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SECTION 4A
DIRECT AND INDIRECT IMPACTS – ALTERNATIVE A

4A.1 INTRODUCTION

This section provides an analysis of the environmental consequences that would result from implementation of Alternative A – CPAI Development Plan and FFD.

The CPAI Development Plan includes five production pads, CD-3 through CD-7. Produced fluids would be transported by pipeline to be processed at APF-1. Gravel roads would connect CD-4 through CD-7 to CD-1. CD-3 would be accessed by ice road or by air. Gravel used for construction of roads, production pads, and airstrips would be obtained from the existing ASRC Mine Site and Clover. A bridge across the Nigliq Channel near CD-2 would accommodate road traffic and the pipelines. CD-3 would be the only new production pad with an airstrip. CD-6 would be within a 3-mile setback from Fish Creek from which the BLM's ROD for the Northeast National Petroleum Reserve-Alaska IAP/EIS (Stipulation 39[D]) prohibits permanent oil facilities (BLM 1998b). This alternative would provide for an exception to this provision to allow for the location of CD-6, and its associated road and pipeline, within the setback. Additional exceptions would be required to locate oil infrastructure within 500 feet of some water bodies (Stipulation 41), and to allow roads connecting to a road system outside the National Petroleum Reserve-Alaska (Stipulation 48). Aboveground pipelines would be supported on VSMs and would be at elevations of at least 5 feet above the tundra. Powerlines would be supported by cable trays placed on the pipeline VSM, except for one powerline suspended from poles between CD-6 and CD-7.

Alternative A – FFD includes two hypothetical APFs and 22 hypothetical production pads in addition to the five production pads proposed under Alternative A. Gravel roads would connect all but six production pads. Five production pads in the lower Colville River Delta (CD-3, HP-7, HP-12, HP-14, and HP-15), and one near the Kogru River (HP-22) would be designed with airstrips for access, instead of roads. Construction and operation strategies described for the applicant's proposed action would apply for Alternative A – FFD. Exceptions to the stipulations in the Northeast National Petroleum Reserve-Alaska IAP/EIS and ROD would be necessary to allow placement of facilities in certain areas.

4A.2 PHYSICAL CHARACTERISTICS

4A.2.1 Terrestrial Environment

4A.2.1.1 Physiography

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON PHYSIOGRAPHY

CONSTRUCTION PERIOD

Impacts to physiography would result from changes to landforms by construction of roads, production pads, airstrips, and gravel mines. Impacts would be localized to the immediate footprint of the facilities and gravel mines and their immediate surroundings. Surface terrain would change because of placement of gravel roads and production pads. Placement of gravel on the tundra for roads, production pads, and airstrips creates a raised terrain feature that would directly affect physical characteristics, such as thermal regime and hydrology, if not properly accounted for in the design. As an example, if the thickness of the road embankment is not adequate to maintain thermal stability, then the permafrost below the road could begin to melt, creating thaw subsidence (thermokarsting) adjacent to the road. This would lead to settlement of the roadbed, subsequent structural failure, and increased ponding (Frederick 1991).

New gravel mine sites, including the proposed Clover Potential Gravel Source, would affect the existing tundra surface by requiring the complete removal of surface vegetation, and overburden and extraction of the underlying gravels in a fashion similar to the existing ASRC Mine Site. Depending on site-specific conditions, a large disturbance such as this could cause melting of the permafrost soils around the mine site perimeter, which would create additional landform changes. Gravel mining leaves a large hole in the ground. This could result in the creation of shallow and deep water habitats. If ponds are created, they would likely be much deeper than a typical North Slope lake, and as is normal under a water body that does not freeze completely during winter, thaw bulb formation likely would follow.

Gravel mines could affect about 65 acres. Areas that would experience direct physiographic effects from placement of gravel on the tundra include 241 acres.

OPERATION PERIOD

Compared to the landscape that would be altered by original construction, the operational phase of the facilities would have relatively little effect on landforms. Maintenance grading of the surfaces of production pads and roads would modify the surface, but the general shape of the road and production pads would be the same throughout the life of the facilities.

Snow accumulations from wind drifting and snow plowing would increase the meltwater runoff or ponding in areas adjacent to roads and production pads, where utilized gravel fill or overburden placed on the tundra surface would impede the downslope movement of water. Some impedances simply increase soil moisture content on the upslope side of the barrier, while others create ponds. Ponds could dry up during the summer, or they could become permanent water bodies that persist from year to year and thus potentially disturb gravel structures (Walker et al. 1987a, Walker 1996). Project design aspects intended to reduce these effects include orienting production pads to minimize wind drift accumulations, using the natural slope or culverts to alleviate ponding, and depositing snow for removal in designated areas, which would limit ponding during the summer melting period (Frederick 1991).

ABANDONMENT AND REHABILITATION

Upon abandonment, Clover would become a small lake (Appendix O). If land management agencies require the removal of roads or production pads at other sites, Clover is a likely location for the disposal of resulting gravel (the rehabilitation plan may need to be altered if gravel is placed back into the pit [Appendix O]), particularly of that on the west side of the Nigliq Channel. Roads and production pads left in place upon abandonment could remain in place for many decades, particularly in drier areas. In areas that have soils with high ice content, such as at CD-3, the production pads may gradually subside into thermokarst troughs. (BLM and USGS 1992). Complete removal of roads and production pads in these ice-rich areas could result in ponding or other grade alterations from thaw subsidence (Kidd et al. 2004).

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON PHYSIOGRAPHY

The ASRC Mine Site and Clover would experience direct physiographic effects from gravel mining operations. Areas that would experience direct physiographic impacts from the tundra gravel placement and mining include 306 acres for Alternative A and 1,608 acres for Alternative A – FFD.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON PHYSIOGRAPHY

Impacts to physiography would occur primarily during the construction phase and would be a consequence of changes to landforms during and after construction of roads, production pads, airstrips, and mine sites. If not properly designed and constructed, these resulting landforms could adversely affect thermal stability of the tundra and hydrology through thermokarsting and increased ponding.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR PHYSIOGRAPHY

No measures have been identified to mitigate impacts to physiography under Alternative A – CPAI Development Plan or Alternative A – FFD. Adverse impacts to the physiography from gravel mines can be indirectly mitigated by rehabilitation of the mine site to produce a net positive to the affected area by providing either fish or waterfowl habitat (see Appendix O).

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR PHYSIOGRAPHY

There were no stipulations identified in the Northeast National Petroleum Reserve-Alaska IAP/EIS regarding physiography, and there are no potential mitigation measures developed in this EIS.

4A.2.1.2 Geology

Plan Area geology is comprised of marine limestones and marine and deltaic sands and shales of Mississippian to mid-Creatceous age (Gyrc 1985), mantled largely by Quaternary-aged fluvial and glaciofluvial sediments (Rawlinson 1993). Oil production efforts in the Plan Area target a Jurassic sandstone reservoir located in the Beaufortian Sequence (BLM 2003b).

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON GEOLOGY

CONSTRUCTION PERIOD

Direct Effects

Drilling oil production wells at the five production pad locations (CD-3 through CD-7) would directly impact the physical integrity of reservoir and overlying bedrock by pulverization and fracture. The only surface bedrock identified in the Plan Area outcrops at the bend in the lower Colville River, upstream of Ocean Point (Mayfield et al. 1988). Alternative A does not propose excavation activities in this area, and would therefore not directly impact surface bedrock. The volume of rock impacted by drilling is insignificant compared to the total volume of bedrock comprising the Plan Area. Direct impacts to Plan Area bedrock during construction would produce no measurable effect and are considered negligible under this alternative.

Indirect Effects

No indirect effects are recognized for the construction period.

OPERATION PERIOD

Direct Effects

Annular disposal or injection of Class I and II wastes would directly impact the receiving bedrock via possible propagation of existing fractures, increase of pore space pressure, and alteration of pore space composition within an approximately 0.25-mile radius of the injection well (40 CFR 146.69 (b)). The volume of rock impacted by waste disposal is insignificant compared to the total volume of bedrock comprising the Plan Area. Direct impacts to Plan Area bedrock during operation would produce no measurable effect and are considered negligible under this alternative.

Production of petroleum hydrocarbons from subsurface reservoirs constitutes an irreversible and irretrievable commitment of resources. Direct impacts to petroleum hydrocarbon resources in the Plan Area would be major under Alternative A.

Indirect Effects

No indirect effects are recognized for the operation period under Alternative A – CPAI Development Plan.

ABANDONMENT AND REHABILITATION

Geology would not be impacted by abandonment activities under Alternative A – CPAI Development Plan.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON GEOLOGY

Direct and indirect impacts incurred during construction and operation of Alternative A – FFD would be similar to those presented for Alternative A – CPAI Development Plan in Section 4A.2.1, but would be experienced over greater spatial and temporal extents. Direct impacts to Plan Area bedrock would remain negligible under Alternative A – FFD. Direct impacts to Plan Area petroleum hydrocarbon reserves would be major under the Alternative A – FFD.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON GEOLOGY

Under either Alternative A or Alternative A – FFD, development scenario the irreversible and irretrievable commitment of petroleum hydrocarbon resources constitutes a major impact, however petroleum hydrocarbon production is the purpose of the project. Impacts to bedrock under either alternative would be negligible.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR GEOLOGY

Mitigation of impacts to petroleum hydrocarbons would be in conflict with the purpose of the applicant's proposed action. Therefore no measures have been identified to mitigate impacts to geological resources under Alternative A or Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR GEOLOGY

There were no stipulations identified in the Northeast National Petroleum Reserve-Alaska IAP/EIS regarding geology, and there are no potential mitigation measures developed in this EIS.

4A.2.1.3 Soils and Permafrost

The thermal regime of permafrost is the dominant control on soil formation and soil properties on the Arctic Coastal Plain. Problems associated with oil field development in the continuous permafrost zone stem from alteration of ground temperatures by construction and operation of oil production infrastructure. Destructive thermokarst often results where permafrost melting occurs in ice-rich, fine-grained sediments (Truett and Johnson 2000, Walker et al. 1987a).

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SOILS AND PERMAFROST

CONSTRUCTION PERIOD

Direct Effects

Direct effects on soil and permafrost that would occur during Alternative A – CPAI Development Plan's construction period include gravel excavation, placement of fill on tundra, ice road and ice pad construction, tundra travel, and culvert, VSM, and power pole installation.

Gravel excavation/blasting would occur during the winter and would require overburden removal and storage on an ice pad adjacent to the pit. Overburden would be replaced before break-up and recontoured following pit closure. Gravel excavation constitutes a loss of overburden and active layer soils, alters local hydrology, and causes erosion and landscape scarring (Meehan 1988).

The estimated volume of gravel required for construction under Alternative A – CPAI Development Plan is 20 million cy. As a basis for rough estimates of mine pit areas, extrapolations can be made from the conditions and overburden depths experience gained during Phase I (1999 and 2000) of ASRC Mine Site operations. About 35,000 cy of material per acre were extracted at the site (TMA 2000). Thus, extraction of the subsurface gravel required for construction of Alternative A – CPAI Development Plan would impact approximately 65 acres of tundra at Clover (Appendix O).

Ice pads may be constructed adjacent to active material sources to stockpile overburden. The impacts of ice pads to the underlying soil and permafrost would likely be greater than those sustained from ice roads, due to the greater and constant weight of overburden. However studies quantifying the impacts were not identified for this evaluation. Overburden extends to approximately 22 feet at the ASRC Mine Site (TMA 2000) and is estimated to range from 6 to 20 feet at Clover (Appendix O). Assuming an average overburden thickness of 16 feet and that 1 acre of ice pad would be required for each 25,000 cy of overburden (TMA 2000). Ice pads would cover a maximum 267 acres of tundra under Alternative A – CPAI Development Plan.

The construction of gravel pads, roads, and airstrips requires a thickness of fill equal to or greater than the depth of summer thaw. Addition of fill effectively increases the insulating capacity of the active layer and prevents destructive thaw settlement (NRC 2003, Brown et al. 1984). Placement of fill on tundra constitutes a direct loss of the underlying soil and alters active layer properties and surface hydrology (Hanley et al. 1980). Compaction of vegetation and soil at the edge of fill provides greater heat conductivity and has been shown to cause subsidence parallel to road beds (Auerbach 1997). The damming effect of fill creates impoundments and diverts surface water flow along the edge of fill (Auerbach 1997, Hanley et al. 1980). Assuming a depth of fill is 5 feet for roads and airstrips, 5 to 6 feet for production pads, and further assuming a 2:1 side-slope on all fill, gravel would overlie approximately 241 acres of tundra under Alternative A – CPAI Development Plan.

Temporary ice roads and ice pads would be constructed to stage and transport materials and equipment, to access drill sites, and to construct pipelines, gravel roads, bridges, and overhead powerlines. Although thaw settlement could result if the ice road compaction of vegetation appreciably decreased the insulating capacity of the active layer (Felix et al. 1992), investigations addressing ice road impacts show that impacts are confined to the vegetative layer (Walker et al. 1987b). One, 2 and 24 years after abandonment, no significant variation in active layer depths was found across the traces of 1-year ice roads on the North Slope (BLM 2002, Payne undated). In addition, a pilot study conducted west of Nuiqsut concluded that no significant difference in active layer depth existed between a 2-year and 1-year ice road (Yokel et al. undated). Temporary ice roads and adjacent ice pads would cover a total of 1,449 acres of the Plan Area over six winter construction seasons under Alternative A – CPAI Development Plan, assuming the following conditions exist:

- A standard ice road width of 40 feet
- Placement of a 150- by 300-foot ice pad every 0.5 miles along ice roads for pipeline construction
- Placement of a 800- by 800-foot ice pad on either side of the proposed seven bridge sites

Winter tundra travel would occur during construction in order to pre-pack ice roads, transport gravel, and construct pipelines and overhead powerlines. Winter tundra travel permits allow operation of low-pressure (less than 4 psi) vehicles only and requires a 12 inch depth of frost and 6 inches of snow cover. When low-pressure vehicles are used, winter travel does not appear to adversely affect soil and permafrost. The difference in thaw depth between tundra disturbed by 400 passes of 20 Rolligon tractor-trailers (low-pressure vehicles) on a North Slope winter trail and undisturbed tundra was not significant (Roth et al. undated). The miles of temporary winter trails required for construction under Alternative A – CPAI Development Plan is circumstantial, and is therefore difficult to estimate.

The installation of culverts, VSMs, and power poles all involve ground disturbance and therefore have similar impacts on soil and permafrost. Excavation and drilling required for installation alter soil properties and destroy the overlying vegetative mat. Loss of the insulating vegetation, soil compaction, and installation of dense infrastructure can increase heat flux to the subsurface.

To preserve natural drainage patterns, roads would be culverted for all alternatives. Culvert installation involves excavating across the roadbed to a depth 2 feet below the bottom of fill, placing bedding material, laying the culvert, and backfilling with gravel (McDonald 1994). The passage of air and water through culverts placed in the active layer would introduce heat into the subsurface during the summer and could potentially degrade permafrost. Conversely, culverts not filled with snow in the winter would be poorly insulated from the winter cold and may allow permafrost to aggrade (Brown et al. 1984). Assuming culverts are placed every 500 feet, and that the average width and depth of a culvert trench in tundra soil is 5 and 2 feet, respectively, 280 culverts would be placed, consequently disturbing approximately 5,800 cy of soil.

Installation of VSMs and power poles are proposed to carry power cable and fiber-optic cables between production pads. Placement of VSMs would utilize drilling and slurry backfill techniques. Borings 20 to 25 feet-deep and spaced 55 feet apart would be drilled directly from an ice road for the installation of VSMs. Assuming an average boring diameter of 26 inches, 3,418 VSMs would be installed and would disturb approximately 12,200 cy of soil under Alternative A. Alternative A proposes suspension of an overhead powerline on poles between CD-6 and CD-7. Power cables would be carried in a VSM cable tray between all other production pads. Borings for power pole installation would be two feet in diameter, approximately 15.5 feet-deep, and spaced 250 feet apart. Under Alternative A, 137 power poles would be installed and installation would disturb approximately 250 cy of soil. Heaving of both VSMs and power poles due to active layer freeze and ice lens formation has been a reoccurring problem in northern regions. The integrity of the VSM or power pole is affected when heave results from the failure of permafrost soil to adfreeze to the pile (Nottingham and Christopherson 1983).

Wastewater and water discharged to the tundra could originate from temporary camps and hydrostatic pipeline testing, respectively. Temporary camps would be necessary to support the construction and drilling activities under either alternative. All project pipelines would undergo hydrostatic testing before operation. Domestic wastewater from these camps could be disposed of through onsite annular injection, by hauling to the Alpine wastewater system, or by treatment and discharge to the tundra. Fresh water used for hydrostatic testing of pipelines would be tested for contaminants, filtered, and subsequently discharged onto the tundra. Discharge of wastewater or test water during the frozen season could create sheet ice that would increase soil moisture levels following the spring melt. Discharge during the nonfrozen season could cause soil erosion and create impoundments. Discharge to the tundra of both domestic wastewater and water used for hydrostatic testing is allowed under a General NPDES Permit. The volume of wastewater discharged to the tundra would be dependant on the number of personnel housed in temporary camps, the duration of camp use, and the method of disposal chosen. The volume of test water discharged to the tundra would be dependant on the type of water used (fresh or salt) and the volume of water required. Because of these variables, the volume of water discharged to the tundra is difficult to estimate.

Indirect Effects

The primary indirect effect of impacts to soil and permafrost sustained during the construction period is permafrost degradation. The construction activities most likely to initiate permafrost degradation are gravel excavation, the placement of fill on tundra, and culvert installation. Where permafrost degradation occurs in ice-rich sediments, thermokarst would likely result (Truett and Johnson 2000, Walker et al. 1987a). Permafrost degradation and thermokarst are considered indirect impacts due to their delayed manifestation and potential to propagate from the original area of impact. Discussion and estimates of potential thaw settlement for geomorphic units in a portion of the Plan Area are provided in Section 3.2.1.3.

The degree and extent of permafrost thaw and thermokarst initiated by gravel excavation largely depends on the hydrological condition of the pit following its closure. The modification of surface topography accompanying gravel excavation often alters natural drainage patterns, and results in the creation of impoundments or of flowing water which may thermally and hydraulically erode sediments (Walker and Walker 1991, IPASC 2003). If the pit is flooded by either natural drainage or human action to a depth greater than 6 feet, geologic material at the lake bottom would remain unfrozen year-round, allowing formation of a thaw bulb (talik) in the soils below the lake base. If depth of flooding is less than 6 feet, the lake and lake bottom soils would freeze each winter (NRC 2003). Degradation of local permafrost would still occur in this scenario due to the lower albedo and greater heat absorption of water relative to the original vegetation, but less permafrost melting would occur than that associated with thaw bulb formation (Walker et al. 1987a). If the pit does not flood and overburden is not replaced before break-up, exposure of mineral sediments to summer heat would increase the active layer depth at the expense of permafrost.

The placement of fill on tundra impounds and diverts surface water flow and intercepts drifting snow. Klinger et al. (1983b) reported that snowbanks within 39 feet of the West Road at Prudhoe Bay were 5 to 10 times deeper than the natural snowpack. Greater than normal accumulations of plowed or drifted snow increases local soil moisture levels (Brown et al. 1984). Ponding and channeling of surface water flow along the edge of fill (Auerbach 1997, Hanley et al. 1980) increases heat flux to the subsurface, can initiate thermokarst, and would erode surface sediments (Walker et al. 1987a, Walker 1996). Relative to dust and snowbanks, flooding was determined to be the most spatially-extensive impact at West Road (Klinger et al. 1983a). Impoundments cover an area more than twice the area of initial gravel placement in a heavily developed portion of the Prudhoe Bay Oilfield (Walker et al. 1987b).

Roadbeds constructed for Alternative A would be culverted to preserve natural patterns of surface flow to the extent possible. When improperly placed, culvert function is compromised and can potentially expand the area and extend the duration of spring flooding (Walker et al. 1987b). Culverts placed during winter construction, as is proposed for this project, often misjudge the location and elevation of natural drainages and thus do not completely drain the upgradient side of the road. Blockage of seasonal floodwaters may be compounded by the presence of late-melting snow and ice in culverts or the bowing of culvert ends above the level of impounded water. Culvert bowing is caused by greater thaw settlement along the centerline of the road relative to road margins; differential thaw settlement is likely due to inadequate compaction of frozen road and culvert bedding material (Brown et al. 1984). Wind-generated wave action in the temporary impoundments of floodwater can erode the roadbed and sudden release of floodwater may result in washouts (McDonald 1994, Brown et al. 1984).

The effects of water discharge to the tundra are not well defined. If water discharged to the frozen or nonfrozen tundra is eventually or immediately impounded, enhanced absorption of summer heat by active layer soils could initiate thermokarst. Active layer changes resulting from winter tundra travel and VSM and power pole installation represent minor thermal impacts that permafrost soils could sustain without thermokarst.

OPERATION PERIOD

Direct Effects

The operation phase would result in no additional physical disturbance to the ground surface. However, permafrost degradation and thermal and hydraulic erosion initiated during the construction phase would continue and possibly become more severe (Hanley et al. 1980). Direct effects on soil and permafrost that would occur during the operation period include: dust fallout, snowplowing, gravel spray, tundra travel, transmission of warm reservoir fluids, sub-permafrost injection of waste, and accidental oil spills.

Dust generated from vehicle travel decreases the albedo of roadside snow and increases the alkalinity of the underlying soil (Walker et al. 1987b). In turn, the lower albedo of dust-coated snow initiates early melt and allows for greater cumulative absorption of radiation by the active layer. Increase in the alkalinity of soil adjacent to roads diminishes the vigor of acidophilus moss species and thus the insulating capacity of the vegetative mat (Auerbauch 1997). On roads with minimal winter traffic, snowdrifts do not receive much dust and melt about 2 weeks later than the surrounding tundra (Klinger et al. 1983b). Late-melting snow provides greater insulation to the underlying permafrost (Auerbauch 1997).

Snowplowing and road-grading may spray gravel onto the tundra. Thin deposits of fill on dry tundra lower the surface albedo and stimulate plant growth by increasing soil temperatures. An increase in plant growth may eventually lead to greater insulation of the active layer. Alternatively, thick deposits of gravel would compact or kill vegetation (Truett and Johnson 2000). Greater heat conductivity and the decreased albedo of thick gravel, relative to intact vegetation, would increase the active layer depth.

Summer and winter tundra travel would occur during the operation period for maintenance and repair of infrastructure, for response to oil spills and other emergences, to facilitate ice road construction, or for transport to roadless sites. Travel by low-pressure vehicles during the summer is allowed by special permit only, however exceptions are made for emergency situations. The regulations for, and impacts associated with, winter travel via low-pressure vehicles are the same as those previously described under direct effects for the construction period. Low-pressure vehicle travel in the summer produces a greater impact than winter travel and varies in accordance with vegetation type and the number of vehicle passes. Wet tundra is most vulnerable to low-pressure vehicle impacts and a concentration of low-pressure vehicle traffic on a limited number of tracts produces the most noticeable impact (Walker et al. 1987b). The miles of summer trails required for pipeline maintenance and oil spill response is partially dependant on the proper functioning of infrastructure, and is therefore difficult to estimate.

The passage of warm oil, gas, and produced water through oil wells results in the conduction of heat to surrounding permafrost ground. Up to 32 oil wells with 20-foot well head spacing are proposed at each of the five production pads (CD-3 through CD-7) for a total of 160 oil wells. At the Alpine Development Project, thawing caused by the passage of 109°F fluids is slowed by a combination of passive heat pipes (thermo-siphons) and insulated conductor pipe installed to 50 and 80 feet, respectively. Similar refrigeration technology is proposed for Alternative A. Despite these mitigation measures, annular thaw below the refrigerated interval would gradually expand and coalesce with zones of annular thaw from neighboring wells (NRC 2003).

Disposal of hazardous and non-hazardous waste, or oil and gas production wastes, would occur by injection into Class I Hazardous, Class I Non-Hazardous, or Class II injection wells, respectively. Similar to the production of reservoir fluids, injection of warm waste slurry would raise the temperature of permafrost ground adjacent to the well-casing. Warming of the permafrost base above the receiving reservoir has also been documented (NRC 2003). Class I Non-Hazardous and Class II wells exist at APF-1. Alternative A – CPAI Development Plan proposes installation of at least one additional Class II disposal well. Specific production pads have not yet been identified for installation of injection wells.

The accidental release of oil to the ground surface alters soil and active layer properties. Three years after the addition of crude hydrocarbons to wet soil in Barrow, soil pH shifted toward neutral and the infiltration rate and availability of plant cations were decreased. These trends were attributed to the absorption of hydrocarbons into soil organic matter (Everett 1978). The degree of impacts on soil and permafrost by oil is dependant on the thermal condition of the ground at the time of the spill and on moisture levels in nonfrozen receiving soils (Walker 1978). Release of oil to snow or frozen tundra produces a larger area of impact, due to enhanced lateral movement of oil over the frozen surface (Collins et al. 1993). However, oil is easier to clean up and would be less likely to impact vegetation, soil, and permafrost under Alternative A, due to the retarded penetration into frozen ground (Truett and Johnson 2000). Penetration of oil at water-saturated sites would be minor. Oil spilled onto saturated soil would disperse as thin film, allowing lighter components to volatilize (Walker et al. 1987b). Because volatilization of oil at saturated sites is enhanced, recovery of vegetation takes less than 10 years, whereas recovery at dry sites may take twice or three times as long. Impacts on soil and permafrost by potential oil spills is conjectural and cannot be quantified, however Truett and Johnson (2000) report that, historically, relatively few oil spills in North Slope oilfields have contacted and killed tundra vegetation. By extension, impacts to soils and permafrost would be minor.

Indirect Effects

The primary indirect effects of impact on soil and permafrost sustained during the operation period would be permafrost degradation. Where permafrost degradation occurs in ice-rich sediments, thermokarst is the likely result (Truett and Johnson 2000, Walker et al 1987a). Estimates of potential thaw settlement for geomorphic units in the Plan Area are provided in Section 3.1.1.3. Permafrost degradation and thermokarst are considered indirect impacts due to their delayed manifestation and potential to propagate from the original area of impact.

Accumulations of plowed and drifted snow, dust fallout, loss of insulating moss, and thick deposits of gravel spray contribute to roadside thermokarst. Several studies have found that the depth of active layer thaw was significantly deeper adjacent to Prudhoe Bay roads than they were at greater distances from the roads (Haag and

Bliss 1982, Webber et al. 1985, Walker and Everett 1987, Auerbach 1997). Webber et al. (1985) and Walker and Everett (1987) also documented ice wedge melting and the subsequent conversion of low-center polygons to high-center polygons along Prudhoe Bay roads. Indirect impacts due to dust fallout and changes to moisture and thermal regimes were quantified by creating a 164-foot buffer (Hettinger 1992, BLM and MMS 1998a, 2003b) in the ArcView 8.3 GIS application around the outside of the gravel fill. Based on these calculations, the estimated area of thermal impact under Alternative A is 1,152 acres.

Compaction and exposure of vegetation and soil by low-pressure vehicles operating in the summer have been shown to cause thermokarst under certain conditions. In general, the impact of summer tundra travel by low-pressure vehicles is dependant on hydrological and permafrost conditions. The trace of a single Rolligon's pass through wet tundra could not be located 7 years after the disturbance. However, tracks from ten passes of Rolligons depressed the wet tundra surface by 5.9 to 7.9 inches and produced collapse features 11.8 inches-deep where the tracks crossed ice wedges. Persistence of thermokarst features indicates thermal equilibrium had not been achieved in the 7-year period following the disturbance (Walker et al 1987b).

Transmission of warm production fluids and waste slurries through the permafrost interval cause permafrost melt adjacent to the well-casing, and can potentially cause well-bore and well-house subsidence. It is estimated that annular thaw would advance upward to 40 feet bgs and cause an eventual thaw settlement of 12–24 inches at the ground surface (NRC 2003). Waste injection would have the additional impact of degrading the base of permafrost. Sub-permafrost injection of waste at Prudhoe Bay Pad 3 was shown to cause warming in the bottom 150 feet of permafrost (NRC 2003).

The increased albedo and reduction of plant cover caused by oil spills alters the thermal regime of the active layer and may cause thermokarst (Truett and Johnson 2000). The depth of thaw in soils impacted by a 6-year old crude oil spill from the TAPS at Franklin Bluffs was 39 inches greater than average thaw depth in undisturbed tundra (Walker et al 1985). Similarly, Everett (1978) reports 28 years after a spill at the Fish Creek test well site vegetation had recovered little, strong diesel odors persisted, and thaw depth was significantly deeper beneath the spill. Petroleum contamination persists in the arctic due to the low rates of biodegradation and volatilization.

Thermal impacts to permafrost are exacerbated by recent increases in high-latitude air temperatures. If correlative trends in permafrost warming continue, permafrost temperatures would increase 2°F at coastal sites and 5.4°F at inland sites over the 20-year life of the project. Because the temperatures of Arctic Coastal Plain permafrost are low (19.8°F to 15.6°F) (Romanovsky and Osterkamp 1995) permafrost can sustain substantial warming before actual melt occurs.

ABANDONMENT AND REHABILITATION

Soils and permafrost would be negligibly impacted by removal of aboveground facilities at CD-3 (pipelines, bridges, and power poles), assuming that they are removed during winter. Removal of aboveground facilities at CD-4 through CD-7 also would have negligible impacts on soils and permafrost. If production pads and roads are maintained, soils and permafrost would remain unaffected. Once maintenance of the roads and production pads is stopped, thaw subsidence in ice-rich areas will result in settling of the gravel structures into thermokarst troughs. Removal of the roads and production pads would accelerate the thaw subsidence, but would also accelerate the reclamation process.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SOILS AND PERMAFROST

Direct and indirect impacts incurred during construction and operation of Alternative A – FFD would be similar to those presented for Alternative A – CPAI Development Plan, but would be incurred over greater spatial and temporal extents. Alternative A – FFD infrastructure would extend to the Plan Area boundary and construction would occur over a 20-year period. The volumes, areas, and distances listed below were calculated under the same assumptions presented for Alternative A. but do not include the impacts quantified for Alternative A's infrastructure and activities.

Alternative A – FFD would place 8.8 million cy of gravel over 1,262 acres of tundra. Gravel excavation required for Alternative A – FFD would disturb 346 acres of tundra and would require 358 acres of ice pad for stockpiled overburden. Temporary ice roads and ice pads associated with construction and staging would cover a total of 2,575 acres over 20 winter seasons. Because the number of bridges required for construction of Alternative A – FFD was not determined, the area of ice roads and adjacent pads does not include ice pads associated with bridge construction. Installation of 1,300 culverts and 14,411 VSMs would disturb 27,000 and 51,400 cy of soil, respectively. Additional overhead powerlines are not proposed for Alternative A – FFD. This alternative would construct two HPFs (HPF-1 and HPF-2) and 22 HPs, in addition to the five production pads (CD-3 through CD-7) proposed under Alternative A – CPAI Development Plan. Up to 32 oil wells are proposed at each HP. Alternative A – FFD would include both Class I and Class II disposal wells at each HPF, and additional Class II disposal wells at the HPs. Specific production pads have not yet been identified for the installation of injection wells under Alternative A – FFD. Assuming 704 oil wells and four waste injection wells are constructed for FFD, impacts to permafrost would be approximately four times those incurred under the Alternative A – CPAI Development Plan. Due to the hypothetical nature of Alternative A – FFD, impacts due to tundra travel, bridge construction, and discharge of water to the tundra could not be estimated.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SOILS AND PERMAFROST

Placement of fill on the tundra and the construction and operation of roads represent the greatest impacts on Plan Area soils and permafrost, respectively. Impacts that increase heat flux to ice-rich permafrost can initiate thermokarst and compromise the integrity of overlying or adjacent infrastructure. Impacts to Plan Area soil and permafrost resources would be unavoidable and semipermanent.

Alternative A would place gravel or ice over approximately 1,757 acres of soil, disturb approximately 2 million cy of soil via gravel excavation and the placement of infrastructure, and thermally impact 1,152 acres of tundra. The surface area of soil impacted both directly and indirectly under Alternative A represents approximately 0.2 percent of the total Plan Area, which is an inconsequential impact.

Alternative A – FFD would place gravel or ice over approximately 4,195 acres of soil and disturb approximately 8.8 million cy of soil via gravel excavation and the placement of infrastructure. The surface area of soil impacted both directly and indirectly under Alternative A – FFD represents approximately 1.2 percent of the total Plan Area. This area includes the disturbance associated with both direct and indirect impacts, however, it does not account for disturbance of ice pads for bridge construction.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SOILS AND PERMAFROST

Soil and permafrost systems could recover to their pre-impact state but not without appropriate mitigation. Because impacts to soil and permafrost are generally unavoidable, mitigation measures aim to minimize the degree and magnitude of the action.

