect of disturbance is identified for polar bears, but the impact is expected to be not significant. This determination is depicted as Y (NS) on Table 7-10.

Mortality

Polar bear mortality can occur through:

- Collisions with construction equipment, vehicles or vessels.
- Necessity of killing a bear to protect life and property.
- Ingestion of spilled fuels and other operations-related materials (see Section 7.3.4 for a discussion of cumulative impacts of spills).

Mortality impacts on polar bears due to project-related equipment, vehicles, and vessel traffic will be negligible. However, should a polar bear den be disturbed or a bear be attracted to cooking odors or camp activities, it may necessary to kill a threatening bear. Therefore project-induced mortality is possible, but the effect is likely to be not significant due to mitigation and avoidance measures. The effect is depicted as Y (NS) on Table 7-10.

Past External Impacts

Past activities in the area of consideration for polar bears could have had created additional disturbance or mortality for this species (Table 7-2). Past external actions in the area include:

- Military operations particularly at the Bullen Point DEW line station.
- Oil and gas exploration, seismic investigations and drilling in the Badami and Point Thomson Units.
- Construction and operation of the Badami facility.
- Flaxman Island Remediation – cleanup of several old exploration drill pads on the island could have caused disturbance and mortality to denning polar bears or could have degraded potential polar bear den habitat.
- Scientific research and surveys conducted in the area (in particular annual USFWS den surveys and collaring) could have caused disturbance and mortality.

- Subsistence hunting - could also have added to any mortality or disturbance

The magnitude of past impacts on polar bears due to disturbance from many of these external activities is unknown, but lingering population effects on polar bears are unlikely. Impacts of disturbance from oil-related construction and operations activities have been successfully mitigated in the past. In addition, Flaxman Island remains as a heavily-used polar bear denning location, even though past oil and gas exploration activities, remediation and clean-up of contaminated sites, and scientific survey staging areas have been located on the island, likely contributing to increased disturbance in the area. Therefore, there is assumed to be no lingering influence from past external actions on the polar bear population of the region due to habitat loss or disturbance. Table 7-10 depicts this conclusion as an N for both of these potential impacts under the "Lingering Influence from Past External Action" column.

A lingering effect of due to mortality from past hunting practices on polar bear population size has been identified. This is depicted as Y for mortality in Table 7-10 under the "Lingering Effects" column. However, the southern Beaufort Sea population has increased over the last 20 years (see Section 4.9.3), so the lingering effect is likely to be minimal.

Present and Potential Future External Actions

The following external actions, both human controlled and natural events, have been identified as potentially contributing to disturbance and mortality effects on polar bears in the vicinity of the Point Thomson project:

- Badami – future expansion of onshore facilities could be required to support development in the Slugger Unit. Potential impacts to polar bear include habitat loss due to gravel placement, disturbance, and mortality.
- Far West Pad – impacts to polar bear habitat, and disturbance and mortality impacts due to construction and operation of pad facilities could be realized if the pad is constructed. Effects on the marine environment could occur if it became necessary to dredge offshore of the proposed Point Thomson dock.
- Slugger Development - impacts could occur to polar bears if it became necessary to dredge the Badami dock area, or add to Badami facilities to support exploration and development of this unit. Denning habitat is not likely to impacted by infrastructure for this development since denning areas are typically not located so far inland.
- Sourdough Development - impacts could occur to polar bears if it became necessary to dredge the proposed Point Thomson dock or add additional coastal facilities to support exploration and development of this unit.
- Gas Sales at Point Thomson - impacts could occur to the polar bears if it became necessary to enlarge pads, or if dredging was required offshore of the proposed Point Thomson dock.
- Flaxman Island Remediation – cleanup of several old exploration drill pads on the island could cause potential mortality or disturbance to denning polar bears or could degrade potential polar bear den habitat.
- Scientific Research and Surveys – annual den surveys and other research efforts could cause disturbance or mortality for polar bears either due to direct or indirect effects, or due to the potential for killing a bear to protect human life.

- Subsistence hunting - could also add to any mortality or disturbance from project actions.

Individually, many of these external factors could impact habitat or cause behavioral disturbance or mortality for polar bears. They are shown as Y, N, or N/A, on Table 7-10. However, due to the expected minimal amount of offshore activities that could be associated with the external actions, and the results of observation that polar bears are apparently not disturbed by work at Flaxman island, the significance of an external impact for any given action is likely to be not significant.

Cumulative Effects

Based on the analysis of potential impacts associated with the Point Thomson Gas Cycling Facility, in conjunction with impacts from present and potential future external actions, it has been determined that cumulative effects on polar bears due to habitat loss/alteration, disturbance, and/or mortality could occur. However, the likelihood that the potential cumulative effect could be significant is low (see Table 7-10). The rationale for determining that the likelihood of significance will be low is based on the following assumptions:

- Denning habitat in the Point Thomson area is not limited.
- Any new developments will minimize footprint and mitigate impacts to polar bears.
- There are no known areas of long-term polar bear displacement within the defined geographical scope.
- Polar bears regularly return to Flaxman Island where exploration and remediation has occurred.
- Population level effects not expected; the polar bear population in the region is not threatened.
- Mortality from the Point Thomson project and other oil/gas development activities is expected to have minimal contribution to the cumulative impact of mortality.
- Mortality from subsistence hunting and scientific surveys is monitored; population level effects not expected.

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