Impacts associated with gravel excavation and placement of fill on the tundra are minimized by reducing the gravel footprint required for the ASDP. The need for gravel can be decreased by reducing road miles and by recycling drill cuttings for use as fill. If reducing the volume of gravel required for construction is not possible, then sequential mining with the replacement of overburden in previously excavated areas is recommended to rectify impacts to local soil and permafrost (Meehan 1988). Revegetation of gravel mine sites restores the insulative capacity of the active layer and allows reaggradation of permafrost where melt has occurred. Irrigation and natural recolonization of tundra plant species is the most effective method of rehabilitation for physically-disturbed sites where some soil remains. Providing that soil overburden is returned to the excavation, diversion of water into the pit would speed the natural colonization of vegetation, thereby improving soil structure and insulating permafrost (Walker et al 1987b). Mineral soil or bedrock (at the base of upland mine sites) and areas of thick gravel fill (such as roads, pads, airstrips) are environments that are too hostile for natural recolonization of most tundra plant species (Jorgenson 1997), and thus would remain barren unless more aggressive rehabilitation measures were initiated (Meehan 1988). These aggressive rehabilitation measures could include topsoil application, gravel removal (for areas of fill only), surface manipulation for moisture enhancement, nutrient addition, and/or plant cultivation (Jorgenson 1997).

Impacts on soil and permafrost associated with the construction and operation of roads can be minimized by placing a sufficient thickness of fill, carefully considering road alignment, culverting, dust control, and snow blowing. A thickness of fill greater than the maximum depth of summer thaw is necessary to prevent melting of the subgrade (NRC 2003). Alignments across ice-rich sediments, natural drainages, and acidic tundra with abundant Sphagnum species should be avoided to reduce the alteration of natural surface water flow, the need for culverts, and the potential for thermokarst (Auerbach 1997). Where the placement of fill would impede drainage, culverts should be placed and maintained so that they are capable of handling flooding (Klinger et al. 1983b). To ensure that culverts completely drain the upgradient side of the road, culvert locations should be determined under conditions of maximum flow prior to road construction, and culvert blockages should be removed or prevented. Culvert maintenance could include annual clearing of snow and ice blockages, placement of an end cap in the fall and removal of the cap before break-up (McDonald 1994, Brown et al. 1984), or installation of steam pipes in culverts to reduce flooding (Klinger et al. 1983b). Because pads and airstrips cannot be culverted (Meehan 1988), they should be oriented parallel to natural drainages and to the direction of prevailing wind to avoid impoundments and accumulations of drifted snow (Meehan 1988). Where alignment of high-traffic roads through sensitive tundra cannot be avoided, chip-seal surfacing, periodic watering, or application of hydroscopic chemicals such as Calcium Chloride ($CaC1_2$) is recommended to control dust (NRC 2003, Meehan 1988, Walker and Everett 1987). The impact of gravel spray on permafrost is minimized by electing to blow snow instead of plowing it. The impacts of ponding caused by snowbank melt can be minimized by designating contained areas for cleared snow.

Impacts associated with placement of infrastructure can be mitigated by selecting an alternative that minimizes the miles of pipeline and powerline required and avoids placing VSMs and/or power poles in ice-rich sediments. Alternatives that shorten the route of pipelines and powerlines would require less VSMs and power poles for construction, and would thus disturb a smaller volume of soil. Similarly, running power cable in a tray supported by pipeline VSMs would eliminate the need to construct a separate powerline or to bury power cable. VSM and power pole jacking can be minimized by avoiding clays and coarse-grained material (which have characteristically low adfreeze bond strengths), and by placing VSM or power poles at least twice as deep as the maximum summer thaw (Nottingham and Christopherson 1983). To prevent well-bore and well-house subsidence, thermo-siphons and insulated conductor pipe should be installed.

Impacts resulting from water discharge onto the tundra would be avoided if the water generated by temporary camps is hauled to the APF-1 for treatment or disposed of onsite by injection. Onsite injection of hydrostatic pipeline test water would also be permissible if sea water was used instead of fresh water. If wastewater and hydrostatic test water are released to the tundra, impact to soil and permafrost would be minimized by targeting terrain that is sloped enough to allow drainage of water, but is not so steep that soils are eroded. Controlling discharge flow and protecting the tundra surface would further minimize erosion.

To avoid impacts of tundra travel on soil and permafrost it is best to restrict travel to winter months, when impacts extend to the vegetative mat only. If summer travel is necessary, measures to minimize impacts include limiting traffic, avoiding tight turns, using different paths to disperse disturbance, and following the shortest path from origin to destination (Jorgenson et al. 1996).

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SOILS AND PERMAFROST

The Northeast National Petroleum Reserve-Alaska IAP/EIS stated that emphasis should be focused on maintaining the thermal properties of the existing vegetation and surface organic mat, or substituting other thermal insulation. In particular, replacing topsoil, removing gravel fill, and in some cases reseeding, would be effective mitigation measures to accomplish this goal. In addition, reducing erosion by diverting runoff from exposed surfaces, and taking measures to reduce overland flow velocities, would be effective measures in reducing soil and permafrost impacts.

4A.2.1.4 Sand and Gravel

Once used, sand and gravel resources utilized for road, production pad and/or airstrip construction could only be available for re-use upon abandonment.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SAND AND GRAVEL

CONSTRUCTION PERIOD

The estimated volume of gravel needed for Alternative A is 2 million cy. ASRC has a gravel mining and restoration plan already in place for their pit. The restoration plan for Clover is presented in Appendix O. Impacts to sand and gravel are similar to those discussed in Section 4A2.1.3 Soils and Permafrost. The primary construction activities consist of removing sand and gravel for road and production pad construction.

OPERATION PERIOD

During the operation period, small amounts of gravel are expected to be extracted from existing permitted mine sites for repair of road and production pad embankments (for example, if a washout occurs).

ABANDONMENT AND REHABILITATION

Abandonment will not impact sand and gravel unimpacted by construction. The sand and gravel in production pads, roads, and airstrips that are left in place will gradually become unavailable for re-use in ice-rich areas as it settles into thermokarst troughs. If the BLM Authorized Officer (AO) determines that the gravel cover should be removed, it could be used for other development in the area, or returned to the pits from which it was extracted. Returning gravel to pits may require alteration of mine rehabilitation plans. Contaminated sand and gravel in the production pads would not be re-used, but treated and disposed of in an approved manner.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SAND AND GRAVEL

Alternative A – FFD would utilize and expand on the same road network that would be constructed under Alternative A – CPAI Development Plan. Alternative A – FFD, depicted in Figure 2.4.1.2-1, is estimated to require 8.8 million cy of gravel (see Tables 2.4.1-6 and 2.4.1-7). With the exception of the potential use of Clover, the source of this gravel has not yet been determined.

If alternative embankment designs, such as use of insulation in embankments, are used under Alternative A – FFD (see Section 2.3.1.1), less sand and gravel would be affected.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SAND AND GRAVEL

Once used, sand and gravel utilized for road, production pad and/or airstrip construction could only be available for re-use upon abandonment. Removal of gravel fill is not currently a scheduled element of abandonment activities.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SAND AND GRAVEL

No measures have been identified to mitigate impacts to sand and gravel resources under Alternative A nor Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SAND AND GRAVEL

Stipulations 32 and 40 of the Northeast National Petroleum Reserve-Alaska IAP/EIS would reduce impacts associated with the sand and gravel operations for the applicant's proposed action. Stipulation 32 minimizes the amount of utilized gravel by minimizing the number of production pads and roads between them, integrating facilities (such as an airstrip with a road) as much as possible, and implementing gravel saving technologies, such as insulated or pile-supported production pads. Stipulation 40 reduces the effects of gravel mining by prohibiting mining in the active flood plain of a river, stream, or lake, and by restricting the number of new sites to the minimum necessary for efficient development. This current EIS has not identified any additional mitigation measures

4A.2.1.5 Paleontological Resources

Paleontological resources are nonrenewable. Once they are adversely impacted or displaced from their natural context, the damage is irreparable.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON PALEONTOLOGICAL RESOURCES

Because paleontological resources are not ubiquitous within the Plan Area as are habitat and wildlife, it is quite possible that the applicant's proposed action would have no impact on paleontological resources, simply because the activities would occur where paleontological resources are not present (BLM and MMS 1998a). The only known paleontological sites within the Plan Area are found outside of areas likely to be disturbed by the applicant's proposed action, with the heaviest concentration of known fossil localities in the vicinity of Ocean Point, on the bank of the Colville River, approximately 13 miles southwest of Nuiqsut. Places of particular concern are those areas that have bluff exposures.

CONSTRUCTION PERIOD

The likelihood of affecting surface paleontological materials within the Plan Area is low because of their isolated and rare occurrence.

The primary source of potential impacts to paleontological resources would result from the excavation of sand and gravel material at the ASRC Mine Site and at Clover. Disturbance at the ASRC Mine Site would occur within the permitted footprint. Surface disturbance at Clover would encompass approximately 65 acres (Appendix O). Extraction of sand and gravel from these sites could affect paleontological resources.

Drilling of as many as 150 production wells could occur under Alternative A. Resulting subsurface disturbance would be limited to the annulus of the well-bore itself. It is unlikely that drilling would affect important, accessible paleontological material.

Pipelines and overhead powerlines would be constructed during the winter months from ice roads and pads. Therefore, the only impact resulting from pipeline and powerline construction would be associated with the placement of approximately 3,418 VSMs and the potential placement of power poles between CD-6 and CD-7. Vehicle bridges at river crossings would be constructed during the winter months from ice roads and pads. Therefore, the only impact resulting from bridge construction would be associated with placement of sheet piling at bridge abutments, and foundation piles at abutments and in-stream locations. Because route surveys are required for all construction activities, the location of important archaeological and paleontological resources would be known and their disturbance would be avoided.

OPERATION PERIOD

No additional impacts to paleontological resources are expected during the operation period unless infrastructure is expanded (for example, pads are expanded or bridges are widened).

ABANDONMENT AND REHABILITATION

Paleontological resources will not be impacted by abandonment activities.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON PALEONTOLOGICAL RESOURCES

Under the Alternative A – FFD, the mechanisms associated with impacts to paleontological resources would remain the same as those described under Alternative A. However, the larger extent of the development would increase the intensity of the actions. The primary potential cause of impacts would be excavation of gravel on approximately 346 acres. Approximately three gravel mine sites would be developed to provide the volume of construction material necessary for Alternative A – FFD. The location of the gravel mine sites is unknown, but could potentially be sited so as to result in affects on paleontological resources. It is likely that the additional sand and gravel mine sites would be situated in the vicinity of the Fish–Judy Creeks Facility Group and/or the Kalikpik–Kogru Rivers Facility Group. In addition, approximately 1,262 acres could be covered by gravel during the construction of pads, roads, and airstrips.

ALTERNATIVE A–SUMMARY OF IMPACTS (CPAI AND FFD) ON PALEONTOLOGICAL RESOURCES

Surface activities, such as the construction of pad, road, and airfield embankments, are not likely to affect paleontological resources. Impacts could result from activities involving subsurface disturbance, such as sand and gravel mining. Installation of VSMs, power poles, and bridge piles would occur only after route surveys had been conducted, so important paleontological resources would be known and avoided. Excavation of sand and gravel (under approximately 65 acres for Alternative A and 346 acres for Alternative A – FFD constitute the greatest risk to paleontological resources. This "greatest risk" represents inconsequential impact potential to paleontological resources.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR PALEONTOLOGICAL RESOURCES

No additional measures have been identified to mitigate impacts to paleontological resources under Alternative A nor Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR PALEONTOLOGICAL RESOURCES

Stipulation 74 of the Northeast National Petroleum Reserve-Alaska IAP/EIS requires surveys for cultural and paleontological resources prior to any ground disturbing activities. This stipulation ensures that resources are noted and that appropriate avoidance or collection measures are taken. No additional mitigation measures are identified in this EIS.

4A.2.2 Aquatic Environment

4A.2.2.1 Water Resources

This section consists of four main parts: an introduction to general concepts regarding impacts to water resources, a description of the impacts to water resources during construction, a description of the impacts during operations, and last, a description of Alternative A – FFD in relation to water resources issues. The construction and operation discussions within each part are structured similarly, as follows: impacts to subsurface waters are described first, followed by impacts to surface waters, and lastly, impacts to the nearshore and estuarine environment.

Within the surface waters discussion, construction impacts are discussed in the following order: those associated with water supply demands, those associated with water withdrawals, those related to roads and pipelines, and those associated with pads.

Within the operational impacts section, six major topics are discussed in the following order: 1) impacts to subsurface water, 2) impacts to lake hydrology, 3) hydrologic analyses and modeling to assess effects of facilities and structures, 4) impacts to surface waters associated with facilities and structures, 5) impacts to the nearshore and estuarine environment, and 6) impacts associated with ice conditions during break-up. At the end of the water resources section, a summary of impacts is included and followed by a section describing mitigation measures (including monitoring), and the effectiveness of protective measures.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON WATER RESOURCE QUANTITIES AND PHYSICAL PROCESSES

Potential impacts to water quantities and physical processes associated with groundwater, surface water (lakes and streams), estuaries, and the nearshore environment could result from construction and operation activities associated with Alternative A. Elements that could affect water resources include gravel roads, ice roads, pipelines, production pads, bridges, culverts, airstrips, gravel pits, groundwater well reinjection activities, and water supply extraction (for potable water and construction use). Potential impacts would typically fall into one or more of the following categories:

- Shoreline disturbance and thermokarsting
- Blockage or convergence of natural drainage
- Increased stages and velocities of floodwater
- Increased channel scour
- Increased bank erosion
- Increased sedimentation
- Increased potential for overbank flooding
- Removal or compaction of surface soils and gravel, and changes in recharge potential
- Produced water spills
- Demand for water supply

CONSTRUCTION PERIOD

Table 4A.2.2-1 summarizes potential construction impacts to water resources in the general vicinities surrounding CD-3 through CD-7, including the roads and pipelines connecting the facilities. The table also provides qualitative indicators of whether a particular impact may occur to a specific water resource (i.e., groundwater, lakes, streams, etc.), but does not provide a measure of likelihood. The potential type of impacts listed above are numbered from 1-10, and shown at the bottom of the table for each type of facility/project component (i.e., gravel road, production pad, etc.). If an impact is indicated, it is understood that appropriate best management practices (BMPs) and design features will be incoporated to reduce the likelihood of specific impacts.

Impacts to Subsurface Water During Construction

As described in Section 3.2.2.1, North Slope groundwater resources are rare but are primarily shallow. Sparse data indicates that sub-permafrost groundwater is brackish to saline, rendering it non-potable. The permafrost forms an aquiclude that prevents the mixing of sub-permafrost and supra-permafrost groundwater. Therefore, deep groundwater injections are not expected to affect the quality or quantity of shallow groundwater.

Injection well permits and aquifer exemptions are issued by the USEPA and the AOGCC and take into consideration UIC regulations under the SDWA. UIC regulations are designed to protect all underground sources of drinking water. Thus, until proven otherwise, groundwater zones are assumed to be potential drinking water resources. UIC regulations define an underground source of drinking water as any aquifer that:

- Contains a sufficient quantity of groundwater to supply a public water system
- Contains fewer than 10,000 mg/L total dissolved solids
- Is not an exempted aquifer

The USEPA retains ultimate authority to exempt water in aquifers from this UIC criteria (USEPA 2004).

The State of Alaska, upon receipt of a Class II permit application may submit a request for approval of an aquifer exemption to the USEPA Region 10. An aquifer exemption may be determined to be a minor or substantial revision of the State's program. After consultation with the USEPA Region 10, an exemption may be considered if the USEPA concurs with the findings of the State of Alaska that an underground source of drinking water exists (40 CFR §144.3) and that specific criteria for an aquifer exemption (40 CFR §144.7 and §146.4) are met. To date, the USEPA has not made a determination that aquifers in the vicinity of the applicant's proposed action meet the UIC's criteria for an exemption.

In order to dispose wastes in a USDW, an operator must obtain an aquifer exemption from the USEPA and/or AOGCC. Three types of injection well permits are relevant to the applicant's proposed action: a one-time use (annular injection during drilling activities), a Class I Well, and a Class II Well permit. During the drilling phase of a wellfield, operators may dispose of drilling wastes (e.g. mud and cuttings that originated from down hole sources) one time, without obtaining additional class permits. Non-hazardous wastes associated with oil and gas exploration, domestic wastewater, non-hazardous wastes, stormwater, and other non-exploration and production materials can be injected into a Class I Well. Only non-hazardous wastes from downhole associated with oil and gas exploration and production can be injected into a Class II well. As with the one-time annular injection, the drilling wastes approved for injection are those that originated from down hole sources. Non-hazardous domestic wastewater can also be injected into a Class II Well, with approval from AOGCC, if it is intended to enhance oil recovery (USEPA 2004).

The drilling wastes that would be produced as a result of the applicant's proposed action from construction of the proposed wellfields could be disposed of into Class I and Class II Wells at CD-1. However, rather than haul the drilling wastes to CD-1, it may prove more practical to dispose of the wastes via annular disposal at the drilling sites. Class I and Class II Wells would be installed at the production pads as they are needed. Injecting drilling waste into deep groundwater zones would represent an insignificant impact since the potential injection zones likely contain non-potable resources, the sub-permafrost groundwater does not mix with supra-permafrost groundwater, and the deep groundwater would not be extracted for construction activities.

Water in shallow taliks or local supra-permafrost zones could be affected during the construction, operation, and rehabilitation of any gravel mine. These zones could be enlarged or eliminated by the removal of shallow surface soils, blasting and excavation of gravel, and rehabilitation of the site. Rehabilitation would include allowing natural flows to fill the mine site excavation, and then allowing the shallow zones to recharge naturally (Appendix O). In general, the construction of CD-3 through CD-7 could temporarily affect shallow subsurface water (or the hyporheic zones that exist as thaw bulbs around lakes and streams) and could temporarily change the thickness and vertical location of the active thaw zone in the immediate vicinity of each gravel mine. Impacts would be highly localized.

Impacts to Surface Waters During Construction

Impacts Associated with Water Supply Demands During Construction.

Lakes will supply fresh water for the construction of ice roads and pads during the winter construction months. Potential uses of the water include: for hydrostatic testing of newly-installed pipelines, for potable water at temporary construction or drilling camp facilities, for mud-plant operations during drilling, and for other maintenance activities. Long-term (more than 1 year) effects on lake water levels are not expected because natural annual recharge processes sufficiently recharge the lakes (Michael Baker, Jr. Inc. 2002). While some lakes have been found to have subsurface connections between adjacent lakes (USFWS 2003), whereby water withdrawals from one lake might lower the level of an adjacent lake, this effect would likely be short-lived, also due to the annual recharge processes. Pre- and post-lake level monitoring would be required to verify these impact predictions.

TABLE 4A.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES

Alternative A – CPAI Development Plan

	Groundwater		Lakes		Major and Minor Stream Crossings					Estuaries and Nearshore Environment	
CD-3 and Vicinity											
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamayayak Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta Mouth	Harrison Bay
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	NI	NI	NI	NI	NI	NI	7	NI
Ice Roads	NI	NI	8,10	8,10	2,3	NI	NI	NI	2,3	2,3	NI
Airstrip	8	NI	NI	NI	2,3,4,5	NI	NI	NI	NI	6	NI
Pipeline Segment: CD-1 to CD-3	NI	NI	NI	NI	2,7	2,7	2,7	NI	2,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	NI	1,2,3	6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI

	Groundwater		Lakes		Major and Minor Stream Crossings		Estuaries and Nearshore Environment
CD-4 and Vicinity							
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Colville River Delta including the Nigliq Channel	Minor Streams	Harrison Bay
Gravel Road Segment from CD-1 to CD-4	8	NI	NI	NI	2,7	2,3,4,5,6	NI
Ice Roads	NI	NI	8,10	8,10	NI	2,3	NI
Culverts and Culvert Batteries	NI	NI	2	2	2,3,7	2,3,4,5,6,7	NI
Pipeline Segment from CD-1 to CD-4	NI	NI	NI	NI	NI	2,7	NI
Production Pad	8	NI	8	NI	NI	1,2,3,4,5,6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

TABLE 4A.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – CPAI Development Plan

CD-5 and Vicinity

	Groundwater		Lakes		Major and Minor Stream Crossings		Estuaries and Nearshore Environment
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
Gravel Road Segment: CD-2 to CD-5	8	NI	NI	NI	2,3,4,5,6,7	2,4,5,6	NI
Ice Roads	NI	NI	10	10	NI	2,3	NI
Pipeline Segment: CD-2 to CD-5	NI	NI	NI	NI	2,7	6	NI
Production Pad	8	NI	8	NI	NI	2	NI
Bridges/Culverts (e.g., Nigliq Crossing)	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	6
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

CD-6 and Vicinity

	Groundwater		Lakes		Major and Minor Stream Crossings			Estuaries and Nearshore Environment
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish–Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-5 to CD-6	8	NI	5,6	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Ice Roads	NI	NI	10	10	2,3	2,3	2,3	NI
Pipeline Segment: CD-5 to CD-6	NI	NI	5,6	NI	NI	2,7	2,7	NI
Production Pad	8	NI	8	NI	NI	NI	2	NI
Bridges/Culverts	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	6
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

TABLE 4A.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – CPAI Development Plan							
	Groundwater		Lakes		Major and Minor Stream Crossings		Estuaries and Nearshore Environment
CD-7 and Vicinity							
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish–Judy Creek Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-6 to CD-7	8	NI	2	2	2,3,4,5,6,7	2,3,4,5,6,7	NI
Ice Roads	NI	NI	10	10	2,3	2,3	NI
Pipeline Segment: CD-6 to CD-7	NI	NI	NI	NI	2,7	2,7	NI
Production Pad	8	NI	8	NI	NI	2	NI
Bridges/Culverts	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

Notes:
1 = Shoreline disturbance and thermokarsting
2 = Blockage of natural drainage
3 = Increased stages and velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over-banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI = No Impact

The water demand during construction and maintenance of ice roads is expected to be approximately 1 million gallons [or 3.1 acre foot (ac-ft)] of water per mile of constructed ice road. The estimates for the periods of ice road construction provided in Section 2.4.1.1, indicate that annual demands for lake water could range from 16 to 67 million gpy (or 50 to 208 ac-ft/yr) over the 6 years of ice road construction needed to complete the project infrastructure. The estimated maximum annual water demand for ice road construction is roughly similar to the annual water demand of 2002 (64.7 million gallons) (Table 4A.2.2-2). As explained below, this represents only 3 percent of the total permitted lake volume. Water withdrawals are usually made from the nearest or largest permitted lakes along the route. Because it is sometimes difficult to pre-determine which lakes will be used for ice road development, permitting of additional lakes could be needed in the future. Prior to lake withdrawals, lake monitoring studies are recommended for each lake to evaluate the possibility of affecting habitats and recharge potentials.

Approximately 38,000 gpd, or 3.5 ac-ft per month, of water would be required to support drill rig and mud plant operations at each production pad location, and an additional, 5,000 gpd, or 0.46 ac-ft per month, of potable water would be used by the drilling camp until drilling is complete. Thus, activities at each pad would consume approximately 1.3 million gallons per month (4 ac-ft per month). Fresh water also would be used during any additional drilling or fire-fighting activities over the long-term. Fresh water might also be used to conduct hydrostatic testing of newly constructed pipelines, although it is likely that other sources (i.e., sea water, salt brines) will also be used. Based on preliminary analyses, a 12-inch pipeline would require about 5.9 gallons of fluid per foot of pipeline and a 24-inch pipeline would require about 23.5 gallons per foot. Testing will be conducted over short segments (likely no more than a few thousand feet) and the test fluid would be reused in successive subsections. Thus, the total fluid volumes needed for testing are rather small (i.e., about 12,000 gallons for 2,000 feet of a 12-inch line, or 47,000 gallons for 2,000 feet of a 24-inch line) compared to other needs. This volume is expected to be very small compared to the overall water demand associated with ice-road construction and other activities during the construction period.

Recent Monitoring of Impacts to Lakes Associated with Water Withdrawals

The ADNR regulates water withdrawals from any surface or subsurface water bodies such as those that may be utilized by the applicant's proposed action. In addition, as part of the National Petroleum Reserve-Alaska stipulations, minimum lake water depths associated with total permitted volumes for extraction have been established by the ADF&G, including sustained withdrawal, based on surface water flow during spring break-up events (see Table 4A.2.2-2). National Petroleum Reserve-Alaska Stipulation 20 limits the time and volumes of water withdrawals from lakes, as described below:

- No water will be withdrawn from rivers and streams during winter.
- No water will be withdrawn during winter from lakes less than 7 feet-deep if they are connected with, or subject to, seasonal flooding by a fish-bearing stream.
- Water may be withdrawn from isolated lakes less than 7 feet-deep that are not connected with, or subject to, seasonal flooding by a fish-bearing stream.
- Water withdrawals may be authorized from any lake less than 7 feet-deep if it is demonstrated that no fish exist in the lake.
- Water withdrawal during winter from lakes 7 feet-deep or deeper will be limited to not more than 15 percent of the estimated free-water volume (i.e., excluding the 7 feet of ice).
- Operators are encouraged to use new ice construction methods (e.g., aggregate "chips" shaved from frozen lakes) to decrease water demands, construction time, and impact on fisheries.
- Water withdrawals may be authorized for a drawdown exceeding 15 percent from a lake deeper than 7 feet when it is demonstrated that no fish exist in the lake.

TABLE 4A.2.2-2 2002 NATIONAL PETROLEUM RESERVE-ALASKA LAKES WATER WITHDRAWAL VOLUMES FROM ALL WATER SUPPLY DEMANDS

Lake	Location	Total Gallons Permitted	Total Pumped Volume Jan–May 2002 (Gallons)						Rank	Percent Used of Total Permitted
			January	February	March	April	May	Total		
R0052	Hunter	1,520,000	628,220	222,000	315,000	117,000	18,000	1,300,220	12	86.00
R0053	Hunter	24,000,000	9,000	0	0	0	0	9,000	16	0.04
R0054	Hunter	23,690,000	990,192	0	0	0	0	990,192	15	4.00
R0056	Hunter	339,670,000	3,426,474	444,000	330,000	0	0	4,200,474	5	1.00
L9911	Rendezvous	463,590,000	0	1,226,744	0	0	0	1,226,744	13	0.30
L9804	East National Petroleum Reserve-Alaska	106,860,000	87,990	2,441,376	0	0	0	2,529,366	8	2.00
L9806	East National Petroleum Reserve-Alaska	262,980,000	8,277,528	526,907	113,400	0	0	8,917,835	3	3.00
L9817	Peak Camp	72,150,000	2,400,696	10,330,410	3,444,060	1,115,106	0	17,290,272	1	24.00
M9602	Colville	415,900,000	2,479,428	358,971	0	0	0	2,838,402	7	0.70
M9605	Colville	238,300,000	3,336,228	303,450	1,687,350	1,001,700	56,700	6,385,428	4	3.00
M9606	Colville	3,900,000	476,322	596,232	0	0	0	1,072,554	14	28.00
M9912	Mitre	27,610,000	0	9,112,176	919,800	0	0	10,031,976	2	36.00
M9915	Rendezvous	23,360,000	0	297,360	1,158,780	0	0	1,456,140	10	6.00
M9922	Spark/Mitre	175,890,000	0	3,126,807	217,728	0	0	3,344,535	9	2.00
M9923	Spark/Mitre	175,890,000	0	3,126,807	217,728	0	0	3,344,535	6	2.00
M0183	Puviaq	2,000,000	0	0	0	1,405,800	27,000	1,432,800	11	72.00
Total		**2,290,070,000**						**64,664,442**		**3.00**

Source: Michael Baker Jr. Inc. 2002e

Table 4A.2.2-6 summarizes the volumes of water withdrawn from permitted lakes within the Plan Area during the winter of 2002 and shows the percentage of used volume relative to total permitted lake volume. The data indicate that for each lake the proportion of pumped-to-permitted lake volume was highly variable (ranging from 0.3 to 86 percent) during the 2002 exploration season, but the total lake volume used from all lakes combined was only 3 percent (Michael Baker Jr. Inc. 2002e) of the total available permitted volume. In a related study, MJM Research (2002) concluded that, in addition to determining the maximum extractable volumes, the water withdrawals did not affect fish populations or water quality.

Michael Baker Jr. Inc. (2002e) conducted monitoring and recharge studies of lakes in the Plan Area that were designed to evaluate the impacts associated with water withdrawals for ice road/pad construction during exploration activities. The studied lakes included five pump lakes: L9911, L9817, M9912, M9922, and M9923, and four reference lakes: L9807, L9823, M0024, and M9914. Site visits were conducted so that that lake conditions during pre-pump, post-pump, post-break-up, and pre-freeze-up periods could be measured.

The results of the study indicate that impacts to lake water levels were offset annually by natural recharge processes that occurred primarily during spring break-up. Table 4A.2.2-3 presents estimates of recharge for the nine lakes studied by Michael Baker Jr. Inc. (2002e). The table also presents the volumes of water withdrawn from each pump lake and the difference between that volume and estimated recharge. The data indicate that all the pump lakes received spring recharge in excess of winter withdrawal volumes. Further, the estimated recharge and surplus volumes shown in the table did not account for the excess water that entered and subsequently exited the lake during the monitoring period. Thus, the reported recharge and surplus volumes are minimum amounts. It should be noted, however, that only two of the lakes received drawdowns approaching the limit of 15 percent below 7 feet (DNR 2003).

Impacts Associated with Water Withdrawals During Construction

Some broad-based conclusions regarding impacts associated with water withdrawal from lakes were found by the Michael Baker (2002e) studies, and were based on comparisons of results from their 2002 lake monitoring and recharge studies, as well as from other studies, data, and information about the North Slope. The study concluded that water surface elevations decreased in most lakes between pre-pump and post-pump sampling events, and the water surface elevations in most pump lakes were lowered more than those in reference lakes, where no pumping was conducted. These water level changes in pump lakes were almost certainly the result of winter water withdrawal. Further, water surface elevations in all lakes declined over the summer to levels below those measured during the pre-pump sampling event. These summer declines in water surface elevations were the result of lake outflow and/or evaporation. The water surface elevations in all lakes increased to well above the pre-pump levels as a result of recharge (from snowmelt and snowmelt runoff) during spring break-up. Michael Baker Jr. Inc. (2002e) concluded that, without exception, natural recharge volumes to pump lakes were sufficient to compensate for winter water withdrawals. Moreover, lake discharge to streams was not compromised by pumping. They concluded that lake discharge to streams was more related to the location and timing of ice road melting than pumping.

Overall, the results of the lake monitoring indicate that when adhering to permitted pump volumes from permitted lakes, impacts to lake water levels are short-term. Water monitoring programs should be continued and further developed for representative areas within the Plan area. Any program should measure lake water levels through time, provide estimates of recharge and surplus volumes, and document any observed changes of water quality parameters over time. These programs should also be integrated with assessments of impacts to lake habitat to determine if additional or more frequent monitoring is required and changes to pumping programs is warranted.

TABLE 4A.2.2-3 WATER WITHDRAWAL AND SPRING RECHARGE VOLUMES

Water Surface Elevation (ft)						Lake Area (acres)	Lake Volume[a] (millions of gallons)	Minimum Recharge Volume (millions of gallons)	Total Withdrawal[b] (millions of gallons)	Minimum Surplus Volume [c] (millions of gallons)
Lake	Pre-Pump	Post-Pump	Breakup	Post-Breakup	Recharged[d]					
Pump Lakes										
L9911	68.38	68.35	68.67	--	0.32	540	464.6	56.3	1.2	55.1
M9912	41.41	40.64	41.63	--	0.99	33	27.6	10.6	10.0	0.6
M9922	50.30	49.88	50.83	--	0.95	191	108.6	59.1	1.6	57.5
L9923	57.76	57.44	--	57.96	0.52	252	175.9	42.7	3.3	39.4
L9817	N/A	53.98	--	54.96	0.98	75	72.2	23.9	17.3	6.6
Reference Lakes										
L9807	28.39	28.40	28.65	--	0.25	94	83	7.7	0.0	7.7
L9823	24.95	24.88	25.31	--	0.43	5	6.4	0.7	0.0	0.7
M0024	57.09	56.95	57.26	--	0.31	139	108.8	14.0	0.0	14.0
M9914	47.07	47.16	47.56	--	0.40	127	106.8	16.6	0.0	16.6

Sources: Michael Baker Jr. Inc. 2002e, MJM Research 200b, PAI
Notes:
[a] Based on water surface elevation changes
[b] January–May 2002
[c] Recharge and surplus volumes are considered minimum amounts, as these values do not include recharge volumes that flowed into and subsequently out of the lakes.
[d] Recharged elevation is equal to the difference between the break-up water surface elevation and the post-pump water surface elevation.

The ADNR has authorized water withdrawals from the Colville River. Under-ice discharge in the vicinity of the ice bridge location has never been measured, but based on observations made by CPAI hydrologists, in mid-February the under-ice flow cross-sectional area at the bridge is on the order of 7,000 square feet. Under those conditions, even assuming a flow velocity of 0.1 fps (which is about what was measured during winter 2003–04), under-ice discharge is still about 700 cfs (about 315,000 gpm). This discharge is likely well above the rate at which the water would be withdrawn (CPAI, e-mail communication, 2004). Thus, the dynamic equilibrium of the channel is maintained and the depositional regime unchanged. At about the same time, a saltwater wedge begins moving upstream under the ice, past the icebridge crossing. Presence of this wedge is interpreted as a condition where flow has ceased and where pumping is no longer permitted.

Impacts Related to Roads and Pipelines During Construction.

Natural drainage patterns can be disrupted when activities associated with the construction of roads and pipelines block, divert, impede, or constrict flow in active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. Because construction of roads and pipelines will occur during the winter season, direct construction-related impacts to streamflow processes are negligible. However, as described above, as a result of ice road construction and subsequent ice road melting, more water will enter particular stream systems depending on their locations and the timing of melts, or it could enter its usual system by a different route.

The construction of permanent gravel roads will compact underlying soil and reduce the soil surface area available for infiltration. Such effects impact the recharge potential of the tundra soils during spring break-up on a local level. The delta-wide affect of reduced recharge would be negligible. An indirect effect of road and pipeline construction is the potential disturbance of soils, which would not be realized until break-up when erosion and subsequent sedimentation occur.

Impacts Associated with Pads During Construction

Natural drainage patterns can be disrupted when activities associated with pad construction block, divert, or impede flow during flooding episodes of active stream channels, ephemeral or seasonal drainages, or shallow water (overland) flow paths. However, because construction of pads will occur during the winter season, construction-related impacts related to flow processes are negligible. Soil compaction beneath the ice will occur, which affects the soil recharge potential. As with road construction, erosion and sedimentation processes could be increased due to the potential disturbance of soils, which would not be realized until break-up, when surface runoff processes begin and entrain loosened sediment from disturbed soils.

Impacts to Estuaries and the Nearshore Environment During Construction

No impacts to wave processes, erosion buffers, water quantities, or flow processes within the estuarine and nearshore environment are expected during winter construction. The Colville River Delta may be subject to increased sedimentation (but likely not measureable) as an indirect and delayed effect of bridge construction (i.e., when break-up entrains sediment left from construction activities) over the Nigliq Channel, Ublutuoch River channel, construction activities at CD-3, or other facilities being constructed across or close to drainages.

OPERATIONS PERIOD

Table 4A.2.2-4 summarizes potential operation impacts to water resources in the general vicinities surrounding production pads CD-3, CD-4, CD-5, CD-6, and CD-7, including the roads and pipelines connecting the facilities.

Impacts to Subsurface Water During Operations

Operational impacts to subsurface water are limited to activities that generate waste and require injection disposal. After pretreatment to meet existing permit requirements, the incremental volume of wastewater from the permanent-worker housing at CD-1 would be injected into the approved Class I Disposal Wells at CD-1.

TABLE 4A.2.2-4 POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative A – CPAI Development Plan

	Groundwater		Lakes		Major and Minor Stream Crossings					Estuaries and Nearshore Environment	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamayayak Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
CD-3 and Vicinity											
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	5	NI	NI	NI	NI	NI	7	NI
Ice Roads	NI	NI	NI	5	NI	NI	NI	NI	NI	6	NI
Airstrip	8	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6	NI
Pipeline Segment: CD-1 – CD-3	NI	NI	NI	NI	2,7	2,7	2,7	NI	2,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI

	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams	Harrison Bay
CD-4 and Vicinity							
Gravel Road Segment CD-1 to CD-4	8	NI	NI	NI	NI	2,3,4,5,6,7	NI
Culverts and Culvert Batteries	NI	NI	1,2,7	NI	NI	2,3,4,5,6,7	NI
Pipeline Segment: CD-1 to CD-4	NI	NI	NI	NI	NI	2,7	NI
Production Pad	8	NI	8	NI	NI	2,3,4,5,6	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI
CD-5 and Vicinity							
Gravel Road Segment: CD-2 toCD-5	8	NI	NI	NI	2,4,5,6	2,4,5,6	NI
Pipeline Segment: CD-2 to CD-5	NI	NI	NI	NI	NI	6	NI
Production Pad	8	NI	8	NI	NI	NI	NI
Bridges/Culverts (including Nigliq Crossing)	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

TABLE 4A.2.2-4 POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – CPAI Development Plan								
	GROUNDWATER		LAKES		MAJOR AND MINOR STREAM CROSSINGS			ESTUARIES AND NEARSHORE ENVIRONMENT
CD-6 Pad and Vicinity								
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish–Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-5 to CD-6	8	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Pipeline Segment: CD-5 to CD-6	NI	NI	NI	NI	NI	2,7	2,7	NI
Production Pad	8	NI	8	NI	NI	NI	NI	NI
Bridges/Culverts	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI
CD-7 Pad and Vicinity								
Gravel Road Segment: CD-6 to CD-7	8	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI	
Pipeline Segment: CD-6 to CD-7	NI	NI	NI	NI	2,7	2,7	NI	
Production Pad	8	NI	1,7,8	NI	NI	NI	NI	
Bridges/Culverts	NI	9	NI	NI	NI	2,3,4,5,6,7	NI	
Groundwater Wells	9	9	NI	NI	NI	NI	NI	
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	

Notes:
1 = Shoreline disturbance and thermokarsting
2 = Blockage of natural channel drainage
3 = Increased stages & velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI = No Impact

There are no camps at the satellites during operations, only during construction and drilling activities. Class I Disposal Wells allow for the disposal of non-hazardous industrial wastes, stormwater, and certain wastes that are exempt under federal regulations (40 CFR 261(b)(5)). Domestic wastewater must be injected via a Class I Well unless it is beneficially used in a Class II EOR (enhanced oil recovery) well (with AOGCC approval). In addition the disposal of non-hazardous industrial wastes, stormwaters and other non-exploration and production-related wastes can only be disposed of into a Class I Well (with USEPA approval), and not into a Class II Well (USEPA 2004). Approximately 2,000 to 3,000 gpd (or 2.3 to 3.4 ac-ft/yr) of wastewater would be generated by pad operations. Since groundwater from these potentially affected zones is not potable and would not be extracted for operation activities, no impacts to groundwater are expected.

Impacts to Lake Hydrology During Operations

Impacts Associated with Water Supply Demands

During operations lakes would supply fresh water for: the periodic construction of ice roads and pads during the winter seasons, dust abatement on roads, pads, and airstrips during summer, potable water needs, and fire suppression and maintenance activities. The ice road demand will be much greater than the other three demands, which except for potable water needs, by their nature are short in duration and/or of small volume. The water demand for ice roads would be comparable, on a per-mile of ice road basis, to construction period demands. However, the length of ice roads to be constructed during operations would be much less [requiring approximately 10 million gallons per year (gpy)]. Long-term (more than 1 year) effects on lake water levels are not expected because natural annual recharge processes are sufficient to fully recharge the lakes (Michael Baker, 2002e). Once construction and drilling are completed, the overall water demand would be reduced because of fewer miles of ice roads, lack of mud plant operations except for occasional well workovers, lack of hydrostatic testing, and lack of temporary camps.

As indicated for the construction period, the results of lake monitoring above indicate that with prudent lake level monitoring and adherence to pumping only permitted volumes, impacts to lake water levels would be short-term. Continued monitoring programs should measure lake water levels through time and provide estimates of recharge and surplus volumes. These programs should also be integrated with assessments of impacts to lake habitat to determine if additional or more frequent monitoring is required.

Impacts to Lake Recharge Conditions During Operations

The proposed gravel access road from the existing Alpine facilities to the proposed CD-4 production pad, referred to here as the CD-4 road, follows a naturally occurring topographic high (comprised primarily of a vegetated aelion-dunal complex) that is oriented essentially parallel to flows in the area. Lake 9323 is situated at the southern end of this ridge, and the proposed CD-4 production pad is south of this topographic high. The proposed road crosses through a narrow section of Lake 9323. A series of culverts are planned to maintain fish passage (i.e., keep the lake open, unobstructed, and supplied with a sufficient quantity of water to admit freely the passage of fish) within the lake. Recharge to Lake 9323 during breakup has been observed to occur by one of three possible scenarios depending on the ice-affected water surface elevations of various channels: 1) northward- and westward-moving overflow from the Niqliq Channel; 2) northwestward-moving overflow through Lake 9324 from the Sakoonang Channel; and 3) southward-moving overflow originally from the Sakoonang Channel and passing through the long and narrow southern portion of Lake 9525 (which occupies a paleochannel). The proposed road route through Lake 9323 is not expected to affect these recharge mechanisms as long as the culvert battery allows for a sufficient flow through Lake 9324 to maximize recharge potential during breakup (i.e., as is planned to maintain fish passage).

Impacts to Surface Water Conditions at Gravel Mines

Upon completion of gravel extraction activities from a mine site, the site would be rehabilitated. Rehabilitation could include knocking down any gravel piles to near tundra-grade, and development of a water reservoir suitable to support fish and wildlife habitats if feasible and appropriate. The potential exists to create fish habitat by reclaiming gravel mines, if they are sufficiently close to waterways. The existing ASRC Mine Site was not designed with post-operational fish habitat creation in mind. Converting the pits into fish habitat was deemed not feasible during the site's original permitting and thus is not part of its rehabilitation plan.

The proposed Clover A Mine Site is still in the planning stages and only preliminary characterization of the material source has been done. The rehabilitation plan (ABR and PN&D, 2004) calls for the creation of a high-value waterbird habitat from the gravel pit (Appendix O). Specifically, the plan proposes to create a mosaic of shallow-water habitat, aquatic grass marsh, and vegetated islands within the shallow-water area for waterfowl nesting. The area of the flooded mine pit is expected to be approximately 60 acres, with a maximum lake depth of over 50 ft. Over 50 percent of the area is expected to be greater than 30 ft deep. The large volume of water that will eventually fill the pit is expected to alter the thermal regime of the permafrost beneath and adjacent to the waterbody, which will preferentially impact the steep side slopes. Maintaining a stable water level within the excavated area, once mining activities cease, will be critical to the success of the rehabilitation. It is expected that the main source of recharge water will come from snow capture (through drifting), snowmelt, and through recharge from overbank flooding from the Ublutuoch River and an existing nearby ephemeral drainage during spring breakup.

The rehabilitation plan calls for two years of monitoring following the completion of the restoration design and after the rehabilitated pit has filled with water. Monitoring plans include inspecting of the pit margin for erosion and instability. This would also include any signs of inflow or outflow erosion. In general, any new surface water bodies created by mine pit excavation would be left to recharge naturally during high flows of natural streams and man-made channels during annual spring break-up floods. This process could be aided by placing upwind snow fences or soil berms to accumulate windblown snow and speed filling the water impoundments. Specific stipulations would outline desired rehabilitation goals for the site.

Hydrologic Analyses and Modeling to Assess Effects of Roads, Pads and Bridges

Two-Dimensional Modeling of Colville River Delta

A two-dimensional surface water model (the USGS' Finite Element Surface-Water Modeling System) (Froehlich 1996) was integrated with a pre- and post-processing software program (Brigham Young University's Surface Water Modeling System) (1994) to predict water surface elevations and velocities in the Colville River Delta. The model boundary conditions and parameter assumptions were originally developed in 1997 (Shannon & Wilson, 1997), and have since been modified with additional data for specific locations (e.g., the Nigliq Crossing, the CD-4 pad location, etc.). The open-water two-dimensional model has proven to be a reliable and integral tool to aid in the design of existing and proposed Alpine Development Project facilities, pads, and pipelines (Michael Baker 2002b). More recently additional modeling was conducted to evaluate potential hydrologic and hydraulic impacts of the proposed facilities (including new production pads on the Delta, the CD-4 road, the Nigliq Bridge and approach roads as well as the existing facilities and structures) (Michael Baker 2004a, 2004c and 2004h). The recent modeling has evaluated four Nigliq Bridge lengths (900-, 1,200-, 1,500- and 1,650-foot) under varying hydrologic conditions, and described how each would affect water surface elevation and velocity at existing and proposed oilfield facilities.

Model runs of the existing and Alternative A conditions predicted water surface elevations and velocities during the estimated 10-, 50-, and 200-year recurrence interval floods. These floods are represented by flows estimated to be 470,000, 730,000 and 1,000,000 cfs, respectively, at Monument 1. Monument 1 is located just upstream of the head of the delta and the split between the Nigliq and East channels. Based on the model set-up, channel and floodplain topography and various parameter assumptions, the model calculates the proportion of flow that would be conveyed down the East and Nigliq Channels, as well as the smaller distributary channels that fork off the East Channel. At the above modeled flows, the Nigliq is predicted to convey 92,100, 163,000 and 246,000 cfs (or 19.5, 22.3 and 24.6%, respectively, of the Monument 1 total flow (Michael Baker, 2004h).

Table 4A.2.2-5 is a compilation of site-specific results for two modeled scenarios (i.e., the existing and CPAI proposed conditions) as presented in the recent modeling report prepared by Michael Baker (2004a). The table provides predicted water surface elevations and velocities at thirteen representative locations across the delta, including locations in the Nigliq Channel, at the bridge crossings and at the Alpine pad facilities for the 10-, 50-

and 200-year floods. For three of the bridge crossings, predicted conditions for the mid-channel and abutment positions are presented. The thirteen locations are shown on Figure 4A.2.2-1. Table 4A.2.2-6 is derived from the data in Table 4A.2.2-5 and provides the predicted absolute change and the percent increase or decrease of water surface elevations and velocities at the same thirteen locations. For example, Table 4A.2.2-5 indicates that the 200-year flood depth-averaged velocity at the mid-channel Nigliq bridge crossing (i.e., location #4) is predicted to increase from 6.6 fps during existing conditions to 9.1 fps during proposed conditions. Table 4A.2.2-6 indicates that this is an absolute increase of 2.6 fps or a 39.0 percent increase. In reviewing Table 4A.2.2-6, two conditions have to be met for the results to be significant. The absolute velocity and percentage increases both have to be relatively high. From the tables, then high velocities and percentage increase occur mainly at the bridge sites.

A select number of figures from the Michael Baker (2002b and 2004a) reports are reproduced here to facilitate presentation of the model results. Figures 4A.2.2-2 through 4A.2.2-18 depict water surface elevation and velocity differences at various locations across the Delta, including at critical facilities, and for the Nigliq Bridge location for the 50- and 200-year floods. Figures 4A.2.2-2 through 4A.2.2-7 illustrate predicted water surface elevations and velocities during a 50-year flood and a 200-year flood under existing conditions (i.e., with CD-1 and CD-2 and associated facilities). Figures 4A.2.2-8 through 4A.2.2-18 illustrate predicted water surface elevations and velocities during a 50-year flood and a 200-year flood under the proposed 1,200-foot Nigliq Bridge scenario (Alternative A).

TABLE 4A.2.2-5 RESULTS OF TWO-DIMENSIONAL MODELING: WATER SURFACE ELEVATION AND VELOCITY MAGNITUDE COMPARISONS BETWEEN THE EXISTING CONDITIONS AND ALTERNATIVE A

ID #	Reference Location	2002 Baseline (CD-1 & CD-2 Only)						Alternative A Facilities and Structures					
		Water Surface Elevations (ft)			Velocity (fps)			Water Surface Elevations (ft)			Velocity (fps)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
1	Nigliq Channel North (approx. 5,600 ft. downstream of bridge)	6.8	9.7	11.5	5.5	6.6	8.6	6.8	9.6	11.3	5.7	7.3	8.7
2	Facility Northwest (approx. 4,700 feet east of Pt 1)	8.1	9.8	11.5	0.0	0.3	0.6	8.2	9.8	11.4	0.0	0.1	0.3
3	National Petroleum Reserve-Alaska Road 80 foot bridge												
	West Abutment (at centerline road)	-	-		-	-		-	11.1	12.4	-	4.3	5.2
	Channel (bridge mid-span)	-	-		-	-		-	11.0	12.4	-	4.0	5.3
	East Abutment (at centerline road)	-	-		-	-		-	10.9	12.5	-	3.3	4.8
4	Nigliq Bridge												
	West Abutment (location same for all models)	-	10.7	12.9	-	4.1	4.7	7.6	10.1	11.1	1.4	2.4	2.9
	Channel West (always 300 feet from west abutment)	7.4	10.7	12.8	6.3	6.1	6.8	7.7	10.6	12.4	5.3	7.1	9.2
	Mid Channel (always 600 feet from west abutment)	7.4	10.7	12.8	4.8	5.2	6.6	7.7	10.6	12.4	5.5	7.0	9.1
	Channel East (always 900 feet from west abutment)	7.4	10.6	12.7	4.1	4.9	5.8	7.6	10.5	12.3	4.8	7.0	9.1
	East Abutment (location same for 1,200-foot bridge and baseline models, varies for others)	7.4	10.6	12.7	4.0	4.6	5.2	7.1	9.2	10.2	1.5	2.2	2.9
5	CD-2 (southwest corner)	8.9	11.6	13.6	0.2	1.7	2.6	9.2	11.8	14.1	0.0	1.2	1.6
6	CD-2 Road 62 foot bridge (bridge mid-span approx. 40 feet upstream)	8.2	10.3	12.0	1.1	3.1	4.2	8.6	10.7	12.4	1.7	3.9	5.5
7	CD-2 Road 452 Foot Bridge												
	West Abutment (at road centerline)	8.0	9.5	10.9	1.3	3.2	4.4	8.1	9.6	10.8	1.4	3.2	4.4
	Channel (bridge mid-span at road centerline)	8.3	10.9	13.0	3.8	7.2	8.7	8.5	10.9	13.0	4.1	7.1	8.8
	East Abutment (at road centerline)	8.2	10.0	11.3	1.7	3.8	4.8	8.4	10.0	11.3	1.9	3.8	4.9
8	Alpine Pad South (southernmost pad corner)	-	12.0	14.3	-	0.5	0.8	-	12.9	15.4	-	0.8	1.4
9	Alpine Pad East (northeasternmost pad corner)	-	-	13.3	-	-	1.0	-	-	14.1	-	-	1.6

TABLE 4A.2.2-5 RESULTS OF TWO-DIMENSIONAL MODELING: WATER SURFACE ELEVATION AND VELOCITY MAGNITUDE COMPARISONS BETWEEN THE EXISTING CONDITIONS AND ALTERNATIVE A (CONT'D)

ID #	Reference Location	2002 Baseline (CD-1 & CD-2 Only)						Alternative A Facilities and Structures					
		Water Surface Elevations (ft)			Velocity Magnitude (fps)			Water Surface Elevations (ft)			Velocity Magnitude (fps)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
10	Nigliq Channel South (approx. 6,200 feet upstream of bridge)	8.4	11.6	14.0	3.8	3.9	4.4	8.7	11.9	14.3	3.5	3.4	3.4
11	Facility Southwest (approx. 3,400 ft east of Pt 10)	9.0	12.1	14.3	0.2	1.0	1.5	9.2	12.2	14.5	0.2	1.2	1.8
12	Facility South (approx. 4,400 feet south of CD-2–CD-4 Road Junction)	-	12.2	14.6	-	0.2	0.6	-	13.2	15.8	-	0.2	0.4
13	CD-4 Pad (southwest corner)	-	13.8	16.1	-	1.3	1.6	-	13.9	16.1	-	0.6	0.9

Notes:
A dash (-) denotes the model predicts the location to be dry during that particular scenario.

TABLE 4A.2.2-6 RESULTS OF TWO-DIMENSIONAL MODELING: COMPARISON OF PREDICTED ABSOLUTE CHANGE AND PERCENT INCREASE OR DECREASE OF WATER SURFACE ELEVATIONS AND VELOCITY MAGNITUDES

ID #	Reference Location	Change: 1,200-foot bridge – existing conditions						Percent Baseline Conditions					
		Water Surface Elevations (ft)			Velocity (fps)			Water Surface Elevations (ft)			Velocity (fps)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
1	Nigliq Channel North (approx. 5,600 feet downstream of bridge)	0.0	-0.1	-0.2	0.2	0.7	0.0	0.4%	-0.6%	-1.6%	4.2%	11.1%	0.3%
2	Facility Northwest (approx. 4,700 feet east of Pt 1)	0.1	0.0	-0.1	0.0	-0.3	-0.3	1.5%	0.1%	-1.0%	0.0%	-76.5%	-50.8%
3	National Petroleum Reserve-Alaska Road 80-foot bridge												
	West Abutment (at centerline road)	-	-	-	-	-	-	-	-	-	-	-	-
	Channel (bridge mid-span)	-	-	-	-	-	-	-	-	-	-	-	-
	East Abutment (at centerline road)	-	-	-	-	-	-	-	-	-	-	-	-
4	Nigliq Bridge												
	West Abutment (location same for all models)	-	-0.6	-1.7	-	-1.7	-1.7	-	-5.6%	-13.3%	-	-40.9%	-37.3%
	Channel West (always 300 feet from west abutment)	0.3	-0.1	-0.4	-1.0	1.0	2.4	4.2%	-0.7%	-3.4%	-15.7%	17.2%	35.4%
	Mid-Channel (always 600 feet from west abutment)	0.3	-0.1	-0.4	0.7	1.8	2.6	4.1%	-0.8%	-3.1%	15.5%	34.4%	39.0%
	Channel East (always 900 feet from west abutment)	0.3	-0.1	-0.5	0.8	2.1	3.3	3.9%	-1.2%	-3.6%	18.7%	41.7%	56.7%
	East Abutment (location same for 1,200-foot bridge and baseline models, varies for others)	-0.3	-1.4	-2.5	-2.4	-2.4	-2.3	-3.7%	-13.4%	-19.9%	-61.3%	-52.6%	-44.7%
5	CD-2 Pad (southwest corner of pad)	0.3	0.2	0.5	-0.1	-0.5	-1.0	3.4%	1.9%	3.6%	-82.4%	29.9%	-38.9%
6	CD-2 Road 62-foot bridge (mid-span approximately 40 feet upstream)	0.4	0.5	0.4	0.6	0.9	1.3	5.0%	4.8%	3.3%	55.1%	28.4%	31.3%

TABLE 4A.2.2-6 RESULTS OF TWO-DIMENSIONAL MODELING: COMPARISON OF PREDICTED ABSOLUTE CHANGE AND % INCREASE OR DECREASE OF WATER SURFACE ELEVATIONS AND VELOCITY MAGNITUDES (CONT'D)

ID #	Reference Location	Change: 1,200-foot bridge – existing conditions						% Baseline Conditions					
		Water Surface Elevations (flood interval)			Velocity (fps) (flood interval)			Water Surface Elevations (flood interval)			Velocity (fps) (flood interval)		
		10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year	10-Year	50-Year	200-Year
7	CD-2 Road 452-foot bridge												
	West Abutment (at road centerline)	0.1	0.1	-0.1	0.1	0.0	0.1	1.5%	0.7%	-0.6%	11.2%	-0.6%	1.8%
	Channel (bridge mid-span at road centerline)	0.2	0.1	0.0	0.3	-0.1	0.1	2.3%	0.6%	-0.1%	8.8%	-1.5%	0.9%
	East Abutment (at road centerline)	0.2	0.1	0.0	0.2	0.0	0.1	1.9%	0.6%	0.4%	11.9%	-0.8%	1.2%
8	Alpine Pad South (southern corner of pad)	-	1.0	1.1	-	0.3	0.6	-	8.0%	7.5%	-	68.0%	74.4%
9	Alpine Pad East (northeastern corner of pad)	-	-	0.9	-	-	0.6	-	-	6.4%	-	-	57.8%
10	Nigliq Channel South (approximately 6,200 feet upstream of bridge)	0.3	0.2	0.3	-0.3	-0.4	-1.0	4.1%	2.1%	2.3%	-8.2%	-11.1%	-22.6%
11	Facility Southwest (approximately 3,400 feet east of Pt 10)	0.3	0.1	0.2	0.0	0.2	0.4	2.9%	1.0%	1.0%	5.6%	24.0%	24.8%
12	Facility South (approximately 4,400 feet south of CD-2/ CD-4 Road Junction)	-	1.0	1.2	-	0.0	-0.2	-	8.0%	8.2%	-	20.0%	-35.0%
13	CD-4 Pad (southwest corner of pad)	-	0.1	0.1	-	-0.6	-0.8	-	0.5%	0.4p%	-	-48.8p%	-46.9%

Notes: A dash (-) denotes that the calculation could not be made from the available data.

For all the figures representing both existing and Alternative A conditions, two views of the water surface elevation model (Delta and project) are presented, and three views of the velocity model (Delta, project and bridge-specific areas) are presented. The Delta scale is represented in Figures 4A.2.2-2 and 4A.2.2-3 for the existing conditions, and in Figures 4A.2.2-8 and 4A.2.2-9 for Alternative A. The project scale is represented in Figures 4A.2.2-4 through 4A.2.2-6, and 4A.2.2-10 through 4A.2.2-15. The bridge-specific scale is shown for only the velocity model of Alternative A in Figures 4A.2.2-16 through 4A.2.2-18. Based on the 2002 (Michael Baker, 2002b) and 2004 (Michael Baker, 2004a) modeling programs, and as depicted in the above-referenced tables and figures, the following generalized conclusions are made:

- As the Nigliq Channel bridge length increased from 900-ft to 1,500-ft water surface elevations increased slightly downstream of the bridge and CD-2 Road, and increased slightly upstream of the bridge and road. All the predicted changes, however, were less than a foot, ranging from about 0.1 to 0.8 ft (likely within or close to the margin of error). At all the bridges (i.e., 80-ft Paleochannel bridge, Nigliq Channel bridge, and the two existing bridges of 62-ft and 452-ft), however, the results were not as clear. Water surface elevations decreased or increased, depending on the bridge crossing considered when the Nigliq Channel bridge length increased from 900 to 1,200 to 1,500 ft. In particular, large + and - changes were evident for the bridge abutment locations (i.e., up to 1.6 ft for the east abutment on the Nigliq Channel bridge)
- For all cases, however, the differences between model runs with varying bridge lengths were even less after calculating scour. This is due to the presence of a scour hole which allows more water to be conveyed thereby reducing velocities and allowing higher water surface elevations.
- Significant velocity increases during frequent and infrequent floods would be generally confined to the channels; markedly increased overland flow velocities would not be expected as a result of the project during the infrequent floods. Smaller velocity increases as compared to baseline are expected during frequent flood events. Larger velocity increases are expected during infrequent flood events.
- In comparing predicted velocities for increasing bridge length, the model result suggests that as bridge length increased from 900-ft to 1,500-ft, depth–averaged velocities under the bridges (i.e., considering all four bridges) decreased over a range from 11 percent at some locations up to 79 percent at other locations. Decreases in velocity associated with increased bridge length were more pronounced at the Nigliq and paleochannel bridges than at the CD-2 access road bridges. At the same time, depth-averaged velocities downstream and upstream of the bridges, regardless of being in the channel or not, changed only marginally or not at all.
- As bridge length at the Nigliq crossing increased, discharge at the Nigliq crossing would be expected to increase, while discharge at the CD-2 access road bridges would be expected to decrease. Conversely, as bridge length at the Nigliq Crossing decreased, discharge there decreased and discharge at the CD-2 access road bridges increased.

In the event that floods on the Delta exceed design criteria (i.e., for the 50- and 200-year events), natural topography and man-made facilities would slow the flood flows and result in widespread inundation and sedimentation across much of the Delta. Flow constrictions would still occur at the main channel crossings and increase the potential for localized scouring of crossing structures and erosion of bridge abutment foundations and road embankments.

If design criteria are exceeded, the extent of additional bank erosion, channel scouring, and sedimentation that could occur would still be controlled by Delta topography. It is possible that a few locations would not be inundated during an event larger than the 1,000,000 cfs flow. However, flows will not necessarily be appreciably faster over most of the Delta, although erosion and sedimentation processes may be more prevalent.

One-Dimensional Modeling of the Ublutuoch River

The one-dimensional model HEC-RAS (hydrologic engineering center river analysis system) was used to predict water surface elevations and velocities for the Ublutuoch River from river mile 14.1 to 1.8 (Michael Baker, 2003, Michael Baker and Hydroconsult, 2004). Input data to the model included surveyed cross sections at seven different locations, Manning roughness coefficients determined from normal depth computations, discharge data at four separate locations, and interpreted hydrologic data at thirty-one locations (Michael Baker, 2003; URS, 2002). The design discharge numbers were derived using regression equations developed by URS (2002). The drainage area used in the regression equations was determined using USGS topographic map data and GIS software (M. Alexander, personal communication, July 2004).

Based on the 100-yr discharge estimate for river mile 8.0 (8,900 cfs) developed by URS and shown in Table 3.2.2-7, the HECRAS model delineated water surface elevations for the 100-yr floodplain from river mile 14.1 to 1.8 (Figure 3.2.2.1-9). For the 120-ft bridge option, the cross section was manipulated at mile 6.8 to reflect the geometry of the proposed bridge and determined to increase the water surface elevation from 12.6 to 13.5 ft BPMSL. This assumed that river ice was still in place. The width of the floodwater over the floodplain and channel at the crossing was estimated at approximately 1140 ft based on the known river geometry and a 12.6' WS elevation.

Scour Analyses

Scouring can affect the structural integrity of bridges and culverts and the channel geometry of areas upstream and downstream of bridges and culverts. Scour analyses have been conducted for the Nigliq Channel bridge site, and general scour concepts and mitigation measures have been analyzed elsewhere.

During February 2004, five borings were drilled in the Nigliq Channel and active floodplain along the proposed bridge crossing (Miller, 2004). The borings indicate that the channel sediments range from organic-silt, silt, silty sand and sand within the upper 35 feet. In deeper zones below 35 ft (to at least 80 ft), sections of gravelly sands and gravels are also found in addition to silts and silty sands. The sequences of sediments observed in all the borings collectively suggest recurrent east-west channel migration during aggradation, The upper 20 ft of the main channel (i.e., the thalweg is currently located nearer the west bank) is composed of sands. Further, the borings indicate that the sediments contain visible ice (from <5% to 30% depending on grain size) in the upper 30 ft of all the boring locations except the main channel boring. At depths greater than 30 ft visible ice is indicated in all the borings.

Site-specific models which assumed that the channel sediment is composed of non-frozen fine-grained silt were developed to evaluate the effect of the Nigliq Channel bridge on the velocity of water through the structure. Scour was estimated using the velocities predicted by the 2D model (assuming pre-scour channel elevations for the 1,200-ft bridge) and both Abscour and HEC-18 programs to determine the depth of scour (CPAI 2004). The results of the scour analyses were then integrated with the two-dimensional modeling results to determine post-scour water surface elevations and velocities The results suggested that the 50-year flow would result in a maximum scour of approximately 12 feet and the 200-year flow approximately 20 feet. These results are depicted in Figures 4A.2.2-19 and 4A.2.2-20.

Based on the results of the drilling, the two principal assumptions (i.e., the sediment across the entire channel and active floodplain is uniformly the same and comprised of uncompacted non-frozen silt) used in the scour calculations are not ideally met, Assuming the sediment is non-frozen silt, however, results in deeper scour estimates than if the sediment was either frozen or coarser, because uncompacted non-frozen silt is more readily scoured than frozen silt or non-frozen sands/gravels.

Because sediment grain sizes and ice conditions are not uniform across the main channel and floodplain, however, scour will likely not be uniform. It is possible that during the 50-yr and 200-yr events, the resultant hydraulic geometries will result in non-uniform scour, such that the non-frozen loose sands in the main channel may be preferentially scoured, while the partially frozen silts in the floodplain may resist scour. This may result in deeper scour in the main channel and less scour over the floodplain in order to maintain continuity and balance hydraulic geometries.

Based on the borings across the Nigliq Channel, the main channel and portions of the east floodplain are comprised of sands. These sands will be scoured during higher velocities under the bridge and then be deposited a short distance downstream due to attenuated velocities downstream of the bridge. The increased sedimentation on the floodplain and main channel could reduce low conveyance water capacity, which could affect navigability and fish passage during very low flows. The scour and sedimentation will occur episodically, resulting in episodic changes in channel characteristics downstream of bridge over the project lifepsan.

For each stream crossing only conceptual designs exist. Since scour-related impacts are possible without sufficient design components, it is conservatively assumed that some scour will occur. Although not likely, this could result in structural failure, additional erosion and downstream sedimentation, and impacts to aquatic habitat. In particular, the scour holes that are created at bridge crossings will result in increased sediment load. If the scoured material is predominantly fine-grained (i.e., silt), then much of the material will be transported farther downstream and to Harrison Bay. If the scoured material is predominantly coarse-grained, then most of the material will be deposited a short distance downstream of the bridge. This would result in reducing channel cross-sectional area and have impacts during low water period.

Bridge abutments and on-tundra aprons should be armored appropriately to protect the road and tundra from scour. During breakup when high flows are expected, the road (except for the outer skin) will be frozen and so scour potential is reduced. If required, culvert inlets and outlets would also be armored. Appropriate slope protection consisting of large gravel-filled fabric bags, armor rock, articulated concrete matting, revegetation, or other appropriate protection would be used where necessary. To protect all bridges (e.g., the Nigliq Channel, Ublutuoch River, and paleochannel bridges) from scour, the abutments would be armored and the piles would be set deep enough so that the structure would remain stable during the design scour event. Piling depths and bridge structural design will take into account the higher magnitude and less frequent floods; slope protection armor would protect against the more frequent, lower magnitude floods. This approach should provide less obtrusive armor to protect against the highest-risk events and to minimize initial habitat impacts caused by armoring. Armoring would be appropriate for bridges that cross completely over the channel and floodplain to avoid erosion and scouring processes. It is conservatively assumed that scour channel holes and bank scars with some structural failure (e.g., road and abutment washouts with downstream sedimentation) may occur, but that these impacts would be limited to the higher magnitude, less frequent events.

Scour at the piers and bridge abutments is a function of flow patterns approaching the structures and shape, alignment and size of the structures. Uncertainties in scour amounts, due to flow and water level uncertainty, are small compared to the potential variability in results due to flow pattern assumptions and techniques available for computing scour. These factors have been considered in the scour analysis for the Nigliq Channel bridge.

Scour estimates have been conducted for the bridge crossing, and the proposed bridge location and design will incoporate agency comments and analysis. In particular, the ADOT&PF is studying discharge and breakup processes on the Colville River in preparation for the proposal to construct a bridge as part of the State of Alaska's proposed Colville River Road project (see Alternative C-2). ADOT&PF will be developing scour estimates associated with design flood values, and their analyses could be considered as a parallel to this project.

Limitations Associated With Hydrology Assessment Predictions

Concern over the accuracy and uncertainty associated with estimating high magnitude infrequent flood events with the limited available hydrology data for the Colville River has led to much discussion and analysis during the DEIS and FEIS review stages. The applicability and appropriateness of the current design criteria are based on:

- The accuracy of the historical peak flow estimates of the Colville River;
- The accuracy of the design flow estimates of the Colville River for various recurrence intervals;
- The assumptions of the upstream (i.e., assumed flows and proportion of these flows into the East and Nigliq channels) and downstream (i.e., water surface elevations at the mouth of the delta) boundary conditions;
- The model validity: how well the digital terrain model represents topography, how representative the finite-element node density is for the given topography, and how well specific model parameters (e.g., channel and terrain roughness) represent flow conditions on the delta; and

- How well designs and design-criteria have incorporated the effects of ice jams on water surface elevations, velocities and erosion processes.

Accuracy of Peak Flow Estimates

The accuracy of design flow estimates is based on the length of record and the accuracy of each data point within the record. There are 15 years of spring breakup peak flow estimates on the Colville River at Monument 1 (Table 4A.2.2-7) and only two years when continuous hydrographs were developed for river flow: the 1962 (Arnborg et al. 1966) station, and the 1977 USGS station, both at Monument 1 near Nuiqsut. The USGS installed an upstream gaging station on the Colville River at Umiat in August 2002.

None of these peak flows were measured by direct methods. Some of these annual peak flows (i.e., probably 1996-2003) were computed using a simplified USGS slope-area method (USGS Techniques of Water Resources Investigations, Book 3, 1967). The method could not be explicitly followed and was simplified because all the required input data were not available to calculate the energy-slope (i.e., high water slope measured on the west bank only, in some cases only one cross-section was available). Annual peak flow estimates computed by indirect methods can exceed 20 percent depending on: 1) how well the high water line (or surface slope) was identified and effected by ice, 2) the accuracy of channel roughness estimates, 3) channel widening in the downstream direction or flow expansion, and 4) the stability of the bed (or channel bottom). In some cases, however, errors can be over 40 percent due to the difficulty in determining high water lines during and after breakup. Computations made from cross-sectional, stage and slope data collected during ice-created backwater conditions (i.e., ice and/or snow in channel, downstream ice jams) may overestimate peak flows. Similarly, extrapolation of stage-discharge ratings during ice-effected flows will also overestimate flows. This suggests that at least some the peak flows listed in Table 4A.2.2-7 are overestimated. This bias was not carried forward in subsequent flood frequency analyses (Shannon & Wilson, 1997; Michael Baker and Hydroconsult 2002), which is discussed in the following section.

TABLE 4A.2.2-7 COLVILLE RIVER BREAKUP PEAK FLOW RECORD

Year	Colville River Peak Flow (cfs)	Measurement Method	Source
1962	215,000	Slope-area	Arnborg et al (1966)
1977	407,000	Stage-discharge extrapolation	U.S.G.S. (1978)
1989	775,000	Estimated from 2D model	Shannon & Wilson 1996
1992	188,000	Stage-discharge extrapolation	Jorgenson et al (1993)
1993	379,000	Stage-discharge extrapolation	Jorgenson et al (1994a)
1994	159,000	Stage-discharge extrapolation	Jorgenson et al (1994b)
1995	233,000	Stage-discharge extrapolation	ABR and Shannon & Wilson 1996
1996	160,000	Slope-area	Shannon & Wilson 1996
1997	177,000	Not provided	Michael Baker (2000)
1998	213,000	Slope-area	Michael Baker (1998)
1999	203,000	Slope-area	Michael Baker (1999)
2000	580,000	Not provided	Michael Baker (2000)
2001	300,000	Normal-depth	Michael Baker (2002)
2002	300,000	Slope-area	Michael Baker (2002)
2003	350,000	Normal-depth	Michael Baker (2003)

Accuracy of Design Flow Estimates

Shannon & Wilson (1997) and Michael Baker and Hydroconsult (2002) used regression analyses, paleo-evidence and an envelope curve (i.e., a hand-drawn curve tracing the upper bounds of the recorded annual peak flood values) to analyze and estimate design flows for Alpine area, and computed the 200-yr flood value to be approximately 1,000,000 cfs. While the error associated with the 200-yr estimate was not explicitly incorporated into designs, it has been assumed that the freeboard criteria accounts for this uncertainty. Due to the sensitive nature of these assumptions and the short-term record (i.e., the Michael Baker and Hydroconsult 2002 report used 14 years) of Colville peak flows, the uncertainty of predicting the flood flows for various recurrence intervals was further examined.

The Michael Baker and Hydroconsult 2002 report, entitled Colville River Flood Frequency Analysis Update, provides an estimated 50-yr peak discharge of approximately 730,000 cfs and an estimated 200-yr peak discharge of approximately 1,000,000 cfs. In the analysis, the 14-year Colville data set (i.e., without the 2003 peak flow) was extended using a regression analysis with the 30-year Kuparuk River data set. The analysis treated the 1989 Colville River observation of 775,000 cfs as an historic adjustment having an estimated return rate of 128 years, so it was not included in the analysis. The analyses concluded with the flood frequency design values in Table 4A.2.2-7.

TABLE 4A.2.2-8 FLOOD FREQUENCY DESIGN VALUES

Return Period	Flood Peak Discharge (cfs)	Upper 95percent Confidence Limit for Flood Peak (cfs)
2-year	240,000	280,000
5-year	370,000	460,000
10-year	470,000	610,000
25-year	610,000	770,000
50-year	730,000	1,030,000
100-year	860,000	1,260,000
200-year	1,000,000	1,550,000

The 95 percent confidence limits provided in Michael Baker and Hydroconsult (2002) indicate that the flood estimates for the infrequent events have an appreciably larger margin of error (i.e., approximately 50 percent for the 200-yr) than the more frequent events (i.e., approximately 24 percent for the 5-yr). This is expected with the short data record. As is indicated in the previous section, there is appreciable uncertainty in some of the peak flows used to calculate the flood frequency values. If the errors were random, then the upper 95 percent confidence limits are still valid; however, if the data is biased (primarily over or underestimated peak values), then the calculated upper 95 percent limit is not a true indicator of the variability in the estimate. Based on an analysis of reported peak flow stages and the discharges described above, there is a likelihood that the peak flows for 2000 and 2003 have been overestimated by 30 and 55 percent. Overestimates of peak flows may have introduced bias into the short-term record used to compute the estimates for the 200-yr, 50-yr and 10-yr flows, such that the re-computed design flows would be less after accounting for the overestimations.

With respect to the regression analyses summarized in the Michael Baker and Hydroconsult 2002 report, the resultant correlation between the Colville and Kuparuk data sets was only r = 0.5 (the correlation excluded the 1989 flow). This indicated that much of the variability in peak discharge in one river is not reflected (or modeled) by the other. Therefore, this variability contributes to the uncertainty in estimation of the Q_{200} peak discharge for the Colville River, and does not provide a compelling improvement to the analysis. The values in Table 4A.2.2-8 were not calculated using the Kuparuk regression analysis.

The Michael Baker and Hydroconsult 2002 report cite the investigations of the 1989 flood event, which are described in Geomorphology and Hydrology of the Colville River Delta, Alaska, 1996 by ABR, Inc. and Geophysical Institute of the University of Alaska, 1997. This work suggested a wide range of return intervals for the 1989 event. Depending on the geomorphic method and level of conservatism assumed, the estimated return periods for the 775,000 cfs ranged from 67 to 393 years. The 1997 report conservatively settled on “the order of a 100-year event” for the 1989 event, but suggested that without the conservative biases it could be as much as a 150 to 300 year event. The September 2002 Report appears to have used only one of the values - 128 years (± 32 yrs) - from the 1997 report, which was the mean return period for what they apparently considered to be the most reasonable method in the 1997 report.

The 1989 peak flow event is not well documented and is estimated from the identification of 26 high-water lines, of which only 17 of the sites could the absolute elevation be established to ± 1.0 ft. The flood was observed in only a few locations, rafted ice was observed strewn on floodplains afterwards, but no direct or indirect discharge measurements were collected. Based on these analyses, they estimated that the 1989 flood had a peak discharge of 775,000 cfs; the estimate had a flow range of 665,000 to 930,000 cfs based on one standard deviation (±0.9 ft) of the accuracy of measuring water surface elevations from high water lines. Because of the high uncertainty associated with the estimation of the 1989 peak flow, the calculated flow value of 775,000 cfs should not be relied on for use in flood frequency calculations and regressions.

A comparison of the flow record with the flood frequency design values indicates that the 50-year design value of 730,000 cfs has been exceeded once (i.e., if one considers the 775,000 cfs in 1989) and the 10-year design value of 470,000 cfs has been exceeded twice in the 15-year record. Conservatively, using the predicted flows for the upper 95 percent confidence limit, the 25-year value of 770,000 cfs was exceeded once by the 1989 event.

When considering all the analyses and their inherent uncertainties, it is not clear that the estimated 200-yr flow of 1,000,000 cfs is conservative enough. Considering standard errors from the Michael Baker and Hydroconsult 2002 report in a conservative fashion could result in a 200-yr design value that is substantially more than 1,000,000 cfs (as much as 50 percent). Therefore, to account for this uncertainty, the 2D model was run at a higher flow of 1,300,000 cfs, to assess the possible effects of underestimating the 50-yr and 200-yr flood values. These results are presented as rating curves at specific locations for each facility or point of interest along the proposed and existing roads, and are discussed later in this section.

In general, calculated 200-year unit runoffs for sites in the region range from 30 cubic feet per second per square mile (cfsm) for the north Brooks Range streams, to over 70 cfsm on the Seward Peninsula. A few on the coastal plain in the vicinity of the project area (e.g., Kuparuk River) fall in the 50 cfsm (Curran et al. 2003). Also, in general, it has been well established that as basin size increases unit runoff tends to decrease for a given region (Dunne and Leopold, 1977). The issue here is whether there are sufficient data in the National Petroleum Reserve-Alaska region to define reasonable unit runoff ratios for large magnitude infrequent events. The calculated unit runoff for the Colville assuming the proposed 200-yr of 1,000,000 cfs is 48.4 cfs per square mile (cfsm), similar to the other values in the coastal plain area largely because the value was calculated using principally the Kuparuk data record. For comparison, at discharges of 770,000 and 1,300,000 cfs the unit runoffs would be 37.3 and 62.9 cfsm, respectively, and both within the observed range for the northern Brooks Range, so it is reasonable to use the 1,300,000 cfs scenario as an upper bounds on addressing freeboard and other design criteria.

The result of underestimating flows for the design criteria can have substantial downstream impacts that include underestimating water surface elevations, levels of inundation and backwater, underestimating conveyance capabilities of various bridge and culvert structures, misrepresenting the velocity distribution during high flows on the delta, and underestimating the prevalence of erosion and sedimentation zones. The result of overestimating flows reduces environmental risks but increases engineering and construction costs.

Assumptions of Boundary Conditions

Up to this point, the discussion has centered on understanding the volume of flows coming down the Colville River upstream of the split between the East Channel and the Nigliq Channel. Because the location of existing and proposed Alpine facilities lies within the western portion of the Delta with flow controlled by the Nigliq Channel system, it is very important to understand what governs the proportion of flow into the Nigliq Channel, and how this flow proportion changes over time based on stage and channel geometry.

The channel and floodplain geometry at the entrance to the Nigliq Channel has changed over time due to upstream and downstream erosion and sedimentation processes. This has also caused the proportion of flow carried by the Nigliq Channel to change.

Based on a review of historical USGS topographic maps, historical air photos and reports by Walker (1983, 1994) and Shannon & Wilson (1996), the following is evident:

- The 1955 version of the USGS Harrison Bay (A-2) 1:63,360 map shows the main entrance to the Nigliq Channel as the Putu Channel; the entrance is at a right angle with the East Channel, while a highwater channel entrance to the Nigliq is located 4 miles upstream from the Nigliq-Putu (and just downstream from the Monument 1 location);

- The 1995 panchromatic image (Shannon & Wilson, 1996) shows that the 1955 highwater channel is now used as the main entrance to the Nigliq, but that its entrance had migrated northward 3,500 ft; the 1995 image also shows that Putu connection with the East Channel had migrated about 3,000 ft northward and joins at a steep angle (i.e., not at a right angle);

- On images, photos and maps, it is also evident that channel width expands northward at the head of the Delta and the entrance to the Nigliq Channel, so that this area is an area of deposition, which may explain why the entrance to the Nigliq Channel is constantly changing and adjusting to episodic sediment flux.

Walker (1994) identified what he termed “the rapidity of sedimentation within parts of the delta and especially those parts that impact the residents of Nuiqsut.” He found that residents of Nuiqsut were facing major problems related to boat transportation. He assessed three areas of the upper Nigliq Channel where naturally occurring sedimentation had resulted in decreased depth and thus navigability: the Putu Channel, the headwaters area of the Nigliq, and the dredge channel near Nuiqsut.

The Putu Channel is a narrow connection between the East and Nigliq Channels that is subject to rapid, naturally occurring sedimentation. According to Walker’s findings, the Putu was easily traversable in the 1960s, even during the low water summer period. During the 1970s, the channel became less passable, and by the early 1990s, became impossible to navigate at low stage. Further, he found that the rapid sedimentation at its mouth forced the east entrance of the Putu to migrate northward. Between 1949 and 1992, Walker estimated that the east entrance had gradually been pinched and forced north a distance of about 1 mile by naturally occurring sedimentation.

Walker also concluded that between 1949 and 1992, the Nigliq Channel entrance migrated northward about 0.7 miles due to sedimentation. This shift has had a major impact on the navigability, led to dredging operations in the channel adjacent to Nuiqsut beginning in 1982, and continues to be one of deposition. He stated that this is a natural process that will continue into the future. In the Michael Baker summary report (2004c), they concluded that natural sedimentation processes have rendered the Putu Channel unusable with respect to navigation for all but a fraction of the open water months. The entrance of the Nigliq, because of its location of divergence of the Colville River, is an area of reduced velocity and naturally occurring deposition (i.e., bankfull channel widens, slope flattens, and deposition results). They suggested that continued growth of the sand bar at the entrance of the Nigliq would result in further slowing of velocity and increased sedimentation. Whether this process is manifest during high magnitude infrequent flood events is possible, but not definite. Based on flood conditions (i.e., locations of ice jams during breakup), the extreme flows may just as readily scour out the entrance and open up the channel and cause deposition in another location.

In essence, the uncertainty here rises from first not having discharge data for the Nigliq Channel entrance or at the bridge site, and secondly from knowing that the natural processes are very dynamic. The ability to predict how the delta will evolve over the next 20 to 50 years is hampered by our lack of delta-wide observations, a good long-term aerial photographic record, a comprehensive understanding of spring break-up dynamics, and an understanding how changes in the volume and distribution of the Arctic Ocean ice cap (as influenced by global climate changes) are affecting rainfall-runoff, fall snowmelt and winter snowfall, and macro (Colville River Basin) and meso-scale (i.e., Colville River Delta) climate and permafrost conditions .

In the 2D open-water model, the proportion of flow entering the Nigliq Channel is determined by channel geometry, delta topography, water surface slope and channel/floodplain roughness. Based on model output, the predicted proportions of Nigliq Channel flow during the 10-yr, 50-yr and 200-yr events shown in Table 4A.2.2-9 are 19.6, 22.3 and 24.6, percent respectively (Michael Baker, 2004h), indicating that the model predicts that as flow increases the Nigliq Channel should carry a higher proportion of the total Colville River flow at Monument 1. According to Michael Baker (2003), during the 2003 peak break-up discharge of 350,000 cfs the Nigliq Channel carried about 61,000 cfs or 17 percent of the total measured flow. (As mentioned above, the 2003 peak flow of 350,000 may be overestimated, so the flow proportion may be underestimated) In 1995, the Nigliq Channel carried an estimated 38 percent of the 233,000 cfs Colville River peak discharge (ABR and Shannon & Wilson 1996). Further, on July 20, 2004, with very low flows measured at Monument 1 (17,100 cfs), the Nigliq Channel entrance was measured to carry only 3.8 percent (650 cfs) of the total flow (R. Kemnitz, 2004). Based on these values, it is clear that the proportion of these flood flows entering the Nigliq Channel is dynamic. Further, all of the above scenarios consider open water conditions only.

TABLE 4A.2.2-9 PROPORTIONS OF NIGLIQ CHANNEL FLOW TO MONUMENT 1 FLOW

	Monument 1 Flow	East Channel below Nigliq	Nigliq Entrance	Nigliq near CD-4	Nigliq at Bridge Crossing	Measurement Method
July 20, 2004 (a)	17,100		650 (3.8%)			Direct streamflow
2003 peak (b)	350,000				61,000 (17.0%)	Indirect Slope-area
1995 peak (c)	233,000	144,000 (61.8%)	89,000 (38.2%)		37,000 (15.9%)	Direct streamflow
Q10 (d)	470,000			92,100 (19.3%)	85,900 (18.3%)	Predicted by 2D model
Q50 (d)	730,000			162,800 (22.3%)	142,000 (19.5%)	Predicted by 2D model
Q200 (d)	1,000,000			246,000 (24.6%)	213,000 (21.3%)	Predicted by 2D model

Sources: a) Kemnitz, 2004, b) Michael Baker, 2003, c) Shannon & Wilson, 1996, d) Michael Baker, 2004h

Due to ice jams, breakup flows could cause the Nigliq Channel to carry a much larger proportion (i.e., possibly over 50 percent) and very low flows could carry less than one percent simply because the change in channel capacity with elevation is not linear (i.e., more capacity becomes available in subordinate channels at slightly higher elevations).

The current design for the 1,200-ft bridge is based on a 200-yr maximum flow of approximately 213,000 cfs. The concern is then, for example, what is the likelihood that flows and under what conditions could flows be greater than 213,000 cfs at the bridge crossing (i.e., are the designs sufficiently conservative). The result of underestimating Nigliq Channel discharge during high flows can have substantial downstream effects including increased scour, erosion and sedimentation, and bridge, pipeline and road failures. Thus, three conditions associated with the Nigliq Channel flow proportion must be considered in addressing uncertainty and assigning freeboard: ice-jam effects, short and long-term evolution of channel and floodplain geometry, and model inaccuracy.

Accuracy of Model

The 2D Delta model was calibrated at a flow of 110,000 cfs (i.e., matched observed with predicted water surface elevations) and validated at the higher water surface elevations estimated for the 1989 flood.

The differences between measured and modeled water surface elevations at a modeled flow of 110,000 cfs were fairly good and ranged from -0.5 to +0.4 feet, while differences in measured and modeled discharges at five locations across the delta ranged from –7.3 to +6.4 percent (Michael Baker, 2004a). Some of the error can be attributed to the density of node-spacing and the effect of depth-averaging over broad distances (over 500 ft across much of the delta but with breaks at major topographic changes and at facilities, and much finer around the bridge sites). Because the model is delta-wide (i.e., over 10-miles wide at the Alpine facilities and over 25 miles long between upstream and downstream boundaries), it has limited uses for site-specific areas (i.e., the shortest node spacing is 80 ft under the bridge). This also means that specific model parameters (i.e., channel and terrain roughness) are also represented by average values for each node.

For model validation using the 1989 flood, Shannon & Wilson (1997) used drift-line elevations identified by ABR (1997) in conjunction with the 2D model to estimate the magnitude of the discharge that best fit the drift line elevations. Based on these analyses, they estimated that the 1989 flood had a peak discharge of 775,000 cfs; the estimate had a flow range of 665,000 to 930,000 cfs based on one standard deviation (±0.9 ft) of the accuracy of measuring water surface elevations from high water lines. Thus, the higher flow conditions as predicted by the model do not have the same level of accuracy as the low flow values, but Shannon & Wilson (1997) concluded that the results were reasonable given the available database. They further indicated that the high flow estimates could be improved by calibrating the model with measured high flow values, but that due to logistics and the physical constraints related to measuring high flows during breakup, this may not be easily achievable and therefore not depended on.

Based on the error observed at 110,000 cfs, CPAI hydrologists estimated that computed water levels for higher flows will likely have an error of less than 1 foot (i.e., relative elevation at a particular node location and not absolute elevation) (Michael Baker, 2004a). This is supported by the nature of delta topography, in that water surface elevations will increase faster in the channel with increasing flows than outside the channel. Thus, once a flood reaches the floodplain large increases in discharge can be accommodated with very little water surface elevation change.

This assumption is probably valid for average depths over most of the delta where topographic variations are well represented by the digital terrain model used in Finite Element Surface Water Modeling System (FESWMS), but may not be appropriate for specific locations due to variations in channel and delta topography. Further, channel geometry is not constant over time, especially when considering erosion and sedimentation processes. It is unclear, how representative the existing digital terrain model is because it is based on air photos taken in the 1990s and ground surveys collected over the past several years, but it is probable that most of the model represents the average topography fairly well.

As discussed above, to account for this variability and determine the degree of uncertainty in water surface elevations at the high flow values, the model was also run for a higher flow of 1,300,000 cfs. Rating curves showing the predicted water surface elevations at specific flows for various proposed and existing Alpine facility locations around the delta are presented in Figures 4A.2.2-21 to 4A.2.2-38. The rating curves are plotted in comparison to the design water surface elevations for each location. For example, Figure 4A.2.2-22 is a stage-discharge rating curve for the road between CD-2 and CD-5 at the paleochannel swale bridge west of the Nigliq Channel. The plot depicts the predicted water surface elevations for six scenarios and compares the results to ground surface and the elevation of the design bridge deck. The plot indicates that for the proposed action (i.e., CD 1,2,3,4 & 1,200 ft bridge on figure), water surface elevation increases from about 11.1 ft to 13.0 ft to 13.8 ft for flows of 730,000 cfs, 1,000,000 cfs and 1,300,000 cfs compared to a bridge deck elevation of 20.0 ft. The plot also indicates that the design criteria of the 200-yr water surface elevation + 1.0 ft will be adequate.

The results of the delta-wide model should be used cautiously to depict conditions down to the scale of it's node-spacing and should not be used to establish flow conditions for designs in specific areas (that are equal to or less than the node-spacing). In these instances (e.g., cross-drainage culverts along CD-4 Road) local hydraulics, erosion, and sedimentation processes must be taken into account as well.

Ice Effects

Current elevation design criteria for facilities (i.e., pads, roads, bridges, etc.) related to the physical environment have not been explicitly developed to consider the effects of ice jams and related ice effects on water surface elevations, but are based on either the prevention of thermal degradation of permafrost (i.e., requiring a minimum pad or road thickness) or on minimizing the risk from open-water flooding (i.e., when ice is not present).

Because of the uncertainties associated with analyses in support of designs (including ice effects), freeboard is incorporated into all the criteria. The issue here is whether the design water surface elevations and freeboard are conservative enough to account for the unknowns associated with predicting the locations, frequency, magnitude and duration of ice jams and flooding associated with ice jams.

Flooding and diversion of flow due to the presence of ice jams in the active channel occurs annually in the Colville River Delta. The magnitude of the flooding and diversion differs markedly, ranging from minor areas of localized backwater to flow over broader areas of the floodplain, and as such, some degree of backwater is associated with any ice jam (Michael Baker, 2004d).

Several large-scale examples of ice-induced flooding have been observed on the Delta. As described in Section 3.2.2.1, in 1981 a large jam at the mouth of the Nigliq diverted a larger than normal volume of water back into the East Channel. A 1974 flood described by Nuiqsut villagers and having flooding characteristics of ice jams (i.e., apparently local flooding only) brought water levels to very high levels near the village, and in 2004 the ice jam at the East Channel entrance shunted a disproportional amount of water down the Nigliq Channel. While these incidents and other incidents have been reported on the Delta, ice-jam related floods are not well documented and are less understood than open-water floods.

Based on the observations of breakup in the Delta and in conjunction with earlier reports, Michael Baker (2004d) concluded that the effectiveness of an ice jam in creating backwater conditions in the Delta is regulated at some point by the relatively flat terrain in the Delta. That is, backwater and floodplain inundation from an ice jam will increase the water surface elevation to a threshold defined by channel geometry and topography. This conclusion concurs with Michel's (1971) theoretical derivation of the stability of a jam. Michel describes a physical limit to the thickening of an ice cover under the effect of hydraulic forces. He states that if the discharge is slowly raised under an ice accumulation the cover thickens by shoves until the increase in hydraulic thrust, due to the reduction of flow area, becomes higher than the resistance of the cover to this thrust.

Michel (1971) mathematically demonstrates that the maximum discharge before shove is directly proportional to the river depth and channel width and inversely proportional to ice and channel roughness. This means that as the discharge reaches a critical water level where either the depth and or width exceed resistance conditions (i.e., overbank discharges), the ice jam tends to release. However, Michel also indicates that if the plug or jam is itself sufficiently resistant, water will rise upstream and find an alternate route and bypass the jam. In many cases with dry jams, most of the discharge can be deflected, possibly even leading to the formation of a new channel or the occupation of abandoned or less used channels. These conditions, although apparently not frequent on the Delta based on past observations, could occur if breakup was rapid, river water levels increased rapidly, and ice strength was still high.

Michael Baker (2004d) performed a computerized simulation of ice jamming in the Colville River using models that were constructed and analyzed with the 2D-model FESWMS described above in sub-section Hydrologic Analyses and Modeling to Assess Effects of Roads, Pads and Bridges. The head of the East Channel was selected as a potential ice jam location for modeling. As noted in Table 3.2.2-9, ice jams have been observed to form here in three of the past seven years, and during breakup 2004 when the ice jam occurred there, a much larger proportion of Colville River flow was re-directed down the Nigliq Channel (Michael Baker, 2004d). It was also observed that the Alpine area experienced appreciably high water levels, much higher than what would have occurred in the absence of a jam. Thus, with an ice jam at this location, additional flow down the Nigliq Channel could potentially create a large impact on water levels in the Alpine area.

This location was considered by Michael Baker (2004d) to be the worst-case scenario because of the possibility of diverting a majority of Colville River flows down the Nigliq. Other such scenarios are also plausible, but it is difficult to make a quantitative judgment of impacts because of the complexity in analyzing or modeling the effects of ice jams. Other possible, but unlikely scenarios might include ice jams in several critical locations across the Delta resulting in a much more widespread backwater and flood release effect, or an ice jam at the Nigliq Channel bridge, which might shunt a disproportionate amount of water towards the swale bridge on the CD-2 road and threaten the existing facilities. Nevertheless, the modeling analysis provides a useful framework to address the potential effects of ice jams.

To simulate the ice jam at the East Channel entrance, elements that defined channel bottom characteristics were revised to represent a groundfast ice jam. The jam was modeled by raising the elevations 9 ft above of the normal elevation of the Colville River channel bottom (or approximately one-third the channel depth at the thalweg position during the 10-yr and 50-yr flows). The 9 ft thick ice jam is approximately 1.5 times the 6 ft ice thickness commonly observed as a relatively thick floe in the Delta. Based on the Michael Baker (2004d) report, the dimensions of the hypothetical ice jam appear to be approximately 2,000 ft wide (perpendicular to flow) by 900 ft long (in the direction of flow).

This hypothetical ice jam does not have some of the important attributes observed in previous ice jams. First, it is fairly small compared to the 5,000 ft by 1,250 ft size of jam observed at the East Channel entrance in June 2004, and does not extend across the entire 3,300 channel width. Second, the long-axis for the ice is perpendicular to flow, rather than diagonal. Thus, the hypothetical jam may not be big enough to represent worst-case type conditions and divert a larger portion of flow down the Nigliq Channel. Third, the 2004 ice jam was floating across the main channel and shorefast to the channel banks and bars, not bottomfast. The floating ice (simple jam) forces water under the floe to flow under hydraulic pressure, whereas the bottomfast jam is more similar to weir-type fluid dynamics. Both reduce flow, so the principal objective of the model is still likely met. Nevertheless, depending on the flow levels assumed, the simulation does provide a mechanism to evaluate ice-jam type dynamics (i.e., creating backwater conditions and redirecting flows). For example, the 9-ft modeled ice jam resulted in an increase in water surface elevations upstream of the jam by 0.71 ft and 0.50 ft for the 10-yr and 50-yr flows, respectively. Downstream of the ice jam, water surface elevations in the East Channel decreased by 0.13 ft and 0.05 ft, respectively, while water surface elevations downstream in the Nigliq Channel increased by 0.52 ft and 0.27 ft, respectively. Based on these results, Michael Baker (2004d) concluded that relative water surface elevation increases were greater for 10-yr floods than 50-yr floods, but by the time the effect of the rise reached the Alpine area, very little change was predicted and no adjustments to freeboard criteria were necessary at any of the proposed Alpine facilities.

Table 4A.2.2-10 compares the change in cross-sectional area, average velocity and discharge as a result of the hypothetical ice jam in the East Channel for both the 10-yr and 50-yr scenarios (data developed from Michael Baker, 2004d). Based on the model results, an ice jam with the 10-yr flood redirects only about 3% (or 11,400 cfs) of the East Channel flow into the Nigliq entrance, while the ice jam with the 50-yr flood redirects about 8% (or 43,100 cfs) to the Nigliq. In both cases, the total ice-effected Nigliq flow did not cause a significant proportion of the East Channel flow to be redirected. Further, the model results also depict that some of the redirected water is returned back to the East Channel via the Putu Channel. Thus, the model suggests that at high flows greater than or equal to the 10-yr flood, ice jams will not cause major shifts in the proportion of flows between channels. This finding does not necessarily agree with the observation of the East Channel ice jam and resultant flow re-distribution during the 2004 breakup. However, the 2004 breakup flows were apparently considerably smaller (on the order of a 2-4 yr flow [M. Alexander, personal communication, 2004]), so that re-direct effect may be greater at the lower flows.

TABLE 4A.2.2-10 COMPARISON OF SIMULATED PRE AND POST ICE-JAM FLOW PARAMETERS FOR EAST AND NIGLIQ CHANNEL

	Simulated 10-year Flood	Simulated 50-year Flood
Total Flow at Monument 1	470,000 cfs	730,000 cfs
East Channel With No Ice Jam		
Total Flow	378,000 cfs (80.4%)	567,000 cfs (77.7%)
Total Cross-Sectional Area	96,900 ft^2	113,400 ft^2
Average Channel Velocity	3.9 fps	5.0 fps
East Channel With Hypothetical 9-ft Bottomfast Ice Jam		
Total Flow	366,000 cfs (77.9%)	524,000 cfs (71.8%)
Total Cross-Sectional Area	59,100 ft^2	74,900 ft2 ft^2
Average Channel Velocity	6.2 fps	7.0 fps
Nigliq Channel Downstream of Putu With No Ice Jam		
Total Flow	92,000 cfs (19.6%)	163,000 cfs (22.3%)
Nigliq Channel Upstream of Putu With Ice Jam in East Channel*		
Total Flow	104,000 (22.1%)	206,000 cfs (28.2%)

Notes:

*Some of the Nigliq flow is returned to the East Channel via the Putu Channel, so the before and after ice-jam values cannot be directly compared. Assuming the Putu is still choked with bottomfast ice so there is little conveyance capacity, then the upstream values can be assumed to approximate the downstream values.

The modeling report (Michael Baker, 2004d) also examined the potential affect of water depth on ice jamming. From their analysis they concluded that based on modeled water depth patterns for the 10-yr, 50-yr and 200-yr flows, ice jams are more likely during 10-yr floods and are least likely during 200-yr floods. They also infer that ice jams are also more likely at even lower flows. Michael Baker 2004d indicated that in some locations, where water depths exceeded 25 ft, there would be adequate cross-sectional area to pass sufficient flow to minimize backwater effects during a jam. Further, they reasoned that for overbank flow, rafted ice is a primary cause of jamming, but that during the 50-yr and 200-yr floods, water depths are sufficient to avoid overbank floodplain ice jams.

The Michael Baker (2004d) report concludes that based on approximately 10 years of observations of breakup conditions on the Delta and their hypothetical ice-jam modeling results, that the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small. They state that water depths and topography of the Delta indicate that during flows greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern. Modeling of a hypothetical ice jam in a "worse-case" location predicts that a maximum increase in water surface elevation at Alpine will be 0.2 ft. Freeboard at the proposed facilities is between 2 and 5 ft. Based on these considerations, and reviews of data and analyses, Michael Baker (2004d) concluded that there is an extremely low probability that the gravel road and pad design elevations will be exceeded by floodwater even when ice-jamming conditions are considered.

Although, these conclusions are reasonable and intuitive, the modeling does not support this conclusively because of the limitations described above. The Michael Baker (2004d) report is the first good synthesis of ice jams and ice jam processes for the Colville River Delta. However, model results should be viewed cautiously due to the difficulty in accurately simulating ice jams, for example; the hypothetical condition does not appear to be representative of the 2004 condition. That is, the size, orientation, and condition (bottomfast versus shorefast and floating) of the modeled ice jam did not result in a significant large re-direction of flow, which was observed to occur in 2004.

Impacts to Pipelines, Roads, Culverts, Bridges, and Pads During Operation

Impacts Related to Pipelines

Natural drainage patterns can be disrupted if pipeline-crossing structures block, divert, impede, or constrict flow in active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. Conceptual designs and general criteria indicate that the proposed pipeline VSMs will not be located in any drainages (except at the very wide crossings where they will be co-located on bridges). In general, design features have been incorporated to protect the structural integrity of pipeline-crossing structures (from scour, ice jams, ice impacts, storm surges, and backwater effects from land-fast sea ice) to accommodate all but the rarest flood events. The alignment of the proposed pipeline would cross the Nigliq Channel, the Ublutuoch River, and other small drainages, and would follow a separate alignment 350 to 1,000 feet from the access road, except at the bridge crossings.

The proposed pipeline corridor to CD-3 follows naturally occurring higher ground, crossing 450- to 750-foot wide sections of the Ulamnigiaq, Tamayayak, and Sakoonang Channels (see Figure 3.2.2.1-3). The pipeline route to CD-4 follows the existing pipeline route parallel to the proposed CD-4 Road but to the east and across the paleochannel. The pipeline route to CD-5, CD-6, and CD-7 would have to cross eight drainages, including the 1,200 foot-wide bridge span on the Nigliq Channel. Pipeline bridges (box girder design) would be used only at major crossings, while large, broadly-spaced VSMs would be used for minor crossings. Therefore, impacts related to flow constriction would be unlikely at the minor crossings at all flows. The potential for ice jams at the pipeline crossings would be minimized by design criteria that will require that the VSMs allow for free passage of ice, and more conservatively account for any additional forces that could damage support structures.

In the event of an ice jam, the increased forces exerted on the VSMs and backwater processes will result in an increase in inundated terrain.

In general, on the Delta and with the major stream or river crossings, pipeline-crossing structures are designed with more stringent standards than road-crossing structures because of the greater sensitivity of the environment to a structural failure. Pipeline-crossing structures are designed to accommodate the 200-year return flood (plus 1 foot of freeboard). Pipeline failure can result in oil spills, as discussed in Section 4.

Impacts Related to Roads

Natural drainage patterns can be disrupted when roads block, divert, impede, or constrict flow in active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. The potential impacts occur during the operations period, but are best avoided by design considerations prior to construction. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Causeways and bridges that do not convey water adequately can constrict flows and result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for flooding. These effects can be minimized by incorporating design features to protect the structural integrity of the crossing structures from scour, bank erosion, ice jams, ice impacts, and storm surges to accommodate all but the rarest (depending on design criteria) flood events.

Where roads cross floodplains, dunal complexes and ancient alluvial-marine terraces (i.e., the proposed road to CD-4 and the west extension of the road from CD-2) of the Colville River Delta, they are designed to accommodate the 50-year return flood (plus 3 feet of freeboard). Except for the stream crossings, project roads elsewhere in the Plan Area (the proposed road from CD-5 to CD-6 and CD-7) may not require the same flood design criteria because they would not be in a flow environment. Because most of the road from CD-2 to CD-5 crosses the Nigliq Channel and the paleochannel to the west it will consist of mainly of bridge and bridge approach aspects, so that the impacts from the road from CD-2 are addressed below in the subsection: Impacts Related to Bridges.

The proposed road from Alpine to CD-4 is hydraulically fundamentally different than the existing Alpine to CD-2 Road (Michael Baker, 2004h). The CD-2 Road runs east-west and crosses delta channels (i.e., perpendicular to flow). However, the CD-4 Road runs north-south (i.e., parallel to flow). About 80 percent of its alignment follows a naturally occurring topographic high (i.e., ancient dunal complex) that forms a natural barrier between two drainage sub-basins; to the east floodwater flows northward along a paleochannel-lake complex from the Sakoonang Channel sub-basin, while to the west floodwater originates as overflow from the Nigliq Channel and occupies Lake 9323 and Nanuk Lake. The remaining 20 percent of the proposed road (i.e., primarily the northern section near Alpine) would traverse relatively low ground and form only discontinuous separation of the Nigliq and Sakoonang sub-basins. This area is exposed to more frequent flooding, but because the road is still designed for 50-year return flood (plus 3 feet of freeboard), overtopping of the road with adequate cross-drainage will occur less often. Based on two-dimensional modeling and field observations (Michael Baker 2002b), flow across the proposed road alignment is infrequent, localized, and has little or no apparent impact on the ground conditions, vegetation, and hydrologic regime between the east and west sides of the alignment.

The two-dimensional hydrologic model of the delta addresses the effects of the CD-4 Road on the surface hydrology western portion of the Delta at various flood frequencies. The results suggest that the road to CD-4 will, during larger flood events (i.e., greater than the delta-wide 10-yr open-water flood, or a local ice-jam effected flood), divert some water from passing through the swale bridge and cause it to flow eastward around CD-1 and joining back up with the swale bridge flow on the north side of CD-1. Modeling results for the 200-yr event (and 1,200-ft bridge scenario) suggest that a difference in water surface elevation of 1.0 to 4.0 ft between the east and west sides of the CD-4 road and the existing Alpine pad will result (Figures 4A.2-4, 4A.2-5, 4A.2-10, and 4A.2-12). The CD-4 road within the delta will channelize the water to flow through both the main Nigliq Channel bridge and the 80-ft bridge on the west (Figures 4A.2-11 and 4A.2-13). Depending on the flood volumes, the routing of water on the west side of the Delta is restricted to the four bridge sites, so that water surface elevation would back-up behind the road and flow directions would be changed. Some of this effect could be reduced by installing adequately-designed overflow or cross-drainage features (culverts and/or culvert batteries) into the CD-4 road. The 2D model did not incorporate any cross-flow drainage features. However, hydraulic capacities of 48-inch and 60-inch culverts are not sufficient to affect the results of the delta-wide model. Thus, neglecting the hydraulic influences of culverts is a conservative position that overstates the predicted difference in water surface elevations.

The results of the 2D open-water modeling for various flood frequencies are compared to CD-4 road design criteria on site-specific rating curves (Figures 4A.2.2-31 to 4A.2.2-34). Four representative points along the road are depicted. The locations of these points are shown on Figure 4A.2.2-22. The results suggest that for large magnitude less frequent events the elevation of the proposed CD-4 Road at the four points is 2.8 to 6.7 ft above the 50-yr flood level. Design criteria states that the road will have to be built to the 50-yr level plus 3 ft for freeboard. Thus, some of this road (based on preliminary design elevations) may not be high enough.

Similarly, rating curves for the Alpine/CD-2/National Petroleum Reserve-Alaska Road are shown on Figures 4A.2.2-22 to 4A.2.2-30. The figures show that at the roads four points depicted in Figure 4A.2.2-21, predicted 50-yr water surface elevations are 5.2 to 8.2 ft below the proposed road elevations, so it appears that this road is high enough after accounting for 3 ft of freeboard. The CD-3 facilities are basically islands during a large flood event. They do not cut off any major channels of flow and the water will flow around them and recombine on the downstream side. Roads topped by floods can become unstable resulting in erosion of road fill and deposition in surrounding areas.

Impacts Related to Culverts

Detailed information about culvert placement and design has not been provided. As a result, the impact of culverts is addressed qualitatively and conservatively. Culverts and/or culvert batteries are required at all water crossings that do not need a bridge. At a discharge of 500 cfs, the number and spacing of culverts required to pass the flow and/or ice may not easily fit within the specific channel/floodplain it is being designed for. Therefore, a bridge would be considered when channelized flow occurs with a 50-year flood of 500 cfs or more. Culverts would be installed when the road is constructed. Additional culverts could be added if later observations indicate that ponding is occurring near the road.

As described in Section 2.3.9.1, the use of large diameter culverts has not been very successful on the North Slope due to long-term thermal stability issues, difficulty of construction, and load carrying capacity issues. Therefore, current road construction practice is to utilize available line pipe, usually up to 60 inches diameter, as culverts in place of corrugated metal culverts. Line pipe culverts have more structural strength and a much better record of survivability and service.

The most southern portion of the proposed CD-4 Road goes through Lake 9323 before joining the CD-4 pad. During breakup, Michael Baker (2003) notes that, depending on breakup flooding conditions, recharge into this lake has occurred from both the Sakoonang and Nigliq Channel sub-basins. Thus, an approximately 400-ft section of the CD-4 road, will require a crossing structure (either a bridge or culvert battery). The lake water is 8 feet-deep at the crossing location and shallower along the road alignment (see Figure 2.4.1.1-3). A culvert battery is proposed but it will need to have adequate capacity to maintain this recharge potential and at the same time minimize impacts to fish habitat and allow free movement of fish in the lake. Fish passage to Lake L9323 from the Nigliq Channel and from the Sakoonang Channel (via Lakes L9324 and M9525) would be maintained by routing the road across the center constriction of the lake and maintaining floodwater paths from both the east and west.

At CD-4, the structure and function of low-lying, high-value wetlands has been evaluated and would be maintained because the access road has been situated on high ground that would not be expected to affect flow associated with a 5-year flood event (Michael Baker, Jr. Inc. 2004a).

Final design of the culverts for the CD-5, CD-6, and CD-7 road will depend upon break-up information for those drainages that could impact the roads. However, these crossings are not expected to present any technical or engineering challenges beyond what is currently practiced on the North Slope.

Impacts Related to Bridges

Nigliq Channel Bridge

At the proposed bridge crossing, the Nigliq Channel is approximately 1,550 to 1,600 ft wide and flows north with its thalweg along the west side and a floodplain on the east side. Although the west bank is actively eroding (primarily due to thermal degradation) it is more defined and steeper than the east bank, which grades less distinctly with the higher less active floodplain to the east. Because the active channel is over 1,200 ft wide, the channel would be constricted somewhat at the proposed 1,200-foot bridge location, thereby slightly increasing velocity through the structure during flood flows. Various flood frequencies, their effect on depth and velocity of water in the channel, and depth and volume of sediment scour were examined.

In general, localized scour associated with bridge supports is only expected to occur during a flood with a recurrence interval greater than 10 years (J. Pickering, 2004). Figure 4A.2.2-16 illustrates the amount and depth of scour caused by changes in water surface elevation during a 200-year flood. Figures 4A.2.2-19 and 4A.2.2-20 illustrate respective project and bridge scour depths and amounts caused by changes in velocity during the 200-year flood. Scour depth ranges up to 20 feet, and is greatest right under the bridge. Scour is even deeper around each bridge pier (i.e., likely an additional 5 ft). These scour estimates assume the channel is non-frozen silt and that scour will occur uniformly across the entire channel. However, as noted above in the subsection – Scour Analyses, the grain-size and thermal character of the channel substrate is variable, so that scouring may not be uniform but preferentially deeper in the sandy non-frozen thalweg, where water depths and velocities will be greatest.

Scour will likely occur in episodic cycles during major flood events followed by more steady rates of sedimentation. The volume of scour attributable to the bridge is estimated to be less than 1 percent of the total suspended load during flood flows (Pickering pers. comm. 2004). Because much of channel bottom sediments are fine-grained they will stay suspended during the breakup flood and be deposited on sea ice. However, a significant portion of the scoured material is sand, which will not remain in suspension, but will be deposited a short distance downstream of the bridge where the high flow velocities would be attenuated. Although the locations and mechanisms of sediment transport have not been studied, the natural sediment load of the Colville River is relatively high. Some aquatic habitat may be impacted by sedimentation, but this will likely be typical of the biophysical system. Additional channel maintenance (i.e., dredging) for navigation or fish passage once the bridge structure is in place is not anticipated. Nevertheless channel monitoring should be utilized to assess the need to maintain channel navigability and fish passage during low water conditions.

A recent analyses of historical bank erosion along the Nigliq Channel was conducted by Michael Baker and Hydroconsult (2004). Various measurements of bank erosion have been made along the Nigliq Channels. A one-time maximum erosion occurrence of 36 feet was measured by Walker et al. (1994), which resulted from the collapse of a thermo-erosional niche. Michael Baker (2004b) suggested that the characteristics of the proposed bridge location are such that a one-time erosion occurrence is likely to have the same magnitude as the observed maximum occurrence.

Walker et al. (1994) also concluded that erosion along the Nigliq Channel is variable from year to year and from location to location. Even for very specific locations, such as a sharp bend at Nuiqsut, the bank erosion at the bend varied from less than 0.7 feet per year to 36 feet in 1 year. In 2003, ABR completed a study of erosion based on photogrammetric analyses of 1955 and 2001 air photos along a 1 kilometer stretch of the west bank of the Nigliq Channel. It was concluded that the erosion rate of the west bank at proposed bridge location was 1.8 feet per year with a maximum of 2.1 feet per year over the 46-year period. Michael Baker Jr. Inc. (2004b) used aerial photography to compare 1948 and 1999 bank lines. The results compared well with the ABR investigation, concluding that the erosion rate of the west bank at the proposed bridge location averaged 2.2 feet per year over the 51-year analysis period.

It can be conservatively assumed that erosion rates comparable to historically documented values will occur in the vicinity of the proposed bridge, such that continued erosion of the west bank would cause the west abutment to lie further into the channel. Bridge construction and design components can be used to minimize or eliminate bank erosion and minimize the effects of this erosion. It is not known whether factors that promote erosion will be transferred and increase erosion in other areas, but this is also a possibility.

Ublutuoch River Bridge

Under Alternative A, a 120-ft bridge is proposed for the Ublutuoch River at river mile 6.9. CPAI engineers developed rating curves based on measured water surface elevations and discharge (in the presence of ground-fast ice) to predict the elevation of backwater created by various bridge lengths (Michael Baker, Jr., 2003-Attachment 1). From the rating curves, bridge height was determined. The proposed 120-ft bridge was designed to span the main channel and the lower west floodplain (specifically, from bank to bank) and be considerably above the 100-yr water surface elevation. The roads approaching the bridge would be required to provide for natural flow. Although the higher west floodplain is inundated during high flows and spring breakup, it does not convey a significant percentage of the total flow due to its elevation. Rather, flow is conveyed along the lower west floodplain and the main channel, but with the presence of ice jams during moderate to large floods backwater could result.

Other than the HEC-RAS calculation of backwater with a 120-ft bridge scenario described above, no hydrologic or hydraulic analyses on the Ublutuoch River bridge were conducted. Water velocity would be expected to vary somewhat from baseline conditions because the channel and lower west floodplain would be constricted; ice jams would only contribute to this effect. Similarly, channel scour and streambank erosion would not be similar to baseline conditions since velocity and flow patterns would change as a result of bridge construction. Appreciable ice jamming, a consideration for the piles, abutment, and height of bridge, is possible with the lower west floodplain alternative flow route (depending on flood level).

Other Bridges

At the major crossings, depending on design attributes, flow would likely be restricted to less-frequent-to-rare high flows, suggesting that a bridge is needed (e.g., at the minor crossings west of the Delta along the National Petroleum Reserve-Alaska Road). It is assumed that constriction will restrict flows at all of these crossings. During flow constriction stream velocities slow upstream and water levels rise (backwater effect) while stream velocities increase in the constricted areas. This could result in increased potential for scour and streambank erosion. This may indicate the need for greater armor or a longer bridge that reduces the effects of the constriction and minimize scour and erosion processes. The potential for these impacts would be reduced by appropriate mitigation incorporated into the bridge designs.

Impacts Associated with Production Pads

Natural drainage patterns can be disrupted when activities associated with production pad location and/or use block, divert, or impede flow of active stream channels, ephemeral or seasonal drainages, or shallow-water (overland) flow paths. Production pads will not be placed in streams. The potential impacts occur during the operations period, but are best avoided by design considerations prior to construction. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. These effects are minimized by incorporating construction mitigation and design features into the pads to protect the structural integrity of the pads and minimize the effects of pads on natural flow processes.

CD-3 through CD-7 and their associated roads were sited to minimize impacts to wildlife, fish, and vegetation, while maintaining a technically and economically feasible project. As much as possible, production pads have also been located to minimize effects on streams and/or drainages. Design criteria are developed to eliminate or minimize the potential for impacts to these facilities and potential impacts from pad development. These criteria, described in Section 2.3.3.1, include more stringent design features for those facilities on the Delta (CD-3 and CD-4) than those on the Coastal Plain. Other pad locations were primarily determined assessing how best to minimize affects on wildlife habitat.

CD-3

CD-3 and CD-4 were studied in detail (e.g. flood frequency and production pad height) in 2001 and 2002. This information was used to develop pad height criteria. However, both CD-3 and CD-4 pad heights are governed more by thermal criteria than by flood criteria. The results of the 2D open-water modeling for various flood frequencies are compared to CD-3 pad design criteria on Figure 4A.2.2-37. CD-3 pad proposed elevation is 12.6 ft BPMSL, which is 4.2 ft above the predicted 200-year (1,000,000 cfs) flood elevation, and 3.7 ft above the 1,300,000 cfs level, so designed with sufficient freeboard.

The proposed CD-3 location is approximately 8 kilometers north of APF-1. The drill site location will be adjacent to Lake M9313 and placed on the highest terrain in the area between the West Ulamnigiaq and East Ulamnigiaq Channels on the Delta. This is an area where infrequent but high-magnitude flood events can potentially occur. The pad would not affect fish passage to Lake M9313 because the site is situated away from the primary route of fish passage (see Section 4A.3.2).

Further, based on the results of the preliminary analyses conducted by Michael Baker Jr. Inc. (2002b), storm surge would not produce a higher water surface elevation than a river flood, with a similar risk of occurrence. The effect of a fall flood concurrent with a storm surge would have a smaller effect than the effects encountered during break-up, because the flows are much lower than spring flows. Observed storm surges and hindcast analysis indicate that these big storms occur in late summer and fall, and thus they are unlikely to coincide with break-up. These late summer/fall storm surges could affect CD-3, but streams are at their lowest level at that time and thus it will not likely be an issue.

CD-4

The proposed CD-4 location and pad heights were arrived at by considering thermal stability and hydrologic factors that include ensuring that cross drainage problems during flooding would not be an issue. Flooding could result in adverse impacts to fisheries using adjacent lakes and connections because of the potential for gravel eroding into the waterways. The pad location is situated to maximize access to the reservoir and is located between Lakes L9323 and L9324, on an abandoned floodplain cover deposit. The decision to construct the road across Lake L9323 was made in order to move the road away from the pipeline racks to the east, thereby facilitating crossing by caribou. Research indicates that pipelines and roads should be separated by at least 350 feet to enable crossing, and this area has been identified as an important area for east–west travel by caribou.

CD-4 is not expected to change the hydrologic regime significantly in the area. The results of the 2D open-water modeling for various flood frequencies are compared to CD-4 pad design criteria on Figure 4A.2.2-35. The proposed CD-4 pad elevation is 19.0 ft BPMSL, which is 4.8 ft above the predicted 50-year (730,000 cfs), 2.3 ft above the 200-yr (1,000,000 cfs), and 0.3 ft above the 1,300,000 cfs level, so designed with sufficient freeboard, Water velocities during the 200-year flood are likely to be relatively slow (on the order of 1 foot to 2.5 fps) on the floodplain near the proposed facility (MBJ 2004a).

CD-5

CD-5 would be located more than 1 mile from the nearest lake or stream and on relatively flat, high ground, so impacts to surface water are unlikely. Nevertheless, rare overland flows during break-up could be widespread across the tundra and could isolate the pad from the access road for small time periods.

CD-6

CD-6 would also be located on relatively flat ground along a small topographic divide, but within the 3-mile no permanent facilities stipulation. Depending on where the measurement is taken, CD-6 would be about 1.3 to 2 miles from Fish Creek, about 1,800 feet from a small unnamed tributary to Fish Creek, and about 2,600 feet from a small lake. Other than these water bodies, no others are within 0.5 miles of the facility, so direct impacts to surface water bodies from this facility are unlikely. The setback stipulations are meant to protect fish and wildlife within the 3-mile corridor, and not related to hydrologic considerations.

CD-7

CD-7 would be located approximately 8.5 miles southwest of CD-6, and south of the 3-mile no permanent facilities stipulation. The production pad would be located near an apparently dry basin and not near any rivers or streams that would undergo break-up flows. One concern is that during high water years the old lake may fill and may ultimately overtop and spill toward Fish Creek. Water level data was collected in the vicinity of CD-7 at Lake M0024 in 2002. Outflow from Lake M0024 towards the dry lakebed was estimated at 45 gallons per minute (gpm) in September 2002. Water surface elevations suggest that M0024 was recharged to the point of overflow in 2002. This type of monitoring should be continued if the proposed CD-7 is incorporated.

CD-7 would be located more than 0.5 miles southwest of an area with many moderate-sized and small lakes. During periods of high water in spring and fall, waters near the production pad that would collect in the dry basin would flow into downstream lakes and ultimately into Fish Creek. Future monitoring of water level conditions and flow paths during spring break-up in the drained lake basin is needed to minimize the potential risks to CD-7 and downstream waters.

The site is located in an area of flooded and saturated ground described as a wet meadow and young basin wetland complex. The two habitats have low to high values for waterbird nesting, but no nests were found within 200 meters of CD-7's center point. However, nests were found in areas as near as 1000 feet. The route to CD-7 was selected to avoid wet and thaw-unstable areas and to avoid approaching the surrounding wetlands that appear to be productive nesting areas. A preliminary road route, between the wetland basin where CD-7 is proposed, and the deep lake immediately to the east, was not recommended because it would separate a loon nesting lake from a brood-rearing lake, access to which is required for successful fledging of young loons. Moving CD-7 to within the basin would probably be detrimental, because it would likely be nearer to waterbird nests. Thus, the pad location is optimal for minimizing environmental impacts, while meeting minimum economic considerations.

Break-up typically occurs as a flood event and, combined with ice and snow damming, can flood large areas of the tundra (i.e., overland flow). Thus, even though the proposed locations for CD-5, CD-6, and CD-7 are relatively remote from streams and placed on relatively high locations, when feasible, design criteria to address spring break-up overland flows have been incorporated into the production pad designs.

Impacts to Estuaries and Nearshore Environment During Operation

Because most of the production pads, roads, and pipelines are not near the coast, no direct impacts to the physical conditions or processes within the estuarine and nearshore environments would be expected. Storm surges and wave action, however, could affect the operation of some of the proposed facilities. CD-3 is located approximately 3 miles from the nearshore environment. Storm surges from Harrison Bay produced by sustained westerly winds concurrent with late summer high flow events could bring sea water flooding inland and result in flooding in the vicinity of CD-3. Evidence of historic storm surges is shown by the driftwood lines that are found a number of miles from the coast, including as far inland as CD-3. While it is evident that storm surge waters have reached as far inland as CD-3, such occurrences are likely infrequent and typically produce flooding impacts comparable to relatively moderate-sized break-up floods.

Coastal Frontiers (2002) examined the potential water level increases due to Arctic Ocean storm surges and waves at CD-3. They used the discrete spectral wave model, STAVE (Resio, 1988) to simulate wave conditions for four combinations of wind and flood events. The model incorporated refraction, shoaling and diffraction effects on wave propagation, along with wind input, wave spreading, non-linear wave interactions and bottom friction. They used the 1997 topographic grid developed by Shannon & Wilson (1997) and updated by Michael Baker (1998) for the 2D surface water model on a 200-ft by 200-ft rectilinear grid. For wind data, they relied on design basis wind speeds developed for the Endicott Project from Oceanweather and Tekmarine (1983). Similarly, they developed wave input data based on hindcast analyses for the Alaska Beaufort Sea (Oceanweather, 1982).

Coastal Frontiers (2002) concluded that at the CD-3 pad site, the still water levels associated with the 200-yr river flood were comparable to those accompanying the 200-yr coastal storm: +7.7 to +8.2 ft during the flood event, and +8.1 during the surge event. The near-equivalence suggested that the pad site would be located in a transition between surge-dominated from the north and flood-dominated from the south. Further, the 200-yr coastal storm (i.e., 200-yr storm surge with the 1-yr westerly wind) produced the severest wave conditions, with maximum heights of 1.2 ft above the still water surge-flood level occurring on the west-facing portion of the pad and runway. Since the CD-3 proposed pad elevation is 4.2 ft above the 200-yr flood level, then the coastal storm including wave conditions would put the pad about 3.0 ft above the waves. Although these results show the pad elevation and criteria to be sufficient, they should be used with caution, because they were developed using weather and ocean-storm input data that is more than 20 years old.

The intensity of Beaufort–Chukchi Cyclones has increased in the summer over the last 40 years (Lynch et al. 2003). These findings indicate that retreating sea ice and increased open water have an affect on the frequency and intensity of cyclonic activity in most of the Arctic, but apparently not yet in the Beaufort Sea. Observed storm surges and hindcast analysis indicate that these big storms occur in late summer and fall rather than in spring, and thus they are unlikely to coincide with break-up.

From studies conducted by the Office of Naval Research, U.S. Arctic Research Commission (2004), there is considerable debate over whether recent changes in arctic climate are a natural feature of cyclical variability or whether a permanent change is being observed due to global warming. The following scenario is one plausible outcome with an appreciable probability of occurring. Over the next 20 years, the volume of Arctic sea will further decrease approximately 40%, and the lateral extent of sea ice will be sharply reduced (at least 20%) in summer. This means that polar low-pressure systems will become more common and boundary layer forced convection will increase mixed (ice-water) precipitation. Cloudiness will increase, extending the summer cloudy regime with earlier onset and later decline. The likelihood of freezing mist and drizzle will increase, along with increased vessel and aircraft icing. This indicates that the data used by Coastal Frontiers (2002) may not sufficiently represent the conditions that will prevail during most of the project lifespan. Updating the storm surge analyses using plausible weather and open-water sea conditions would improve the ability to minimize any climate change effects in the future.

Any floods with accompanying waves that cause high water surface elevations at CD-3 could result in an increase in erosion if bank stabilization measures are not adequate. Impacts might include increased erosion of CD-3, its airstrip and approach road, as well as resultant deposition of sands and gravels on the tundra. The gravel deposition could impact nesting and brood rearing areas for birds. This could then potentially result in increased sedimentation lower in the Delta and in the nearshore environment.

The applicant's previously permitted design criteria built structures meant to withstand the 50-year flood interval +3 feet inside the Delta (bridges and roads); the 200-year flood interval +1 foot inside the Delta (pads); and the 50-year interval outside of the Delta. Understanding and evaluating the causes of flooding from break-up, storm surges, or rainfall events is intrinsic to analyzing specific flood recurrence criteria. The applicant intends to follow these design criteria for future structures, or to base the design on a balance of hydrology, topography, structural stability, economics and environmental protection.

Impacts Associated With Ice Conditions

Pipeline and road bridges, and road culverts, can cause flow constrictions during flood events, which can exert extraordinary stresses on structures. The build-up and impact of ice, especially during the larger-magnitude floods, can exacerbate this condition. Current conceptual bridge and culvert designs have taken ice build-up and ice forces into account, in an attempt to reduce the potential for increased stresses on bridge abutments, increased scouring of bridge supports, increased side slope erosion, and overbank flows onto roads, as well as fish passage at times of increased flow (CPAI 2004).

The impacts associated with ice conditions are more fully described and analyzed in a previous subsection called Ice Effects. The main conclusions from this analysis was that based on approximately 10 years of observations of breakup conditions on the Delta and a hypothetical ice-jam modeling exercise, the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small (Michael Baker, 2004d). In general, Michael Baker (2004d) stated that when water depths and topography of the Delta during flows are greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern. Modeling of a hypothetical ice jam in a "worse-case" location predicts that a maximum increase in water surface elevation at Alpine will be 0.2 ft. Freeboard at the proposed facilities is between 2 and 5 ft. Based on these considerations, and reviews of data and analyses, Michael Baker (2004d) concluded that there is an extremely low probability that the gravel road and pad design elevations at Alpine will be exceeded by floodwater even when ice-jamming conditions are considered.

Potential negative effects to gravel structures, culverts, bridges, and pipelines from ice jams and break-up could occur due to increased flood stages and velocities, increased potential for overtopping (from wave run-up), and side-slope erosion. The structural integrity and design of the proposed facilities will be analyzed using conservative estimates of these influencing factors. Conservative assumptions regarding preliminary bridge design concepts indicate that there is a potential for ice jams. These could result in damage to or failure of facilities and cause increases in erosion and sedimentation.

The likelihood of failure of pipeline, road, or structures due to ice conditions is minimized by conservative designs. Continued monitoring of these bridges, pipeline VSMs, road embankments, and culvert crossings will help to mitigate against potential structural failures and improve subsequent designs. The requirement for continued incorporation of design improvements based on monitoring reduces the likelihood of ice-related impacts.

ABANDONMENT AND REHABILITATION

Removal of facilities, particularly roads, bridges, and culverts, would likely cause subsequent increased sedimentation and erosion. Leaving pads, airstrips, roads, bridges, and culverts in place, particularly without future maintenance would result in long-term, higher levels of erosion, sedimentation, and upslope impoundment. Leaving the roads in place, but removing bridges and culverts, and breaching the roads where culverts had been placed, would reduce upslope impoundment. Ponds would be formed from melting of ice wedges or other ice underlying the gravel facilities. In the case of roads and the CD-3 airstrip, these ponds would be linear. Cleaning the pipeline would create a large, one-time demand for water.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT PLAN IMPACTS ON WATER RESOURCES

Various hypothetical facilities under Alternative A – FFD are distributed throughout the National Petroleum Reserve-Alaska area and the Colville River Delta, and, as a consequence, roads and pipelines would cross many drainages within the Colville River, and the Fish–Judy Creeks and Kalikpik–Kogru Rivers Facility Groups. Production pads could be located adjacent to lakes and stream channels. The impact analysis for Alternative A – FFD is conceptually no different from Alternative A – CPAI Development Plan, except that area covered is much larger. This means that the impacts and design features described above for Alternative A will be relevant here. Table 4A.2.2-9 summarizes potential construction and operation impacts to water resources from the 22 HPs and HPF-1 and HPF-2.

It should be noted that no hydrological modeling associated with Alternative A – FFD has been undertaken. The results of existing two-dimensional modeling of the Colville River Delta (Michael Baker 2004a) conducted for Alternative A cannot realistically be used to evaluate the effects of Alternative A – FFD, simply because of its associated large increase of facilities on the Delta. Thus, the additive effects of roads altering the hydrology in the Colville River Delta, and the potential impacts associated with a road system (and airstrips) could be quite substantial. Further, in the western portion of the FFD, only scant hydrologic baseline data is available (i.e., some lake depth and geomorphic characterization, but no streamflow observations/monitoring or hydraulic assessments/modeling). In general, the impacts associated with Alternative A – FFD are not well understood, but must be assumed to be significantly greater in magnitude and extent than the effects of Alternative A – CPAI Development Plan.Alternative A – Summary of Impacts (CPAI and FFD) on Water Resources

IMPACTS TO SUBSURFACE WATERS

Groundwater resources in the North Slope are rare and primarily shallow. Sparse data indicate that sub-permafrost groundwater is brackish to saline, rendering it non-potable. The permafrost forms an aquiclude that prevents the mixing of sub-permafrost and supra-permafrost groundwater. Therefore, the proposed deep groundwater injections associated with Class I and/or Class II wells are not expected to affect the quality or quantity of shallow groundwater.

Under Alternative A – FFD, it may be beneficial to incorporate into the current design an underground injection line at each production pad, as the potential need for additional Class I and/or Class II Well(s) may arise at some future date. As a result, specific localized deep groundwater zones could be adversely affected by the practice of disposing of drilling wastes and wastewater into development or disposal wells. Although this practice would affect more groundwater zones throughout the Plan Area, because groundwater below permafrost is typically saline, impacts to potable water sources are not expected. As a result of the increased number of pads and facilities, there will be an increase in the required number of Class I and Class II Wells. Permits will be required as per specific SDWA regulations. Additional data would be collected at all potential injection well locations before approvals are issued for additional injection wells.

The proposed alternative and FFD-A requires that gravel quarries will be mined. As described above for the proposed CPAI Development Plan (Alternative A), each new gravel mine would eliminate shallow taliks and supra-permafrost water zones; however, the effect of this loss on water resources would be negligible, because the area would be very local in extent. Although rehabilitation would include allowing natural flows to fill the mine-site excavation, the subsurface water-bearing zone would be permanently eliminated. Thus, in effect the ‘pond’ habitat will be in exchange of the original tundra habitat.

IMPACTS TO SURFACE WATERS ASSOCIATED WITH WATER SUPPLY DEMANDS

Lakes would be the principal freshwater supply for the construction of ice roads and pads during the winter seasons, during production drilling and processing operations, and for potable water at temporary construction or drilling camp facilities. This demand would be dispersed over time and across the road corridors where there are numerous lakes. In general, long-term (longer than 1 year) impacts on lake-water levels are not expected because natural annual recharge processes are sufficient to fully recharge the lakes each year.

Demands of Alternative A – FFD on the water supply would be approximately four to five times those associated with Alternative A. These demands (i.e., more lakes needed to supply water for ice road construction, potability, etc.) would be dispersed over time and across a broad area where there are abundant lakes. Therefore, impacts are not expected to be any greater than for those associated with Alternative A. Lakes would still be the principal fresh water supply for the construction of ice roads and pads during the winter seasons, during production drilling and processing operations, and for potable water at temporary construction or drilling camp facilities. The use of Colville River water is also a possibility, but its use would be restricted to certain times of the year (due to high suspended sediment in the spring and fish requirements during low water conditions, but this would not be a major source of water). In general, long-term (longer than 1 year) impacts on lake water levels are not expected because natural annual recharge processes are sufficient to fully recharge the lakes (Michael Baker, 2002).

For both Alternative A and FFD-A adequate monitoring and adherence to pumping regulations would limit impacts on lake-water levels to short-term duration. Future monitoring is recommended and should continue to measure lake-water levels through time and provide estimates of recharge and surplus volumes in specific lakes targeted for supplying demand. Data from such monitoring and other future studies would be integrated with assessments of impacts on lake habitat to determine if modifications of permit stipulations are necessary (for example, changes in water withdrawal limitations, additional water quality monitoring, changes to existing lake observation programs, etc.). The applicant will likely conduct monitoring in conjunction with permit requirements associated with appropriate government agencies.

TABLE 4A.2.2-11 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative A – Full-Field Development														
Colville River Facility Group	**Groundwater**		**Lakes**		**Major and Minor Stream Crossings**								**Estuaries and Nearshore Environment**	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Sakoonang Channel	Tamayayak Channel	Ulamnigiaq Channel	Elaktoveach Channel	Kupigruak Channel	Colville River	Minor Streams	Colville River Delta Mouth	Harrison Bay
HPs 4, 5, 7, 8, 12, 13 and 14														
Gravel Road Segments: CD-4 to CD-7; HP-1 to HP-4; CD-2 to CD-7; HP-1 to HP-5; HP-7 road to airstrip; HP-12 road to airstrip; HP-13 road to airstrip; HP-14 road to airstrip	8	NI	NI	NI	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 5, 6, 7	NI
Ice Roads: HP-7, HP-12, HP-13, and HP-14	NI	NI	NI	NI	NI	NI	3	3	3	3	3	3	1, 2, 3, 4, 5, 6, 7	NI
Pipeline Segment: HP-4 to CD-4;HP-4 to CD-2;HP-7 to CD-3 (1 pipeline); HP-12 to HP-7; HP-13 to HP-12; HP-14 to HP-12	NI	NI	NI	NI	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	NI
Production Pads: All HPs	8	NI	8	8	2, 3	2, 3	2, 3	2, 3	2, 3	2, 3	NI	2, 3	2, 3	NI
Airstrips: HP-7, HP-12, HP-13, and HP-14	8	NI	8	8	2, 3	2, 3	2, 3	2, 3	2, 3	2, 3	NI	2, 3	2, 3	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI

TABLE 4A.2.2-11 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – Full-Field Development										
Fish and Judy Creeks Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish Creek Basin	Inigok Creek Basin	Judy Creek Basin	Ublutuoch River Basin	Minor Streams	Harrison Bay
HPF-1 and HPs 1, 2, 3, 6, 9, 10, 11, 15, 16, 17, and 19										
Gravel Road Segments: HP-1 to CD-6/5; CD-7 to HP-2; HP-3 to CD-6/5; HP-6 to CD-5/6; HP-6 to HP-9; HP-10 to CD-7/HP-2; HP-9 to HP-11; CD-6 to HP-15; HPF-1 to HP-16; HP-16 to HP-17; HP-17 to HP-19	8	NI	3, 5, 6, 7	3, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7	NI
Pipeline Segment: HP-1 to CD-6/5; CD-7 to HP-2; HP-3 to CD-6/5; HP-6 to CD-5/6; HP-6 to HP-9; HP-10 to CD-7/HP-2; HP-9 to HP-11; CD-6 to HP-15; HPF-1 to HP-16; HP-16 to HP-17; HP-17 to HP-19	NI	NI	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	2, 7	NI
Production Pads: HPs and HPFs	8	NI	8	NI	2, 3	2, 3	2, 3	2, 3	2, 3	NI
Processing Facility: HPF-1	8	NI	NI	NI	NI	NI	2, 3, 4, 5, 6	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI

TABLE 4A.2.2-11 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (CONT'D)

Alternative A – Full-Field Development								
Kogru–Kalikpik Facility Group	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes & Ponds	Large Deep Lakes	Kalikpik River Drainage	Kogru River	Minor Streams	Harrison Bay
HPF-2 and HPs 18, 20, 21 and 22								
Gravel Road Segments: HP-18 to HPF-1; HP-20 to HPF-2/HP-18 road; HP-21 to HPF-2; HP-22 road to airstrip; HPF-2 to HP-18; HPF-2 road to airstrip	8	NI	3, 5, 6	3, 5, 6	2, 3, 4, 5, 6	NI	2, 3, 4, 5, 6	NI
Ice Roads: HP-22	NI	NI	NI	NI	NI	3, 4, 5, 6	3, 4, 5, 6	3, 4, 5, 6
Pipeline Segment: HP-18 to HPF-1; HP-20 to HPF-2/HP-18 road; HP-21 to HPF-2; HP-22 to HP-21; HPF-2 to HP-18	NI	NI	NI	NI	2, 7	2, 7	2, 7	NI
Production Pads: All HPs and HPFs	8	NI	NI	NI	2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	NI
Airstrips: HP-22, HPF-2	8	NI	NI	NI	3, 4, 5, 6	3, 4, 5, 6, 7	3, 4, 5, 6, 7	NI
Processing Facility: HPF-2	8	NI	NI	NI	3, 4, 5, 6	NI	NI	NI
Groundwater Wells	9	9	NI	NI	NI	NI	NI	NI
Surface Water extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

Notes:
1 = Shoreline disturbance and thermokarsting
2 = Blockage of natural channel drainage
3 = Increased stages and velocities of floodwater
4 = Increased channel scour
5 = Increased bank erosion
6 = Increased sedimentation
7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
8 = Removal/compaction of surface soils/gravel and changes in recharge potential
9 = Underground disposal of non-hazardous wastes
10 = Water supply demand
NI =No Impact

These monitoring programs should be developed by the applicant, reviewed by appropriate government agencies, and incorporated into licenses and permits for specific representative areas within the Plan Area. These programs should develop strategies to measure lake-water levels through time and provide estimates of recharge and surplus volumes. These programs should also be integrated with assessments of impacts on lake habitat.

IMPACTS TO SURFACE WATER CONDITIONS AT GRAVEL MINES

Upon completion of gravel extraction activities from the proposed Clover A Mine Site, the site will be rehabilitated. The preliminary rehabilitation plan (Appendix O) calls for the creation of a high-value waterbird habitat from the gravel pit. The area of the flooded mine pit is expected to be approximately 60 acres, with a maximum lake depth of over 50 ft. The flooded mine may alter the thermal regime of the permafrost beneath and adjacent to the waterbody and likely impact the steep side slopes. Maintaining a stable water level within the excavated area will be critical to the success of the rehabilitation. The main source of recharge water will come from snow capture (through drifting), snowmelt, and through recharge from overbank flooding from the Ublutuoch River and an existing nearby ephemeral drainage during spring breakup.

The rehabilitation plan calls for two years of monitoring following the completion of the restoration design and after the rehabilitated pit has filled with water. Monitoring plans include inspecting of the pit margin for erosion and instability. This would also include any signs of inflow or outflow erosion.

In general, any new surface water bodies created by the mine pit excavation in both Alternative A and FFD-A would be left to recharge naturally during high flows in natural streams and man-made channels during annual spring break-up floods. Impacts would be mitigated by providing for appropriate fish passage (for example, during spring flows) into and out of these small lakes to nearby water bodies or the maintenance of a lake deep enough for over-wintering. Further, attempts would be made to minimize thermal erosion and degradation or lake shorelines, channel and bank erosion associated with lake inlets and outlets, and maintain natural conveyance characteristics of the terrain. These details would be described in mine and reclamation plans.

SUMMARY OF HYDROLOGIC ANALYSIS AND MODELING IN SUPPORT OF THE IMPACT ASSESSMENTS

In support of the proposed action, various hydrologic analyses and modeling have been conducted to assess the effects of roads, pads and bridges. The results of these evaluations in conjunction with recent experiences with the existing Alpine development has been used to develop conceptual, preliminary or detailed designs for the proposed facilities. Concern over the accuracy and uncertainty associated with certain hydrologic issues, however, has led to much discussion and analysis during the DEIS and FEIS review stages. This section summarizes the detailed discussions and analyses of a number of these issues that included assessments of the accuracy of peak flow and design flow estimates, an assessment of flow distribution in Delta channels, the accuracy of the two-dimensional hydrologic modeling of the Delta, an evaluation of spring breakup related conditions, and an assessment of scour analyses.

The following main points summarize issues with respect to the accuracy of the peak flow data record and the development of design flow estimates:

- The accuracy of design flow estimates is based on the length of record and the accuracy of each data point within the record. There are only 15 years of spring breakup peak flow estimates on the Colville River at the head of the Delta. None of these peak flows were measured by direct methods. Some of these annual peak flows were computed using a simplified USGS slope-area method, but the method could not always be explicitly followed because all the required input data were not available. The errors associated with these peak flow estimates computed by the indirect method can exceed 20 percent depending on a number of factors including the ability to accurately estimate: high water lines in ice-effected areas, measuring water surface slope, channel roughness estimation, non-uniform channel conditions (flow expansion), and bed stability. In some cases, these errors may be over 40 percent. In general, computations made from cross-sectional, stage and slope data collected during ice-created backwater conditions (i.e., ice and/or snow in channel, downstream ice jams) may overestimate peak flows. Similarly, extrapolation of stage-discharge ratings during ice-effected flows will also overestimate flows. This suggests that at least some of the peak flows in the data record are overestimated.

- A large flood event was reported to occur on the Delta in 1989. The 1989 peak flow event is not well documented. The flood was observed in only a few locations, rafted ice was observed strewn on floodplains afterwards, and systematic searches for high-water driftlines were observed a few years later, but no direct or indirect discharge measurements were collected. Based on the identification of 26 high-water lines, of which only 17 of the sites could the absolute elevation be established to ± 1.0 ft, and the use of the two-dimensional model, the peak flow was estimated to be 775,000 cfs with a range from 665,000 to 930,000 cfs. Further, the return period of the event was estimated to be on the order of a 100-yr event, but with a possible range from 67 to 393 years. Based on the high uncertainty associated with the estimation of the 1989 peak flow, the calculated flow value of 775,000 cfs should not be relied on for use in flood frequency assessments, calculations and regressions.

- Using the available peak-flow database, design flows for Alpine area were computed for the 50-, 100- and 200-yr flood values to be approximately 470,000, 730,000 and 1,000,000 cfs, respectively. The 95 percent confidence limits for these values indicate that the flood estimates for the infrequent events have an appreciably larger margin of error (i.e., approximately 50 percent for the 200-yr) than the more frequent events (i.e., approximately 24 percent for the 5-yr). Based on the analysis of reported peak flow stages and the discharges described above, there is the likelihood that some of the peak flows have been overestimated which may have introduced bias into the short-term record used to compute the estimates for the 200-yr, 50-yr and 10-yr flows, such that the re-computed design flows would be less after accounting for the overestimations.

- To put these confidence limits in perspective, calculated 200-year unit runoffs for sites in northern Alaska range from 30 cubic feet per second per square mile (cfsm) to over 70 cfsm. The calculated unit runoff for the Colville River assuming the proposed 200-yr of 1,000,000 cfs is 48.4 cfsm, similar to the other values in the coastal plain area largely because the value was calculated using principally the Kuparuk River (a smaller river located to the east of the Alpine area) data record. For comparison, at discharges of 770,000 and 1,300,000 cfs the unit runoffs would be 37.3 and 62.9 cfsm, respectively, and both are within the observed range for the northern Brooks Range.

- To account for these variations, the 2D model was run at a higher flow of 1,300,000 cfs, to assess the possible effects of underestimating the 50-yr and 200-yr flood values, and to address the reasonableness of freeboard values. These results are presented as rating curves and evaluated at specific locations for each facility or point of interest along the proposed and existing roads.

The location of existing and proposed Alpine facilities lies within the western portion of the Delta with flow dominated by the Nigliq Channel system. Surface conditions on the Delta are by nature complex, governed by the interaction of hydrologic, geomorphic, biologic and thermal processes. Predicting hydrologic conditions in support of designs is much more difficult than with rivers with only single reaches. In this case because of the existing and proposed developments in the west Delta, it is very important to understand what governs the proportion of flow into the Nigliq Channel, and how this flow proportion changes over time based on stage and channel geometry. The following main points summarize issues with respect to the assessment of the flow distribution between the Nigliq and East Channel and how this might effect model accuracy:

- Historical photos and observations indicate that the channel and floodplain geometry at the entrance to the Nigliq Channel has changed over time due to upstream and downstream erosion and sedimentation processes. Further, as the depth of flow changes the conveyance capacity of the channels also changes. These factors cause the proportion of flow carried by the Nigliq Channel to change over short-term and long-term periods. Measured proportions of Monument 1 flows in the Nigliq (at entrance) range from 3.8 to 38.2 percent for flows of 17,100 and 233,000 cfs, while the model predicts the proportion to have a much smaller range (19 to 24 percent) at high flows, 470,000 to 1,000,000 cfs.

- The entrance of the Nigliq, because of its location of divergence of the Colville River, is an area of reduced velocity and naturally occurring deposition (i.e., bankfull channel widens, slope flattens, and deposition results). This suggests sedimentation will continue near the entrance to the Nigliq Channel. Whether this process is manifest during high magnitude infrequent flood events is possible, but not definite. Based on flood conditions (i.e., locations of ice jams during breakup), the extreme flows may just as readily scour out the entrance and open up the channel and cause deposition in another location.

- Part of the uncertainty is due to a lack of continuous discharge data for the main Delta channels in addition to knowing that the natural processes are very dynamic. The ability to predict how the delta will evolve over the next 20 to 50 years is also problematic and hampered by our lack of delta-wide observations, a good long-term aerial photographic record, a comprehensive understanding of spring break-up dynamics, and an understanding how future climate conditions may change.

- Due to ice jams, breakup flows could cause the Nigliq Channel to carry a much larger proportion (i.e., possibly over 50 percent) and very low flows could carry less than one percent simply because the change in channel capacity with elevation is not linear (i.e., more capacity becomes available in subordinate channels at slightly higher elevations). The possibility of this condition and its effects are summarized below when addressing ice effects.

- The current design for the 1,200-ft bridge is based on a 200-yr maximum flow of approximately 213,000 cfs. Although, the likelihood that Nigliq Channel flows would exceed this are extremely low, it is important to understand the conditions that could cause flows to be greater than 213,000 cfs at the bridge crossing so that the current preliminary designs can be considered sufficiently conservative. The result of underestimating Nigliq Channel discharge during high flows can have substantial impacts including increased scour, erosion and sedimentation at bridge and pipeline crossings, and increased water surface elevations around proposed and existing road, pads and runways. Based on analyses described in the FEIS, there are three conditions associated with the Nigliq Channel flow proportion that must be considered in assigning freeboard: ice-jam effects, short and long-term evolution of channel and floodplain geometry, and model inaccuracy.

A two-dimensional surface water model (FESWMS) was used to predict water surface elevations and velocities in the Colville River Delta. The modeling evaluated four Nigliq Channel bridge lengths (900-, 1,200-, 1,500- and 1,650-foot) under varying hydrologic conditions, and predicted water surface elevations and velocities at existing and proposed oilfield facilities. Model runs of the existing and Alternative A conditions were compared for the estimated 10-, 50-, and 200-year recurrence interval floods. These floods are represented by flows estimated to be 470,000, 730,000 and 1,000,000 cfs, respectively, at the head of the Delta, just upstream of the split between the Nigliq and East Channels. With respect to the 2D model, the following findings are relevant:

- The 2D Delta model was calibrated at a flow of 110,000 cfs (i.e., matched observed with predicted water surface elevations) and validated at the higher water surface elevations estimated for the 1989 flood.

- The higher flow conditions as predicted by the model do not have the same level of accuracy as the low flow values. The high-flow predictions could be improved by calibrating the model with measured high flow values, but that due to logistics and the physical constraints related to measuring high flows during breakup, this may not be easily achievable.

- Based on the error observed at 110,000 cfs, computed water levels for higher flows were estimated to have an error of less than 1 foot. This error was used to help establish freeboard criteria for various facility designs. This 1 foot error is supported by the nature of delta topography, in that water surface elevations will increase faster in the channel with increasing flows than outside the channel. Thus, once a flood reaches the floodplain large increases in discharge can be accommodated with very little water surface elevation change.

- The results of the delta-wide model should be used cautiously to depict conditions down to the scale of it's node-spacing and should not be used to establish flow conditions for designs in specific areas (that are equal to or less than the node-spacing). In these instances (e.g., cross-drainage culverts along CD-4 Road), local hydraulics, erosion, and sedimentation processes will determine the spacing and size of culverts.

Also, the one-dimensional model HEC-RAS was used to predict water surface elevations and velocities for the Ublutuoch River up and downstream of the proposed crossing. Based on the 100-yr discharge estimate for river mile 8.0 (8,900 cfs), the delineated water surface elevations for the 100-yr floodplain. For the 120-ft bridge option, the model predicted the bridge would cause a 0.9 ft increase in the 100-yr water surface elevation.

Current elevation design criteria for facilities (i.e., pads, roads, bridges, etc.) related to the physical environment have not been explicitly developed to consider the effects of ice jams and related ice effects on water surface elevations, but are based on either the prevention of thermal degradation of permafrost (i.e., requiring a minimum pad or road thickness) or on minimizing the risk from open-water flooding (i.e., when ice is not present). Because of the limitations associated with analyses in support of designs (including ice effects), freeboard is incorporated into all the criteria. The issue here is whether the design water surface elevations and freeboard are conservative enough to account for the unknowns associated with predicting the locations, frequency, magnitude and duration of ice jams and flooding associated with ice jams. With respect to the establishing criteria to account for ice effects, the following findings are relevant:

- Several large-scale examples of ice-induced flooding have been observed on the Delta, including the 1974 flood at Nuiqsut, and the 1981 and 2004 ice jams at head of Delta, which apparently changed the proportions of flow entering the Nigliq and East Channels.

- Based on the observations of breakup in the Delta and in conjunction with earlier reports, Michael Baker (2004d) concluded that the effectiveness of an ice jam in creating backwater conditions in the Delta is regulated at some point by the relatively flat terrain in the Delta. Backwater and floodplain inundation from an ice jam will increase the water surface elevation to a threshold defined by channel geometry and topography. This conclusion concurs with theoretical derivations of ice-jam stability (Michel, 1971). Michel describes a physical limit to the thickening of an ice cover under the effect of hydraulic forces. He states that if the discharge is slowly raised under an ice accumulation the cover thickens by shoves until the increase in hydraulic thrust, due to the reduction of flow area, becomes higher than the resistance of the cover to this thrust.

- Michel (1971) mathematically demonstrates that the maximum discharge before shove is directly proportional to the river depth and channel width and inversely proportional to ice and channel roughness. This means that as the discharge reaches a critical water level where either the depth and or width exceed resistance conditions (i.e., overbank discharges), the ice jam tends to release.

- However, Michel also indicates that if the plug or jam is itself sufficiently resistant, water will rise upstream and find an alternate route and bypass the jam. In many cases with dry jams (ice blocking the entire channel), most of the discharge can be deflected, possibly even leading to the formation of a new channel or the occupation of abandoned or less used channels. These conditions, although apparently not frequent on the Delta based on past observations, could occur if breakup was rapid, river water levels increased rapidly, and ice strength was still high.

- The Michael Baker (2004d) report concludes that based on approximately 10 years of observations of breakup conditions on the Delta and hypothetical ice-jam modeling results, that the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small. They state that water depths and topography of the Delta indicate that during flows greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern.

- Although these conclusions are reasonable and intuitive, the ice jam modeling that supports this conclusion was unable to simulate conditions similar to those in 2004. For example, in the model assumptions (i.e., the size, orientation, and condition - bottomfast versus shorefast and floating - of the modeled ice jam did not result in a significant large re-direction of flow, which was apparently observed to occur in 2004).

- The Michael Baker (2004d) report is the first good synthesis of ice jams and ice jam processes for the Colville River Delta, but much of the dynamics are still not well understood. Therefore, underestimating impacts the model results should be viewed cautiously due to the difficulty in accurately simulating ice jams.

During high flows in the region's streams and rivers, scour can change the channel geometry of areas upstream and downstream of bridges and culverts and affect their structural integrity. Scour analyses have been conducted for the Nigliq Channel bridge site but not for any of the other bridge sites. However, general scour concepts and mitigation measures have been provided. The following main points summarize issues with respect to the evaluation of scour at the proposed Nigliq Channel bridge crossing:

- Soil borings drilled into the Nigliq Channel at the bridge crossing indicate that the channel sediments range from organic-silt, silt, silty sand and sand within the upper 35 feet. The borings also indicate that the sediments contain visible ice in the upper 30 ft of all the boring locations except the main channel boring.

- Based on velocities predicted by the 2D model, and assumptions regarding grain size, channel uniformity and thermal condition of the sediments, the depth of scour was estimated using both Abscour and HEC-18 programs. The results suggested that the 50-year flow would result in a maximum uniform (across the entire channel) scour of approximately 12 feet and the 200-year flow approximately 20 feet at the Nigliq Channel bridge site.

- However, using more conservative assumptions regarding sediment grain sizes, ice conditions, and channel uniformity will result in non-uniform scour, such that the non-frozen loose sands in the main channel may be preferentially scoured, while the partially frozen silts in the floodplain may resist scour. This may result in deeper scour in the main channel and less scour over the floodplain than estimated.

- At the crossing, the main channel and portions of the east floodplain are comprised of sands. These sands will be scoured during higher velocities under the bridge and then likely deposited a short distance downstream of the bridge due to attenuated velocities. The increased sedimentation on the floodplain and main channel could reduce low water conveyance capacity, which could adversely affect navigability and fish passage during very low flows. The scour and sedimentation will occur episodically, resulting in episodic changes in channel characteristics downstream of bridge over the project lifespan.

- Scour at the piers and bridge abutments is a function of flow patterns approaching the structures and shape, alignment and size of the structures. Uncertainties in scour amounts, due to flow and water level uncertainty, are small compared to the potential variability in results due to flow pattern assumptions and techniques available for computing scour. These factors have been considered in the scour analysis for the Nigliq Channel bridge.

- Scour estimates have been conducted for the bridge crossing, and the proposed bridge location and design will incorporate agency comments and continuing analyses. In particular, the ADOT&PF is studying discharge and breakup processes on the Colville River in preparation for the proposal to construct a bridge at the head of the Delta as part of the State of Alaska's proposed Colville River Road project (see Alternative C-2). ADOT&PF will be developing scour estimates associated with design flood values, and their analyses should be considered as an important contribution to developing design conditions for this project.

In general, for each stream crossing only general stream and channel characteristics are known, and only conceptual designs exist, so that the potential for scour must be assumed and appropriate mitigation incorporated in final designs. Since scour-related impacts are possible without sufficient design components, it is conservatively assumed that some scour will occur. Although not likely, this could result in structural failure, additional erosion and downstream sedimentation, and impacts to aquatic habitat. Designs should demonstrate that specific protection from scour and sedimentation has been developed for each crossing, and appropriate mitigation measures (including monitoring and adaptive management scenarios) are incorporated.

IMPACTS TO SURFACE WATERS – RIVERS AND CREEKS – RELATED TO PIPELINES, ROADS AND BRIDGES

Rivers and creeks can be affected when construction and operation activities associated with road and pipelines block, divert, impede, or constrict flows. Blockage or diversions to areas with insufficient flow capacity can result in seasonal or permanent impoundments. Constricting flows can result in increased stream velocities and a higher potential for ice jams, ice impacts, scour, and streambank erosion. Impeding flows can result in a higher potential for bank overflows and floodplain inundation. These potential impacts need to be minimized by incorporating design features to protect the structural integrity of the road- and pipeline-crossing structures to accommodate all but the rarest flood events.

Specific designs have been provided for some locations; and conceptual designs for other locations have also been provided. It is assumed conservatively that some impacts might occur. In most cases designs for Alternative A – FFD will be based on from the results of monitoring existing and proposed structures and facilities.

Pipelines

Design features have been incorporated into existing conceptual and/or detailed plans to protect the structural integrity of pipeline-crossing structures from flooding, erosion, sedimentation, scour, ice jams, ice impacts, and storm surges during all but the rarest flood events. The alignment of the proposed pipeline would cross the Nigliq Channel, the Ublutuoch River, Fish Creek, and other small drainages, and would follow a separate alignment 350 to 1,000 feet from the access road, except at the bridge crossings.

Impacts related to flow constriction would be unlikely at the minor pipeline crossings at all flows. The potential for ice jams at the major pipeline crossings is likely similar to that for the bridges. Specific design criteria must be supported by analyses that demonstrate that the VSMs will allow for free passage of ice, and more conservatively account for any additional forces that could damage support structures.

In general, on the Delta and for the major stream or river crossings, pipeline-crossing structures are designed with more stringent standards than road-crossing structures because of the greater sensitivity of the environment to a structural failure. Pipeline-crossing structures are designed to accommodate the 200-year flood (plus 1 foot of freeboard), while road-crossing structures are designed to accommodate the 50-year flood (plus 3 feet of freeboard) (See Sections 2.3.1 and 2.3.2).

RoadsThe proposed road from Alpine to CD-4 is hydraulically fundamentally different than the existing Alpine to CD-2 Road. The CD-2 Road runs east-west and crosses delta channels (i.e., perpendicular to flow), while the CD-4 Road runs north-south (i.e., parallel to flow).

The results of the 2D open-water modeling for various flood frequencies are compared to road design criteria, which states that the road will have to be built to the 50-yr level plus 3 ft for freeboard. The modeling results suggest that for the large magnitude less frequent events the elevation of a few sections of the proposed CD-4 Road (based on preliminary design elevations) may not be high enough, while the existing and proposed CD-2 to CD-7 road is above all criteria. However, design criteria were exceeded at two of the existing bridges.

Bridges

At the proposed bridge crossing, the Nigliq Channel is approximately 1,550 to 1,600 ft wide. Because the active channel is over 1,200 ft wide, the channel would be constricted somewhat at the proposed 1,200-foot bridge location, thereby slightly increasing velocity through the structure during flood flows. In general, localized scour associated with bridge supports is only expected to occur during a flood with a recurrence interval greater than 10 years.

Estimates of scour depth ranges up to 20 feet, and is greatest right under the bridge. Scour is even deeper around each bridge pier (i.e., likely an additional 5 ft). These scour estimates assume the channel is non-frozen silt and that scour will occur uniformly across the entire channel. However, the grain-size and thermal character of the channel substrate is variable, so that scouring may not be uniform but preferentially deeper in the sandy non-frozen thalweg, where water depths and velocities will be greatest.

Scour will likely occur in episodic cycles during major flood events followed by more steady rates of sedimentation. Because much of channel bottom sediments are fine-grained they will stay suspended during the breakup flood and be deposited on sea ice. However, an appreciable portion of the scoured material is sand, which will not remain in suspension, but will be deposited a short distance downstream of the bridge where the high flow velocities would be attenuated. Although the locations and mechanisms of sediment transport have not been modeled, the natural sediment load of the Colville River is relatively high. Some aquatic habitat may be impacted by sedimentation, but this will likely be typical of the biophysical system. Additional channel maintenance (i.e., dredging) once the bridge structure is in place is not anticipated, but may need to be considered. Channel depth monitoring is recommended to assess the need to maintain channel navigability and fish passage during low water conditions.

It can be conservatively assumed that erosion rates comparable to historically documented values will occur in the vicinity of the proposed bridge, such that continued erosion of the west bank would cause the west abutment to lie further into the channel. Bridge construction and design components can be used to minimize or eliminate bank erosion and minimize the effects of this erosion.

Under Alternative A, a 120-ft bridge is proposed for the Ublutuoch River at river mile 6.9. The proposed 120-ft bridge was designed to span the main channel and the lower west floodplain (specifically, from bank to bank) and be considerably above the 100-yr water surface elevation. The roads approaching the bridge would be inundated during very high flows. Although the higher west floodplain is inundated during high flows and spring breakup, it does not convey a significant percentage of the total flow due to its elevation. Rather, flow is conveyed along the lower west floodplain and the main channel, but with the presence of ice jams during moderate to large floods backwater could result.

It is assumed that some constriction will occur at all of the bridge crossings. During flow constriction stream velocities slow upstream and water levels rise (backwater effect) while stream velocities increase in the constricted areas. This could result in increased potential for scour and streambank erosion. This may indicate the need for greater armor or a longer bridge that reduces the effects of the constriction and minimizes scour and erosion processes. The potential for these impacts would be reduced by additional mitigation incorporated into the bridge designs.

Mitigation of these impacts includes the detailed designs for proposed bridge crossings (i.e., on the CD-4 Road), culverts, pads and roads that are supported by comprehensive analyses of impacts associated with these features and based on detailed hydrologic modeling as necessary to characterize flood conditions for various scenarios, including the characterization of model and data uncertainty that considers appropriate and sufficient scrutiny of statistical parameters and engineering risk. Continued data gathering (including some additional programs that are not currently being undertaken: continuous monitoring of water-surface elevations and streamflow throughout break-up, the summer and freeze-up periods for all affected streams) should be undertaken as a mitigation measure. In particular, it is recommended that for those streams with important bridge crossings (the proposed 120-foot bridge on the Ublutuoch River, the 1,200-foot bridge on the Nigliq Channel, and the 80-foot bridge on the paleochannel) a comprehensive data set will enable better characterization of flood frequency, flooding processes, channel conditions, and scour potential.

In the event that floods exceed design criteria, it is likely that natural delta topography and the increase in man-made facilities (including more crossing structures) would slow the flood flows, which would result in more widespread inundation and an increase in erosion and sedimentation across much of the Delta. Flow constrictions and high velocities would still occur at the main channel road and pipeline crossings and increase the potential for localized scouring of crossing structures and erosion of bridge abutment foundations and road embankments. This effect would also occur in the Fish Creek and Kalikpik–Kogru River basins, but to a lesser extent simply because the size of flows in these basins will not be as great, and the floodplains are smaller in area.

Under Alternative A – FFD, roads and pipelines would cross numerous rivers and creeks, and production pads could be situated in locations adjacent to lakes, streams, and rivers. These structures would affect surface waters when construction and operation activities block, divert, impede, or constrict flows. Conceptually, designs of these structures would be similar in scope to that under Alternative A. Thus, recommendations provided for Alternative A also apply to Alternative A – FFD. These include detailed design features for bridge crossings, culverts, pads and roads, and hydrologic modeling as necessary to characterize flood conditions for various scenarios. Pre-existing facilities (i.e., existing and proposed Alpine Delta pads, roads, bridges and pipelines) may be impacted by the building of more crossing structures which would slow the passage of flood flows. It is plausible that conditions that now meet criteria may change so that criteria are not met when the Delta is more fully developed. The 2D open-water model could be used to explore various open-water scenarios to determine how floods are attenuated if FFD Delta development occurs. Further additional data gathering and continued monitoring would be conducted prior to permitting FFD, including impacts to the hydrology of the Delta and the entire Plan Area.

In general, existing data, information, and studies conducted in the areas of the Colville River and Fish–Judy Creeks Facility Group can be applied to developing appropriate mitigation and design elements for road and pipeline crossings and production pads, and the impact analysis described above is relevant here. Very little data and information are available, however, for streams in the Kalikpik–Kogru Rivers Facility Group. In any case, future monitoring programs would need to be developed for representative locations throughout the Plan Area to help develop appropriate design and mitigation strategies. Further, potential impacts would be minimized by incorporating design features that protect the structural integrity of the road- and pipeline-crossing structures to accommodate all but the rarest flood events (i.e., based on specific flood recurrence criteria).

In general, for those roads and pipelines serving the seven production pads in the Colville River Delta Facility Group on the Delta, potential impacts would be greater, so design criteria are more stringent. Further, because there is a greater sensitivity of the environment to a structural failure of pipelines, more care is necessary to locate pipeline crossings. In the rare event when design floods are exceeded, the potential impacts associated with Alternative A – FFD would be greater than those under Alternative A, simply because there are more structures and facilities at risk.

IMPACTS TO SURFACE WATERS RELATED TO PRODUCTION PADS

All proposed production pads have been designed to account for thermal criteria (minimum thickness to prevent permafrost degradation) and hydrologic criteria (200-yr water surface elevation plus 1 ft of freeboard on the Delta, 50-yr flood plus 3 ft of freeboard for CD-5, CD-6 and CD-7). For CD-3 and CD-4, the results of the 2D surface water model indicate 200-yr water surface elevations below the thermal criteria, so that the proposed pad elevations are adequate. These conclusions are based on the open-water delta-wide 2D model that does not account for ice-effected water surface elevations. Michael Baker's (2004d) recent analysis of ice-jamming also concludes that ice-jamming related effects will not create water surface elevations at the proposed pad locations above the 200-yr flood levels.

Because construction of pads will occur during the winter season, construction-related impacts on flow processes are negligible. Nevertheless, erosion and sedimentation processes could be increased as a result of the potential disturbance of soils/tundra, which would not be realized until break-up when surface runoff processes begin and entrain loosened sediment from disturbed soils.

During operations, the rationale for the locations of pads CD-3 to CD-7 and road placement minimizes impacts on wildlife, fish, and vegetation while attempting to maintain a technically and economically feasible project. As much as possible, pads have been located to minimize effects on streams and drainages. Design criteria are developed to eliminate or minimize the potential for impacts on these facilities and potential impacts from pad development. These criteria include more stringent design features for those facilities on the Delta (CD-3 and CD-4) than those on the coastal plain. Other pad locations were primarily determined by minimizing effects on wildlife habitat.

CD-3 is located approximately 3 miles from the coast. Storm surges from Harrison Bay produced by sustained westerly winds concurrent with late summer high flow events could bring sea water flooding inland and result in flooding in the vicinity of CD-3. Evidence of historic storm surges is shown by the driftwood lines that are found a number of miles from the coast, including as far inland as CD-3. While it is evident that storm surge waters have reached as far inland as CD-3, such occurrences are likely infrequent and typically produce flooding impacts comparable to relatively moderate-sized break-up floods.

The predicted 200-yr coastal storm (i.e., 200-yr storm surge with the 1-yr westerly wind) produced the severest wave conditions, with maximum heights of 1.2 ft above the still water surge-flood level occurring on the west-facing portion of the pad and runway. Since the CD-3 proposed pad elevation is 4.2 ft above the 200-yr flood level, then the coastal storm including wave conditions would put the pad about 3.0 ft above the waves. Although these results show the pad elevation and criteria to be sufficient, they should be used with caution, because they were developed using weather and ocean-storm input data that is more than 20 years old that do not incorporate many of the more recent observations and findings related to climate changes occurring in the Arctic.

The intensity of Beaufort–Chukchi Cyclones has increased in the summer over the last 40 years. These findings indicate that retreating sea ice and increased open water have an affect on the frequency and intensity of cyclonic activity in most of the Arctic. The Office of Naval Research, U.S. Arctic Research Commission (2004) report that although there is considerable debate over predicted changes in arctic climate patterns due to global warming, it is very plausible that over the next 20 years, the volume of Arctic sea will further decrease approximately 40%, and the lateral extent of sea ice will be sharply reduced (at least 20%) in summer. This means that polar low-pressure systems will become more common and boundary layer forced convection will increase mixed (ice-water) precipitation. Cloudiness will increase, extending the summer cloudy regime with earlier onset and later decline. The likelihood of freezing mist and drizzle will increase, along with increased vessel and aircraft icing. This indicates that the 1970's database used to predict storm surges and waves in region may not sufficiently represent the conditions that will prevail during most of the project lifespan. Updating the storm surge analyses using plausible weather and open-water sea conditions would improve the ability to minimize any climate change effects in the future.

It is conservatively assumed that storm-surge related flooding impacts could occur sometime during the pad's duration. These might include increased erosion of the CD-3 pad, airstrip, and approach road, as well as resultant deposition of sands and gravels on the tundra. The gravel deposition could affect nesting and brood-rearing areas for birds.

Various features and criteria for the production pads proposed under Alternative A – FFD will need be similar to those incorporated into the pad designs under Alternative A (CD-3 through CD-7) to eliminate or minimize the potential for impacts to and from surface waters. These criteria are more stringent for those facilities on the Delta (that is, 200-year flood for CD-3 and CD-4) than those on the Coastal Plain (a 50-year flood for CD-5, CD-6 and CD-7), which are not close to creeks or lakes. Future monitoring of water level conditions and flow paths in potential FFD pad locations will be needed to ascertain the potential risks to each production pad location and to downstream waters.

IMPACTS TO ESTUARIES AND NEARSHORE ENVIRONMENT

Because the locations of production pads, roads, and pipelines for Alternative A are not near the coast, no direct impacts to the physical conditions or processes within the estuarine and nearshore environments would be expected. Storm surges and wave action, however, could affect the operation of some of the proposed facilities (i.e., CD-3 pad). This is discussed in the previous section.

The CD-4 pad and short sections of the roads will, however, be situated close to delta channel shorelines, so it is important to characterize the potential for channel migration and channel bank erosion. Detailed analyses have been done at a few locations (at the Nigliq Bridge crossing), and these analyses suggest bank shoreline erosion rates are highly variable from year to year. Nearshore monitoring should be conducted in critical areas where pad sites and roads are relatively close to channel shorelines. An increase in channel shoreline erosion rates would hasten the need to conduct monitoring studies and programs prior to implementing erosion abatement measures.

Except for one HP in the Kalikpik–Kogru Rivers Facility Group (HP-22), all the production pads and access roads under Alternative A – FFD would be located at least 3 miles from the coast. Because the pad, road, and pipeline locations would not be near the coast, direct impacts to the physical conditions or processes within the estuarine and nearshore environments are not likely. However, due to the increase in road- and stream-crossings, increased erosion and downstream sedimentation is likely. Although prudent and effective designs can mitigate much of the potential for these effects, it is still likely that due to the sheer number of crossings, some impacts will occur. The result would be an increase in sedimentation to the delta and to Harrison Bay which could impact sediment transport processes and estuarine and nearshore habitat. The site of HP-22 appears to be on relatively high ground between two thaw-lakes approximately 1,500 feet from an actively eroding coastline. This indicates that appropriate monitoring of coastal processes is warranted to locate and design for any potential access road, pipeline, or production pad in this area. Nearshore monitoring could also be conducted at other pad sites that are relatively close to the coast or channel shorelines (CD-3, HP_-3, HP-5, HP-12, HP-13 and HP-14). An increase in coastal and channel shoreline erosion rates would hasten the need to conduct comprehensive monitoring studies and programs.

IMPACTS ASSOCIATED WITH ICE CONDITIONS

The Michael Baker (2004d) report concludes that based on approximately 10 years of observations of breakup conditions on the Delta and their hypothetical ice-jam modeling results, that the likelihood of exceeding design elevations for Alpine facilities as a result of ice jamming effects is extremely small. They state that water depths and topography of the Delta indicate that during flows greater than or equal to the 10-yr flood, ice will be dispersed across the Delta and ice jamming will not be a major concern. Modeling of a hypothetical ice jam in a "worse-case" location predicts that a maximum increase in water surface elevation at Alpine will be 0.2 ft. Freeboard at the proposed facilities is between 2 and 5 ft. Based on these considerations, and reviews of data and analyses, Michael Baker (2004d) concluded that there is an extremely low probability that the gravel road and pad design elevations will be exceeded by floodwater even when ice-jamming conditions are considered.

Although these conclusions are reasonable and intuitive, the ice jam modeling that supports this conclusion was unable to simulate conditions similar to those in 2004 because of the limitations described above. For example, the size, orientation, and condition (bottomfast versus shorefast and floating) of the modeled ice jam did not result in a significant large re-direction of flow, which was observed to occur in 2004. The Michael Baker (2004d) report is the first good synthesis of ice jams and ice jam processes for the Colville River Delta, but because of the sensitivity in underestimating impacts these model results should be viewed cautiously due to the difficulty in accurately simulating ice jams.

For both Alternative A and Alternative A – FFD, the likelihood of failure of pipeline, road, and facility structures associated with ice conditions is possible but minimized considerably by conservative designs. Monitoring of such structures during development of APF-1 continues to provide input to mitigation design features. The continued incorporation of design improvements based on this monitoring suggests that potential impacts from ice conditions are not likely to increase from current conditions and practices.

ALTERNATIVE A – POTENTIAL MONITORING PLANS AND MITIGATION MEASURES (CPAI AND FFD) FOR WATER RESOURCES

SUBSURFACE WATERS

- The USEPA has not determined whether the aquifers in the vicinity of the production pad wells meet the other elements of the underground sources of drinking water (USDW) definition. For each proposed disposal well, the USEPA (the primary agency responsible for granting an aquifer exception) will make the appropriate decision, in consultation with the AOGCC.

SURFACE WATER – LAKES

- Prior to lake withdrawals, lake monitoring studies are recommended for each lake where withdrawals are proposed to evaluate the possibility of affecting lake habitat and recharge potential, and to verify the prediction that the lakes are fully recharged annually during break-up.

- It is also recommended that water monitoring programs should be further developed for representative areas within the Plan area where withdrawals are anticipated. These programs would measure lake water levels over time, provide estimates of recharge and surplus volumes, and document any observed changes of water quality parameters over time as an assessment of impacts on lake habitats. Data from such monitoring and other future studies would be integrated with assessments of impacts to lake habitat to determine if modifications of permit stipulations are necessary (e.g., changes in water withdrawal limitations, additional water quality monitoring, or changes to existing lake observation programs, etc.).

SURFACE WATER – FLOW

- Approaches to both the Nigliq Channel and Ublutuoch River bridges and the road from the existing facility to CD-4 will need to provide for natural water flow to adhere to CWA Section 404(b)(1) guidelines and assure that cross flow maintains the natural hydrologic regime. The bridge approach and road design for the road from CD-2 to CD-5 must demonstrate that cross flow will be adequate to prevent raising the water level on the upstream side of structures by more than 6 inches, compared to that for downstream for more than 1 week after peak discharge. The need for a similar requirement for the CD-4 Road may not be necessary because of the nature of flow (parallel to the road as opposed to perpendicular to the road). The bridge approach and road designs must remain sound and not be washed out at all flow levels. Cross flow along the bridge approaches and roads would be allowed using culvert batteries or box culverts.

- Limiting road, production pad and bridge construction to the winter season would minimize potential impacts to surface waters.

- After construction, continued monitoring of bridges, pipeline VSMs, road embankments, and culvert crossings is recommended to develop adaptive mitigation measures that protect against potential structural failures and improve on subsequent designs. This monitoring should also incorporate breakup observations to decrease the potential impacts from ice conditions.

- Streambank erosion monitoring and nearshore coastal erosion monitoring is recommended for all production pad sites that are relatively close to the coast or channel shorelines (CD-3, CD-4, HP-3, HP-5, HP-12, HP-13 and HP-14). Further, similar monitoring programs including geotechnical investigations are recommended for the proposed bridge/culverts at all stream crossings. An increase in coastal and channel shoreline erosion rates would also hasten the need to conduct even more comprehensive monitoring studies prior to implementing erosion abatement measures. Nearshore monitoring is recommended for critical areas where pad sites and roads are relatively close to channel shorelines.

- It is recommended that the storm surge analyses be updated using plausible weather and open-water sea conditions that represent conditions that will prevail over the next 20-30 years or for the projected lifespan of the project. Based on recent studies, climate change processes are likely to yield smaller ice packs and more open water, resultant bigger rainfall events and higher magnitude storm surges

- Continued data gathering (including some additional programs that are not currently being undertaken) is recommended and includes: continuous monitoring of water-surface elevations and streamflow throughout break-up, summer and freeze-up periods for all affected streams. This continued monitoring would provide data in support of models and analyses and future development in the region. In particular, it is recommended for those streams with important bridge crossings (the proposed 120-foot bridge on the Ublutuoch River, the 1,200-foot bridge on the Nigliq Channel, and the 80-foot bridge on the paleochannel) a comprehensive data set would improve the characterization of low-water conditions important for addressing navigation and fish habitat concerns, and improve estimates of flood frequency, flooding processes, channel migration processes, and scour potential.

- Future monitoring of water-level conditions and flow paths in the drained lake basin is needed to minimize the potential risks to the CD-7 pad and downstream waters.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR WATER RESOURCES

Stipulations 5 (a), (b), (c), and (d) of the Northeast National Petroleum Reserve-Alaska IAP/EIS protect water quality by preventing the discharge of wastewater or other discharges into water bodies or wetlands. Stipulations 14, 15, and 16 reduce the likelihood of a fuel spill in a water body by having distance and quantity restrictions. Stipulation 22 protects the banks of waterways by prohibiting alteration of the banks and protecting riparian vegetation. Stipulations 39 and 41 have distance from water body prohibitions for the placement of facilities while 42 and 43 help prevent affecting stream flow and preventing erosion. This EIS has not identified any additional mitigation measures (see Alternative A – Potential monitoring Plans and Mitigation Measures for Water Resources above) which would be effective in minimizing impacts related to erosion, sedimintation, impediment of flows, and lake and stream hydrology .

4A.2.2.2 Surface Water Quality

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SURFACE WATER QUALITY

CONSTRUCTION PERIOD

NPDES Discharge

Temporary camps could be used at each production pad during construction and drilling operations. Most sewage and all solid waste would be transported to CD-1 for disposal with systems in place at CD-1. However, discharges of treated domestic wastewater to tundra could occur in accordance with the NPDES permit (AKG-33-0000) requirements. Specific limitations in the draft NPDES permit include: $6.5<pH<8.5$; no film, sheen or discoloration on receiving water surface; no floating solids, foams, or garbage; no discharge of kitchen oils; and quantitative limitations on flow, biochemical oxygen demand, total suspended solids, fecal coliform, and total residual chlorine. Discharges to tundra wetlands require development of a BMP plan to address prevention of chlorine burn and excessive nutrients and/or sediment loading of the tundra. The applicant's Notice of Intent states that discharges would be to tundra wetlands and not open waters, so USEPA does not plan to authorized NPDES discharges to rivers. These conditions support the conclusion that no measurable, non-localized impacts to water quality from activities performed in compliance with the NPDES permits would be expected.

Table 4A.2.2-12 shows the USEPA's monitoring requirements for the NPDES permit effluent. Monitoring would be conducted for the parameters indicated in the table by measuring, observing, or sampling effluent and recording data. Results would be reported to the USEPA. Detailed records of all monitoring aspects would be kept.

The accidental release of sewage from a spill, while not authorized under an NPDES permit, is another source of potential impacts to surface water quality. Sewage spills are usually small and would typically occur on gravel pads or roads during pumping or transferring, or result from frozen lines. During the winter, clean up would be relatively easy because the fluid freezes rapidly in the low ambient temperatures. In the summer, sewage would soak into the pad and the only response would be to spread lime over the area for disinfection. A BMP plan would be required and should address how to avoid these types of spills. However, the upset provisions of a permit would apply to a spill to Waters of the United States.

TABLE 4A.2.2-12 MONITORING REQUIREMENTS

Parameter	Sample Location	Sampling Frequency[1]		Type of Sample
		Lower Flows[2]	Higher Flows[3]	
Total Flow	Effluent	Daily	Daily	Estimate or measured
BOD_5	Effluent	Monthly	Weekly	Grab or composite
TSS	Effluent	Monthly	Weekly	Grab or composite
pH	Effluent	Monthly	Weekly	Grab
Fecal Coliform	Effluent	Monthly	2/Month	Grab
Dissolved Oxygen	Effluent	Weekly	Weekly	Grab
TRC	Effluent	Weekly	3/Week	Grab
Floating Solids	Effluent	Daily		Observation
Foam	Effluent	Daily		Observation
Garbage	Effluent	Daily		Observation
Oily Sheen	Effluent	Daily		Observation

Notes:
[1] At least one sample shall be taken per discharge event.
[2] Up to and including 10,000 gpd
[3] Over 10,000 gpd

Water Withdrawal from Lakes

Fresh water would be withdrawn from lakes within the Plan Area for three primary uses: construction of ice roads and pads during the winter construction season and for pipeline maintenance; production drilling; and potable water at the camp facilities (CD-1) and temporary construction and drilling camps. Water would also be used for dust control on roads. Ice road construction would require approximately 1 million gallons of water for each mile of road built. Estimated miles of ice roads required each year during construction would vary from a minimum of 16 to a maximum of 67 (see Table 2.4.1-2). The drilling program would require 38,000 gpd of water to support drill rig and mud plant operations at each production pad location (CPAI 2003). The drilling mud would be mixed at CD-1, so water would be withdrawn from lakes near CD-1, not at the individual production pads. In addition, approximately 5,000 gpd of potable water would be used by the rig camp operations. Water withdrawal from lakes would gradually lower the water levels throughout each winter and during the drilling in the summer months each year. However, naturally occurring recharge in the spring would be expected to fully replace—and under certain conditions even exceed—the withdrawn water volumes in the lakes (Michael Baker Jr. Inc. 2002). Permit conditions for water withdrawal would govern which lakes could be used, the acceptable withdrawal quantities and the monitoring that must be performed.

Lakes in the Plan Area that would be used for water withdrawal could be tapped lakes or perched lakes that are recharged by periodic flood events or by snowmelt and runoff each spring (Michael Baker Jr. Inc. 2002). Water withdrawal in the winter would potentially alter lake water chemistry temporarily by oxygen depletion and ion concentration (see Alkalinity and pH and Oxygen sections) (URS Corporation 2001). However, data has shown that at the given levels of use, changes to water chemistry occurred but were minor. In fact, dissolved oxygen concentrations at pumped lakes with a circulator employed to prevent pump intake and hole re-freeze appeared to decrease at a slower rate over the winter than in reference lakes. Permit conditions governing water withdrawals would be written to prevent any degradation of water quality during the winter months that would compromise fish habitats. Because multiple permitted lakes are available as supplemental water supply, degradation at individual locations could be mitigated through use of alternate sources. Oxygen depletion and ion concentration effects would be expected to be seasonal and would cease with the onset of spring break-up and recharge.

Erosion and Sedimentation

Alterations in surface drainage patterns from construction of roads, pads, and airstrips could affect both water levels and water quality in adjacent wetlands and streams. Culverts, berms, and undersized bridges tend to concentrate flows that would otherwise disperse over a wider area. Concentrated flows are more likely to erode ice-rich soils and, consequently, could increase turbidity and sediment deposition within small drainage areas adjacent to roads, bridges, and other facilities. Adequate sizing of culverts and bridges for passage would reduce the likelihood of erosion.

Potability

Surface water bodies in the Plan Area do not meet potable water standards without treatment. Any potable water treatment or domestic wastewater treatment system must undergo the ADEC’s plan review and approval. Domestic (sewage and gray water) effluent discharge would be allowed, but only in compliance with conditions specified in the NPDES permit. Discharges could occur at temporary camps at each drill site. No discharge of sewage directly to water bodies in the Plan Area by industry would occur. Therefore, no increase in fecal coliform counts over the naturally occurring concentrations would be anticipated.

Turbidity

Where gravel fill is placed in wet areas to construct a road, pad, or airstrip, the receiving waters could temporarily have higher suspended solids concentrations and greater turbidity. Because gravel fill construction would take place in winter, and most water bodies would be frozen, impacts on water quality would be limited to the entrainment of fine-grained fill material in runoff from the facilities during the spring thaw and/or during rainfall events during the summer following construction. However, impacts to surface waters are still possible at river and lake crossings that do not freeze to the bottom. For example, at Lake 9323 the water depth is 8 feet at the culvert crossing, indicating that it will likely not freeze to the bottom. Even though construction of the CD-4 road-crossing of this lake would be conducted during the winter, there is a potential to impact water quality within the lake. Similarly, construction of the Nigliq and Ublutuoch River Bridges would be conducted over two winters, including the installation of numerous piers at the Nigliq Crossing; thus, water quality in the channels could be impacted during winter construction.

The primary effect on water quality from construction and placement of gravel structures is related to upslope impoundment and thermokarst erosion (Walker et al. 1987). Thermokarst erosion, partially caused by tundra disturbance and partly by the thermal effect of dust blown off the gravel onto the tundra, can result in water features with high turbidity and suspended-sediment concentrations. Thermokarst erosion could cause the state turbidity standard to be exceeded temporarily within and downflow of the thermokarst features. In flat, thaw-lake plains on the North Slope, gravel construction could result in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel, or approximately 482 acres for the development assumptions made for Alternative A.

Dust fallout from vehicle traffic could temporarily increase turbidity within ponds and lakes adjacent to roads and construction areas in the Plan Area. Algae productivity also could increase from nutrients entering the water with the dust. Depending on the average size of the airborne particles, prevailing wind direction, and wind speed, dust fallout would typically occur within 330 feet of the activity (USACE 1980). However, because construction and most vehicular traffic associated with the applicant’s proposed action would occur during winter, any adverse impacts on water quality from dust should be minimal. If dust control becomes a problem and a chemical binder is required, ADEC approval may be required.

No impact to water quality from winter water extraction from lakes would be expected. Turbidity increased similarly in both pumped and unpumped lakes in 2002 monitoring (Michael Baker Jr. Inc. 2002).

Alkalinity and pH

As surface waters freeze, salts are excluded from the forming ice into the underlying water, increasing salinity. In coastal tundra waters, the alkalinity is associated with the salt content, and increases and decreases in alkalinity parallel those of salinity. Pumping water from a lake in the winter would remove the relatively more saline and more alkaline water from under the lake ice. During snowmelt in the spring, less saline, less alkaline runoff water would replace the removed waters. In lakes less than 6 feet-deep, which freeze to the bottom, the salts normally would be frozen out of the entire water column and extruded into the sediment thaw bulb underlying the lake. These salts then slowly and partially leach back into the water column the following summer. For such lakes, the early summer condition would be relatively low salinity, low alkalinity water, regardless of whether or not water was removed for ice road construction. Based on observed lake pH, these lakes are weakly, but still apparently adequately, buffered against acid snowmelt.

In lakes greater than 6 feet-deep, the salts and alkalinity excluded from ice formation normally would remain in the unfrozen bottom water. These lakes start the summer with more saline, relatively strongly buffered (against acid snowmelt) waters underneath the melting ice. Winter removal of more saline water underneath the ice would result in less saline, less buffered lake waters in early summer, following winter water extraction. Thus, following winter extraction of water, their early summer chemistry would be more similar to that of lakes less than 6 feet deep. However, lake monitoring studies performed in conjunction with water withdrawal for National Petroleum Reserve-Alaska exploration activities showed no measurable difference in salt content for water in pumped versus reference lakes (URS Corporation 2001). Measurements of pH values for pumped and unpumped lakes in 2002 increased by 1.43 and 1.52 units, respectively (Michael Baker Jr. Inc. 2002). Values of pH similarly increased in previous investigations (URS Corporation 2001). No measurements of alkalinity were reported in recent lake studies in the Plan Area.

Another way that ice road construction could affect water quality would be through changes in water chemistry along the roadbed during and after meltout. As described above, the water withdrawn from lakes to construct the roadway is relatively more saline than typical snowmelt waters. In addition, the salts frozen into the ice road would leach out of the ice before it melts during snowmelt, increasing initial salt content of the meltwater. This effect could potentially occur during initial snowmelt, but the effect on water quality should be localized, most likely expressed as a slight buffering of pH during initial snowmelt.

Use of water for construction, drilling, and domestic (crew) needs could affect water quality, as discussed for ice road construction. Effects during construction and drilling on water quality from any of these mechanisms would be short-term, lasting generally one season.

Annual ice road construction could cover between 78 and 325 acres during each year of construction under Alternative A – CPAI Development Plan (based on estimated annual miles of ice roads constructed shown in Table 2.4.1-2). This ice road construction, as well as drilling needs, would require winter extraction of water that would affect up to 200 ac-ft of nearby intermediate-depth (6 feet) and deeper lakes every year. The affected areas of the ice road footprint could change each year because typically the ice roads would be shifted over one road width within the Plan Area to avoid continued compaction of vegetation. Temporary upslope impoundment of snowmelt waters could cover areas parallel to ice road construction for a few days each spring, but without measurable effect on water quality. Due to the seasonal fluctuations in surface water quality, treatment of this water for drinking water purposes is challenging.

Oxygen

Ice road construction over lakes deep enough not to freeze to the bottom could affect dissolved oxygen concentrations. Many of these lakes are just a foot to a few feet deeper than the minimum 6-foot depth necessary to maintain some unfrozen bottom water in winter. An ice road across such an intermediate-depth lake could freeze the entire water column below the road, isolating portions of the lake basin and restricting circulation. With mixing thus reduced, isolated water pools with low oxygen could result. Dissolved oxygen concentrations could be reduced below the 5 ppm dissolved oxygen standard needed to protect resident fish (ADEC 2003b). However, it is rare that industry would build an ice road across a lake.

Withdrawal of water for ice road construction is another potential source of impact to dissolved oxygen concentrations. However, in 2002, dissolved oxygen levels in pumped lakes were nearly three times the average concentration of the reference lakes. Higher levels of oxygenation in pumped lakes could have been a result of circulating water used to keep the hole open in the ice (Michael Baker Jr. Inc. 2002).

Estuarine Waters and Water Quality

No construction, disturbance, or discharges would occur in estuarine areas under Alternative A – CPAI Development Plan. Because almost all of the yearly flow of rivers on the North Slope occurs in the short spring and summer periods, there is a great seasonal difference for suspended sediment flow regimes. During high flow periods, streams often carry highly turbid water toward the ocean and deposit sediments in low-velocity locations within the floodplain, such as deltas or overbank areas. The naturally high turbidity of estuarine waters during high flow levels would show no measurable increase in suspended sediments attributable to activities associated with the applicant's proposed action. During times of lower flow levels, turbidity of entering rivers would be lower, but no project-related increases in river turbidity would be expected. The project-related actions that would result in increased suspended sediment inland to rivers, and thereafter to estuarine water, from erosion or sedimentation would occur only during the spring and summer when the water flow is high, and the increase in estuarine water turbidity would not be measurable.

Marine Water Quality

No measurable degradation of marine water quality would result from construction activities related to the applicant's proposed action.

OPERATION PERIOD

Impacts to surface water quality from potential spills are not presented here, but rather in Section 4.3. Water quality impacts potentially resulting from construction, drilling, operations, and abandonment activities are described in this section. Potentially affected water resources include the Colville River and its distributaries, other rivers and streams in the Plan Area (for example, Fish Creek, Judy Creek, Ublutuoch River), Harrison Bay, and lakes and ponds. The primary beneficial uses for these unimpaired, high-quality surface waters are growth and propagation of fish and wildlife.

NPDES Discharges

Discharges of treated wastewater could occur to tundra in accordance with NPDES permit requirements. For the applicant's proposed action, very little wastewater would be generated at the five production pads after construction and drilling are complete because all personnel would be lodged and based at the existing camp at CD-1. Temporary camps could be used at each production pad during drilling operations. All sewage and solid waste would be transported to CD-1 for disposal with the systems in place at CD-1. No measurable, non-localized impacts to water quality from activities performed in compliance with the NPDES permit would be expected. A condition of the NPDES permit for surface discharge of this treated wastewater is to obtain a mixing zone authorization from the ADEC.

Water Withdrawal from Lakes

Fresh water would continued to be withdrawn from lakes within the Plan Area during the operation period when ice roads are required to access production pads not connected by gravel roads. However, the miles of ice roads to be constructed during the operation period, and thus, the volume of water required, is estimated to be about one-quarter of that built during the construction period (see Table 2.4.1-2). Permit conditions for water withdrawal would govern which lakes could be used, the quantities that could be withdrawn, and the monitoring that must be performed. Because multiple permitted lakes are available as supplemental water supply, degradation at individual locations could be mitigated through use of alternate sources. Any oxygen depletion and ion concentration effects would be expected to disappear after spring recharge and ice melting.

Erosion and Sedimentation

Continued alterations in surface drainage patterns after construction of roads, pads, and airstrips could affect both water levels and water quality in adjacent wetlands and streams. However, installing adequate numbers of sufficiently-sized culverts will reduce the likelihood of erosion damage.

Potability

No discharge of sewage directly to water bodies in the Plan Area by industry would occur during operations. Therefore, no increase in fecal coliform counts over the naturally occurring concentrations is anticipated.

Turbidity

Increased turbidity of water bodies in the Plan Area would result from dust fallout, flooding, erosion, or bank failure. Once construction is completed, the gravel roads between pads or connecting pads to airstrips and the gravel pads would be the only, but potentially large, dust source from the proposed action. Dust fallout from vehicle traffic could increase turbidity within ponds, lakes, creeks, streams, and rivers adjacent to roads and construction areas in the Plan Area. As described in Section 4A.2.2.1, hydrologic changes resulting from project features (i.e., roads, pads, bridges) could increase the chance of flooding, erosion, and bank or gravel road failure. These events would result in temporary increases in turbidity in water bodies, but it is not possible to provide quantitative estimates.

Alkalinity, pH, Oxygen

Water withdrawal for construction of ice roads and for operations would continue to have short-term, (one season) impacts on alkalinity, pH, or oxygen content of water in the Plan Area.

Estuarine Waters and Water Quality

Water quality impacts described above for fresh water would generally be the same for estuarine waters. However, increased salinity and lower turbidity of estuarine waters compared to inland lakes and rivers would result in some differences in expected impacts. No construction, disturbance, or discharges would occur in estuarine areas of the Colville River Delta under Alternative A – CPAI Development Plan or under Alternative A – FFD. However, accidental spills reaching rivers and estuarine waters and activities causing increased sediment in rivers would be two possible sources of impacts to estuarine water quality. Oil spill impacts are described in Section 4.3, and spills of miscellaneous fluids would not be expected to be of sufficient size to reach estuarine waters. A saltwater spill from a pipeline flowing to an individual production pad would be the most likely scenario for an accidental release reaching estuarine waters. However, the higher salinity (approaching marine water salinity) of these waters in comparison to inland water bodies would prevent measurement of any change in salinity in estuarine water. The most detrimental impact to estuarine water quality from a seawater spill would be from the biocides or other chemicals added during treatment before flow to the production pads.

Because almost all of the yearly flow of rivers on the North Slope occurs in the short spring, summer, and fall periods, there is a great seasonal difference for suspended sediment flow regimes. During high flow periods, streams often carry highly turbid water toward the ocean and deposit sediments in low-velocity locations within the floodplain, such as deltas or overbank areas. The naturally high turbidity of estuarine waters during high flow levels would show no measurable increase in suspended sediments attributable to activities associated with the applicant's proposed action. During times of lower flow levels, turbidity of entering rivers would be lower, but no project-related increases in river turbidity should occur. Actions that would result in increased suspended sediment inland to rivers, and thereafter to estuarine water, from erosion or sedimentation would only occur during spring and summer when the water flow and turbidity are naturally high. Increases to estuarine water turbidity during this period would be immeasurable when compared to naturally occurring concentrations.

Marine Water Quality

With the exception of a potential oil spill transported by river flow to Harrison Bay and the Beaufort Sea, no measurable degradation of marine water quality would result from Alternative A – CPAI Development Plan or Alternative A – FFD. Impacts to marine water quality from potential oil spills are presented in Section 4.3.

ABANDONMENT AND REHABILITATION

Water demand during abandonment operations could impact lakes in ways similar to that described for water withdrawal during construction. Also, like construction, abandonment activities (removal of gravel pads and bridges) could cause a short-term and localized increase in sedimentation and turbidity and change alkalinity and oxygen content. Leaving roads and production pads in place, especially without maintenance or stabilization through successful revegetation, could increase sedimentation and turbidity through erosion and upslope impoundment.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SURFACE WATER QUALITY

Impacts to water quality under Alternative A – FFD would be the same as those described for Alternative A, except for those described in the following sections.

CONSTRUCTION AND OPERATION PERIODS

Impacts during construction and operation periods would be similar and are discussed together.

NPDES Discharges

Under Alternative A – FFD, all sewage and solid waste would be disposed of at HPF-1 and HPF-2 by injection to the subsurface in a manner analogous to that used at CD-1. Wastewater discharges to tundra at individual pads could be performed under the NPDES permit (AKG-33-0000). The permit covers gravel pit dewatering, stormwater, and domestic wastewater from temporary camps. The pollutant content of the permitted discharges would be regulated through monitoring of permit conditions as issued by the USEPA. Monitoring is required as a condition of the permit to ensure that discharges do not exceed water quality standards, are not toxic to organisms in receiving waters, do not degrade water quality, and do not pose a threat to human health. Thus, no measurable, non-localized impacts to water quality from activities performed in compliance with the NPDES permit would be expected.

Water Withdrawal from Lakes

Fresh water would be withdrawn from lakes within the Plan Area for three different uses:

- Construction of ice roads and pads during the winter season
- Production drilling and processing operations
- Potable water at the project camp facilities (CD-1, HPF-1, and HPF-2) and temporary construction and drilling camps

Ice road construction would require approximately 1 million gallons of water for each mile of road built. Based on the estimated miles of ice roads shown in Table 2.4.1-9, a maximum of 160 ac-ft of water would be withdrawn from lakes each year for ice road construction. The drilling program would require 38,000 gpd of water to support drill rig and mud plant operations at each production pad location (CPAI 2003). The drilling mud would be mixed at CD-1, so water would be withdrawn from lakes near CD-1, not at the individual production pads. Drilling mud would also be mixed at HPF-1 and HPF-2. In addition, approximately 5,000 gpd of potable water would be used by the rig camp operations. Water withdrawal from lakes would gradually lower water levels throughout each winter and during the drilling in the summer months each year. However, naturally occurring recharge in the spring would be expected to fully replace, and under certain conditions even exceed, the withdrawn water volumes in the lakes (Michael Baker Jr. Inc. 2002). Permit conditions for water withdrawal would govern which lakes could be used, the quantities that could be withdrawn, and the monitoring that must be performed.

Turbidity

Where gravel fill is used to construct roads, production pads, or airstrips in wet areas, the receiving waters could temporarily have higher suspended solids concentrations and more turbidity. However, since gravel fill construction would take place in winter, water quality impacts would be limited to the entrainment of fine-grained fill material in runoff from the facilities during the spring thaw and/or during precipitation events during the summer following construction. Stormwater planning/permitting is covered under the NPDES permit.

The primary effect on water quality from construction and placement of gravel structures relates to upslope impoundment and thermokarst erosion (Walker et al. 1987). Thermokarst erosion, partially caused by tundra disturbance and partly by the thermal effect of dust blown off the gravel onto the tundra, can result in water features with high turbidity and suspended-sediment concentrations. Thermokarst erosion could cause the state turbidity standard to be exceeded within and downflow of thermokarst features. In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to twice the area directly covered by gravel, or 2,524 acres under Alternative A – FFD.

Alkalinity and pH

Annual ice road construction could cover between 44 and 252 acres (9 to 52 miles) each year, on average, during construction activities (based on estimated miles of ice roads shown in Table 2.4.1-9). Ice road construction could affect water quality through changes in water chemistry along the roadbed during and after meltout. As described above, the water withdrawn from lakes to construct the roadway is relatively more saline than typical snowmelt waters. In addition, the salts frozen into the ice road would leach out of the ice before it melts during snowmelt, increasing initial salt content of the meltwater. This effect could potentially occur during initial snowmelt, but the effect on water quality should be localized, most likely expressed as a slight buffering of pH during initial snowmelt.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SURFACE WATER QUALITY

Potential surface water quality impacts under Alternative A – CPAI Development Plan generally fall into three general source categories:

- Accidental release of fuels and other substances, including oil spills, which could occur during both the construction and operation periods
- Reductions in dissolved oxygen and changes in ion concentrations in lakes used for water supply, which would occur mainly during construction but could also happen during operations
- Increases in terrestrial erosion and sedimentation causing higher turbidity and suspended solids concentrations, which would could occur during both the construction and operation periods.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SURFACE WATER QUALITY

No additional measures have been identified to mitigate impacts to water quality under Alternative A nor Alternative A – FFD.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR SURFACE WATER QUALITY

Stipulations 5(a), (b), (c) and (d) of the Northeast National Petroleum Reserve-Alaska IAP/EIS protect water quality by preventing the discharge of wastewater or other discharges into water bodies or wetlands. Stipulations 14, 15, and 16 reduce the likelihood of a fuel spill in a water body by having distance and quantity restrictions. Stipulation 22 protects the banks of waterways by prohibiting alteration of the banks and protecting riparian vegetation. Stipulations 39 and 41 have distance from water body prohibitions for the placement of facilities while 42 and 43 help prevent affecting stream flow and preventing erosion. This EIS has not identified any additional mitigation measures.

4A.2.3 Atmospheric Environment

Air pollutants generated in the Plan Area will consist of emissions from mobile, stationary, portable and fugitive sources from activities occurring in the construction, drilling, and operational phases. Mobile sources would include construction equipment, such as graders and haul trucks, and equipment from aircraft flights and vehicular traffic, such as passenger vehicles and light-duty trucks. Stationary sources would include fossil fuel combustion equipment, such as power generation turbines and backup emergency generator engines, and production and drill site heaters. Portable sources include drill rig engines and associated boilers, and heaters used during drilling operations. Fugitive sources are typically fugitive dust and entrainment from dirt and gravel road use and heavy construction activities which are generally limited to the winter period, with the exception of CD-4, which will be constructed in the summer. However, the arctic climate naturally limits fugitive dust because the ground is generally snow and ice covered, therefore making it an insignificant source in the Plan Area.

Alternative A – CPAI Development Plan would create new sources of air emissions within the Plan Area. A gas-fired drill site heater will be included at each of the five production pads (CD-3 through CD-7), and diesel-fired emergency generators will be installed at CD-3 and CD-6, assuming that all sites but CD-3 will be road-accessible. If they are not road-accessible, diesel-fired emergency generators will be added to those sites, resulting in additional emissions, depending on generator capacity.

Alternative A also includes a component of the existing APF-1's upgrade called the ACX. This three-stage project is designed to increase processing capacity of APF-1. It includes ACX-1 and ACX-2 that are related to handling existing production (i.e. produced water volumes and oil train and water injection) and ACX-3 for production from the proposed development. ACX-3 will include a gas-fired turbine (Frame 5) and a gas-fired process heater located at the existing APF-1.

Alternative A – FFD would add seven additional production pads to the Colville River Delta, along with CD-3 and CD-4, each requiring a gas-fired drill site heater. Emergency generators for each of the seven pads are a worst-case scenario, and might not be required.

Alternative A – FFD would add 11 new pads in the Fish–Judy Creeks Facility Group, along with corresponding drill site heaters and emergency generators. This group also would include the HPF-1, and would be the largest source of criteria pollutant emissions under Alternative A – FFD. For the purpose of this discussion, it is assumed that the processing equipment at HPF-1 would be similar to the existing APF-1, with a similar emissions inventory.

The Kalikpik–Kogru Rivers Facility Group would include four new production pads and the hypothetical processing facility HPF-2.

A summary of proposed emissions is presented in Table 4A.2.3-1. An inventory of the project sources and their respective air emissions is presented in Tables 4A.2.3-2 through 4A.2.3-4 in tabular format according to the construction, drilling, and operational phases. The construction phase emissions inventory shows potential construction equipment, size (by horsepower rating), and the typical criteria pollutant emissions in pounds per hour. Construction emissions would vary according to the operational hours and loading of each piece of equipment during the construction phase.

The drilling phase emissions inventory is presented in tons per year of actual emissions. Only the criteria pollutants NO_x, SO_2,Carbon Monoxide (CO), and PM_{10} are listed, as the project would be a minor source of VOCs. The annual emissions shown on Table 4A.2.3-3 are based on a rolling report of actual hours as required by the current APF-1 operating permit.

Table 4A.2.3-4 is the operational phase emissions inventory. This table delineates the operational sources under Alternative A – CPAI Development Plan and Alternative A – FFD, by facility groups. Estimated operating hours and emissions are based upon current APF-1 operating permit conditions.

A map of the Alternative A layout is shown in Figure 2.4.1.1-1. A map of Alternative A – FFD is shown in Figure 2.4.1.2-1.

TABLE 4A.2.3-1 ALTERNATIVE A – CPAI DEVELOPMENT PLAN AND FFD SCENARIO EMISSIONS SUMMARY

Proposed Project Phase	Facility Group	Maximum Emissions (tons/year)			
		NO_x	SO_2	CO	PM_{10}
Construction	NA	17.7	1.29	4.21	1.29
Drilling	NA	26.66	3.02	5.85	1.34
Operation	NA	742.1	9.72	212.4	7.3
Operation – FFD Scenario	Colville River Delta	339.1	34.7	111.9	10.5
	Fish–Judy Creeks	3,152.8	159.7	559.5	59.9
	Kalikpik–Kogru Rivers	2332.1	168.2	376.9	47.9

TABLE 4A.2.3-2 ALTERNATIVE A – CPAI DEVELOPMENT PLAN CONSTRUCTION PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY

Equipment	Fuel Type	Rating (hp)	Estimated Emissions									
			NO_x		SO_2		CO		PM_{10}		VOC	
			lb/hr	t/yr	lb/hr	t/yr	lb/hr	t/yr	lb/hr	t/yr	lb/hr	t/yr
Dump Truck[a]	Diesel	235	7.3	2.0	0.5	0.14	1.6	0.44	0.5	0.14	0.6	0.16
Dumper, 4-ton[a]	Diesel	200	6.2	1.7	0.4	0.11	1.3	0.35	0.4	0.11	0.5	0.14
Flat Bed/Tractor Trucks[a]	Diesel	250	7.8	2.1	0.5	0.14	1.7	0.46	0.6	0.16	0.6	0.16
Fork Lifts 3-ton[a]	Diesel	75	2.3	0.6	0.2	0.05	0.5	0.14	0.2	0.05	0.2	0.05
Front Loader[a]	Diesel	140	4.3	1.2	0.3	0.08	0.9	0.25	0.3	0.08	0.3	0.08
Grader[b]	Diesel	150	3.8	1.0	0.5	0.14	1.3	0.35	0.4	0.11	0.3	0.08
Mobile Crane, 30-ton[a]	Diesel	100	3.1	0.9	0.2	0.05	0.7	0.19	0.2	0.05	0.2	0.05
Mobile Crane, 60-ton[a]	Diesel	200	6.2	1.7	0.4	0.11	1.3	0.35	0.4	0.11	0.5	0.14
Mobile Crane, 80-ton[a]	Diesel	250	7.8	2.1	0.5	0.14	1.7	0.46	0.6	0.16	0.6	0.16
Shovel[a]	Diesel	100	3.1	0.8	0.2	0.05	0.7	0.19	0.2	0.05	0.2	0.05
Transit Mixers[a]	Diesel	250	7.8	2.1	0.5	0.14	1.7	0.46	0.6	0.16	0.6	0.16
Vibro Roller[b]	Diesel	42	0.9	0.3	0.0	0.0	0.3	0.08	0.1	0.03	0.1	0.03
Water Truck[b]	Diesel	200	4.2	1.2	0.5	0.14	1.8	0.49	0.3	0.08	0.2	0.05
TOTAL			**64.8**	**17.7**	**4.7**	**1.29**	**15.5**	**4.21**	**4.8**	**1.29**	**4.9**	**1.31**

Sources: USEPA and SCAQMD
Notes:
Construction emissions would vary according to the operational hours and loading of each piece of equipment during the construction phase. Air pollutant emissions shown were calculated based on emissions factors and the equipment rating. The emissions impact of the construction phase would be determined based upon loading and operational hours. The actual emissions may be lower than those presented above because most equipment operates at full-load only sporadically.
Portable heaters, light plants, and portable generators are not included in the summary.
[a] From USEPA Ap-42 Compilation of Air Pollutant Emissions Factors, Volume 2, mobile Sources
[b] From SCAQMD CEQA Air Quality Handbook, Table 9-8-C

TABLE 4A.2.3-3 ALTERNATIVE A – DRILLING PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY

Drilling Phase Source Inventory		Maximum Emissions (tons/year)			
Equipment	**Annual operating hrs**	**NO_x**	**PM_{10}**	**SO_2**	**CO**
Doyon Drilling Rig 19, Mud Plant and Bulk Plant[a]					
Caterpillar D398TA Power, 700 kW (4)[b]	820 total	9.33	0.06	0.42	2.04
Caterpillar D399TA Power, 976 kW (2)[b]	270 total	4.28	0.03	0.19	0.93
Caterpillar 3406 Rig Move Engine, 376 hp[c]	385	2.23	0.22	0.08	0.48
Caterpillar 3114 Pipe Shed Move Engine, 105 hp[c]	1390	2.25	0.06	0.08	0.49
Caterpillar D379TA Rig Camp Engines (2), 379 kW[c]	900 total	7.05	0.04	0.25	1.53
Caterpillar 3176 Cement pumps (2), 180 kW[c]	1,000 total	3.73	0.11	0.13	0.81
Superior Boilers (2), 3.4 MMBtu/hr[d]	8,380 total	0.50	0.12	0.48	0.12
Tioga Heater, 4.2 MMBtu/hr[d]	6,665	0.49	0.11	0.48	0.12
Tioga Heater, 3.5 MMBtu/hr[d]	8,000	0.49	0.11	0.48	0.12
Lister Heater, 4,0 MMBtu/hr[d]	7,000	0.49	0.11	0.48	0.12
Mud Plant Boiler, 1.3 MMBtu/hr[d]	8,760	0.20	0.12	0.19	0.05
Detroit 6063-GK35 Power, 300 kW[c]	500	3.10	0.23	0.11	0.67
Detroit 6063-GK35 Power, 160 kW[c]	500	1.66	0.12	0.06	0.36
Total Drilling Emissions		**26.66**	**1.34**	**3.02**	**5.85**

Sources: CPAI and USEPA

Notes:

[a] From actual emissions report as required by operating permit 489TVP01 for the Alpine Central Processing Facility (8/8/03).

[b] Emissions calculated utilizing USEPA AP-42 Emissions Factors for Large Stationary Diesel and All Stationary Dual-Fuel Engines (Table 3.4-1)

[c] Emissions were calculated utilizing USEPA AP-42 Emissions Factors for Uncontrolled Diesel Industrial Engines (Table 3.3-1)

[d] Emissions were calculated utilizing USEPA AP-42 Criteria Pollutant Emissions Factors for Fuel Oil Combustion (Table 1.3-1), except sulfur content by weight is calculated at 0.135 percent pursuant to operating permit conditions. This does not reflect low sulfur diesel requirements USEPA has mandated for 2006.

TABLE 4A.2.3-4 ALTERNATIVE A AND ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO OPERATIONAL PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY

Operational Phase Source Inventory – Proposed[a]						
Location	Equipment [b,c,d,e]	Annual operating hrs	Maximum Emissions (tons/year)			
			NO_x	PM_{10}	SO_2[f]	CO
CD-3	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
CD-4	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
CD-5	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
CD-6	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
	Power generator, gas-fired, 3.1 MW	8,760	472.7	0.8	0.07	64.5
CD-7	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
ACX3	Frame 5 turbine, 36,700 hp	8,760	147.3	0.8	1.05	94.0
ACX3	Heater, gas-fired 30 MMBtu/hr	8,760	13.1	1.0	*	9.2
TOTAL			**742.1**	**7.3**	**9.7**	**212.4**
Colville River Delta Facility Group						
CD-3	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
CD-4	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
7 pads	Drill site heater, gas-fired, 20 MMBtu/hr at each of 7 additional pads	8,760 each	61.3	4.6	*	42.9
7 pads	Emergency generator, diesel-fired, 500 kW at each of 7 additional pads	4,000 each	227.7	3.9	30.4	49.7
TOTAL			**339.1**	**10.5**	**34.7**	**111.9**
Fish-Judy Creeks Facility Group						
CD-5	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
CD-6	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1
	Emergency generator, diesel-fired, 500 kW	4,000	32.5	0.6	4.3	7.1
	Power generator, gas-fired, 3.1 MW	8,760	472.7	0.8	0.07	64.5
CD-7	Drill site heater, gas-fired, 20 MMBtu/hr	8,760	8.8	0.7	*	6.1

TABLE 4A.2.3-4 ALTERNATIVE A AND ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO OPERATIONAL PHASE SOURCE INVENTORY AND EMISSIONS SUMMARY (CONT'D)

Fish-Judy Creeks Facility Group						
11 pads	Drill site heater, gas-fired, 20 MMBtu/hr at each of 11 additional pads	8,760 each	96.4	7.2	*	67.5
11 pads	Emergency generator, diesel-fired, 500 kW at each of 11 additional pads	4000 each	357.8	6.2	4.3	78.1
APF-2	Additional Processing Facility[g]		2,167.0	43.0	151.0	324.0
TOTAL			**3,152.8**	**59.9**	**159.7**	**559.5**
Kalikpik-Kogru Rivers Facility Group						
4 pads	Drill site heater, gas-fired, 20 MMBtu/hr at each of 4 additional pads	8,760 each	35.0	2.6	*	24.5
4 pads	Emergency generator, diesel-fired, 500 kW at each of 4 additional pads	4,000 each	130.1	2.3	17.4	28.4
APF-3	Additional Processing Facility[g]		2,167.0	43.0	151.0	324.0
TOTAL			**2,332.1**	**47.9**	**168.2**	**376.9**

Notes:

[a] Table assumes Alternative A, with all sites except CD-3 road-accessible (If not road-accessible, add an emergency generator at each site.)

[b] Drill site heater emissions are based upon current operating permit emission limits

[c] Emergency generator emissions are based upon USEPA AP-42 emissions factors for large stationary diesel and dual-fuel engines (Table 3.4-1 and Table 3.4-2)

[d] Power Generator emissions were calculated by using USEPA AP-42 emissions factors for Natural Gas-fired Reciprocating Engines (Table 3.2-2)

[e] Frame 5 turbine emissions at ACX-3 are based upon AP-42 emissions factors for stationary gas turbines (Table 3.1-1 and Table 3.1-2a), with added control of 68 percent, assuming 25 ppm NO_x and CO

[f] SO_2 permit emission limits are 200 parts per million by volume (ppmv) hydrogen sulfide (H_2S) in fuel gas; and a sulfur content of 0.135percent percent by weight in fuel oil

[g] Maximum emissions are based upon the current potential to emit of APF-1, which also includes 27 tpy of VOCs and 43 tpy of PM_{10}, for a total potential to emit of 2,712 tons per year (tpy)

4A.2.3.1 Climate and Meteorology

Impacts to climate and meteorology GHG emissions are unlikely to occur because the emissions are an infinitesimal contribution to the global GHG emissions budget. Further, it remains unclear what relationship GHG emissions have with changes in climate and meteorology except that observed and predicted changes are driven on a global scale and not a local or regional scale.

A discussion of GHG emissions and potential global warming as a result of GHG emissions and their impact on climate changes is presented in more detail in Section 3.2.3.1 and Section 4G.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON CLIMATE AND METEOROLOGY

CONSTRUCTION PERIOD

Construction activities would emit some greenhouse gases (GHG) over a short-term period from fossil fuel combustion of construction equipment (graders, bulldozers, trucks, etc.) and from aircraft flights transporting construction crew and materials.

OPERATION PERIOD

To a lesser extent and over a longer term, GHG emissions would occur from operation of natural gas-fired heaters and diesel backup generators, and from mobile sources such as vehicular traffic and aircraft takeoffs and landings.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation activities could have impacts similar to those of construction since it is anticipated that similar vehicles and other emission sources will be used. Because abandonment would not occur at a single location for any significant length of time, the impact of GHG emissions at any single location would be minor and short-term. Impacts would be less than construction if gravel fill is left in place, because there would be less use of the heavy vehicles and machinery that emit GHG. During and following abandonment, production facilities would no longer contribute to GHG emissions.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON CLIMATE AND METEOROLOGY

COLVILLE RIVER DELTA FACILITY GROUP

Some GHG emissions would result from activities at the additional seven production pads.

FISH–JUDY CREEKS FACILITY GROUP

GHG emissions would be somewhat greater than in the Colville River Facility Group because of operations of HPF-1, plus the two new production pads.

KALIKPIK–KOGRU RIVERS FACILITY GROUP

GHG emissions would be somewhat greater than in the Colville River Delta Facility Group because of operations of HPF-2, but somewhat less than GHG emissions from the Fish–Judy Creeks Facility Group because of a smaller number of new production pads.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON CLIMATE AND METEOROLOGY

GHG emissions would occur during construction and drilling activities from the operation of fossil fuel combustion equipment. Because construction does not occur at a single location for any significant length of time, the impact of these GHG emissions on the climate and meteorology at any single location would be minor and short-term. GHG emissions would also occur over a longer period from operations of Alternative A and Alternative A – FFD. However, GHG emissions generated from construction, drilling, and operational activities would have no effect upon the climate and meteorology of the region.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR CLIMATE AND METEOROLOGY

No mitigation measures have been identified. Cumulative impacts of GHG upon climate change are discussed in Section 4F.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR CLIMATE AND METEOROLOGY

There are no stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS nor were potential mitigation measures developed in this EIS.

4A.2.3.2 Air Quality

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON AIR QUALITY

CONSTRUCTION PERIOD

Emissions of criteria pollutants would occur during construction activities under Alternative A. Construction of the all-weather gravel roads, gravel airstrips, pipelines, and five production pads would have a temporary impact to ambient air quality in the immediate vicinity from emissions generated by construction equipment.

Emissions during construction activities would result from heavy equipment exhaust (earth movers, trucks, etc.), electric power generators, heaters, and other fuel-burning equipment. These emissions would consist primarily of NOx, SO_2, PM_{10}, paticle matter less than 2.5 microns, PM_{25}, and CO.

Respirable PM in the form of dust generated by mechanical disturbance of soil would be reduced because of frozen soil and snow cover during winter construction (only CD-4 would be constructed in the summer). Table 3.2.3-5 shows a single day's exceedance of the PM_{10} standard in 1999 (prior to the operation of APF-1). In this case, elevated particulate concentrations measured on that day were the result of wind-generated dust from the dried, exposed banks of the nearby Nigliq Channel.

Emissions would occur during equipment movement and site preparation activities. Because construction does not occur at a single location for any significant length of time, the impact of these emissions at any single location would be short-lived. Additionally, potential impacts of these emissions to regional air quality would be minor because these sources are transient and have relatively small emissions.

Air emissions would result from construction of gravel roads, primarily because of exhaust from diesel and gasoline-powered equipment. Particulate emissions would result from gravel and fugitive road dust. Fugitive dust emissions from primarily winter construction activity would be reduced due to frozen ground and snow cover. Equipment would consist of B-70 haul trucks, bulldozers, grading equipment, vibratory compactors, and tanker trucks (if road watering is required). Bulldozers, excavators/loaders, haul trucks, drill rig/compressors, and road-graders would be utilized to excavate gravel from the gravel mines. Snow removal equipment would be used as necessary. Bridge construction would require cement transit mixers for concrete tower construction.

Pipeline construction would involve the use of cranes, tractor-trailer trucks, welding equipment and other support equipment. Drilling rigs could be diesel-powered, utilizing fuel transported from CD-1. The drilling rigs will initially use diesel and then switch to high-line power as it becomes available.

Aircraft would bring materials and crew to CD-1, then by truck to the construction sites. The construction phase would require about 40 to 70 one-way aircraft flights per month initially, increasing to 180 in the summer of 2005, and peaking to 340 in the summer of 2006. Winter flights are anticipated to be 60 to 70 one-way trips per month. Table 2.3.10-1 presents Alternative A traffic estimates, which shows the breakdown of one-way aircraft flights per month for the construction, drilling, and operations phases of the applicant's proposed action.

Table 4A.2.3-5 shows emissions per landing/takeoff cycle (LTO) from a typical Twin Otter business turboprop aircraft, utilizing USEPA AP-42 emission factors for mobile sources for gas turbine engines specific to a Pratt Whitney PT6A-27 engine (USEPA 1985).

OPERATION PERIOD

Drilling operations would be a source of air emissions from diesel-powered electricity generators to power drill rig engines, and the space heaters and boilers used to heat the rig. Drilling also would occur during the construction period.

Criteria emissions associated with operation of the production pads would be from the combustion of diesel fuel, primarily as NO_x and CO, produced by the heaters and power generators. Final operating restrictions would be determined during permitting to ensure compliance with state and federal regulations. A gas-fired production heater would be installed at each of the five production pads (CD-3 through CD-7). Diesel-powered emergency backup generators would be installed at CD-3 and CD-6. A 3.1 MW power generator would also be installed at CD-6. The ACX-3 would be equipped with a Frame 5 turbine generator (36,700 hp), and possibly a gas-fired heater. These equipment items assume that all roads except CD-3 are accessible. If all pads are not road accessible, emergency generators would be added.

Air emissions would occur from fuel combustion as a result of operation of aircraft at the airstrips and from boat engines at the boat ramp. Aircraft flights during the drilling phase are anticipated during the winters at 70 to 90 one-way aircraft flights per month. Aircraft flights during the operational phase would start in summer of 2006 at about 24 one-way aircraft flights per month. Table 4A.2.3-5 presents a summary of estimated air emissions from aircraft flights.

The applicant's proposed action would not have consequential air emissions under normal operating conditions. The production pads would be subject to federal and state air quality regulations under the CAA. Section 109 of the CAA of 1970 required the USEPA to establish specific standards for the quality of ambient air (see Table 4A.2.3-6). To date, the USEPA has issued NAAQS for the ambient concentrations of six criteria pollutants: NO_2, SO_2, PM_{10} and $PM_{2.5}$, CO, ozone (O_3), and lead. Alaska has adopted these federal standards. Strict adherence to applicable regulations would minimize the potential air quality impacts under Alternative A.

The existing APF-1 is permitted for equipment that is subject to federal NSPS, published in 40 CFR Part 60, including: Subpart Dc Small Industrial-Commercial-Institutional Steam Generating Units (dual-fired heaters rated at 20 MMBtu/hr); Subpart GG Standards of Performance for Stationary Gas Turbines (generator turbines); Subpart Kb Volatile Organic Liquid Storage Vessels (Tanks); and Subpart KKK Equipment Leaks of VOC from Onshore Gas Processing Plants. The USEPA is currently assessing the applicability of Subpart KKK at the request of CPAI. The air quality permit prescribes monitoring, record keeping, and reporting procedures for maintaining compliance with NSPS. As new equipment is added NSPS requirements could apply, such as Subpart GG to the Frame 5 turbine at ACX-3.

The existing APF-1 is considered an existing major source under the federal requirements of PSD new source review regulations. It is subject to PSD preconstruction review because net emission increases associated with the proposed project will exceed 40 tpy of NO_x or 100 tpy of CO.

TABLE 4A.2.3-5 CRITERIA POLLUTANT EMISSIONS FROM AIRCRAFT FLIGHTS, PER LANDING/TAKEOFF CYCLE (LTO) UNDER ALTERNATIVE A

Construction Phase[a]	Aircraft Flights (LTO)/month, one-way[b]	CO[c] (tons/year)	NO_x[d] (tons/year)	HC[e] (tons/year)	SO_x[f] (tons/year)
Winter 2004/05	70	0.251	0.029	0.178	0.006
Summer 2005	180	0.644	0.074	0.457	0.016
Winter 2005/06	60	0.215	0.025	0.152	0.005
Summer 2006	340	1.217	0.139	0.864	0.031
Winter 2006/07	70	0.251	0.029	0.178	0.006
Summer 2007	45	0.162	0.018	0.113	0.004
Winter 2007/08	50	0.179	0.021	0.127	0.004
Summer 2008	100	0.358	0.041	0.254	0.009
Winter 2008/09	50	0.179	0.021	0.127	0.004
Winter 2009/10	50	0.179	0.021	0.127	0.004
Summer 2010	85	0.306	0.034	0.213	0.007
Winter 2010/11	45	0.162	0.018	0.113	0.004
Drilling Phase					
Winter 2004/05	90	0.323	0.037	0.229	0.008
Winter 2005/06	90	0.323	0.037	0.229	0.008
Summer 2006	90	0.323	0.037	0.229	0.008
Winter 2006/07	90	0.323	0.037	0.229	0.008
Summer 2007	90	0.323	0.037	0.229	0.008
Winter 2007/08	90	0.323	0.037	0.229	0.008
Summer 2008	90	0.323	0.037	0.229	0.008
Winter 2008/09	90	0.323	0.037	0.229	0.008
Summer 2009	90	0.323	0.037	0.229	0.008
Winter 2009/10	90	0.323	0.037	0.229	0.008
Summer 2010	90	0.323	0.037	0.229	0.008
Winter 2010/11	90	0.323	0.037	0.229	0.008
Operations Phase					
Summer 2006	32	0.115	0.013	0.081	0.003
Winter 2006/07	16	0.058	0.006	0.040	0.001
Summer 2007	32	0.115	0.013	0.081	0.003
Winter 2007/08	16	0.058	0.006	0.040	0.001
Summer 2008	56	0.202	0.022	0.140	0.005
Winter 2008/09	24	0.086	0.010	0.061	0.002
Summer 2009	56	0.202	0.022	0.140	0.005
Winter 2009/10	24	0.086	0.010	0.061	0.002
Summer 2010	80	0.286	0.033	0.203	0.007
Winter 2010/11	32	0.115	0.013	0.081	0.003

Source: USEPA 1985

Notes:

Emissions were calculated for a DeHavilland Twin Otter turboprop aircraft (USEPA Class P2), Pratt & Whitney Model PT6A-27. Emissions factors are a composite of Table II-1-3 and Table II-1-5 in the source document, consisting of the following: 1) typical duration in minutes for civil aircraft LTO cycles at large congested metropolitan airports, based on taxi/idle out, takeoff, climbout, approach, taxi/idle (Table II-1-3); and 2) engine power settings for typical LTO commercial cycles by percentage thrust or horsepower (Table II-1-5).

[a] Summer = May through September; Winter = October through April

[b] One-way aircraft flights given are average (low-high) monthly estimates. One-way aircraft flights were used, in lieu of separate round trips, because flights could be linked from one pad to another. Summer/winter seasons that have no projected aircraft flights for that phase were not included.

[c] Carbon monoxide

[d] Nitrogen oxides reported as NO_2

[e] Total hydrocarbons – VOCs, including unburned hydrocarbons and organic pyrolysis products

[f] Sulfur oxides and sulfuric acid reported as SO_2

CPAI conducted dispersion modeling of the Alpine Development Project, including APF-1, to assess air quality impacts for its construction permit application submitted to the ADEC in July 2001. The model used was the Industrial Source Complex Short Term model, which is the USEPA's current regulatory model for air permitting applications. The model is based on a steady-state Gaussian plume algorithm, and its applications include point and area sources to a distance of approximately 50 kilometers. The analysis, based in conservative, worst-case assumptions, showed that the project would be in compliance with all Class II PSD increments and NAAQS. Additionally, there were no associated adverse impacts to soil, vegetation, and visibility. Impacts to Class I areas are expected to be negligible because the nearest Class I area is over 450 miles away at Denali National Park.

A revised air quality impact analysis for CD-3 and CD-4 was prepared in January 2004. Results of the dispersion modeling are presented in Tables 4A.2.3-7 and 4A.2.3-8. Since CD-3 and CD-4 represent the expected emissions from the proposed operational phase, Table 4A.2.3-7 indicates that a production pad site will not result in air quality impacts that exceed pollutant-by-pollutant PSD Class II increments. It is noteworthy that the maximum impacts are predicted to occur in the immediate vicinity of facilities. Thus overlapping air quality impacts for proposed production pads are limited.

Representative air quality impacts for the proposed operational phase compared to the NAAQS and AAAQS are provided Table 4A.2.3-8. The cumulative impacts of CD-3 and CD-4 along with existing facilities is representative of the proposed operational phase since these sources provide a reasonable "worst-case" alignment of emissions for a specific downwind receptor (i.e., village of Nuiqsut). As shown in Table 4A.2.3-8, the total air quality impacts (including model-predicted impacts from CD-3/CD-4, existing sources with background air quality levels) do not exceed the pollutant-specific NAAQS/AAAQS.

Under Alternative A – FFD, the potential does exist for the PSD Class II increments to be exceeded for those production pad sites in close proximity (i.e., within 3 miles) for annual NO_2 impacts and 24-hour PM_{10} impacts. In addition, significant impacts similar to those identified in Table 4A.2.3-7 (for CD-4) could occur in the vicinity of the village of Nuiqsut for a nearby site location such as HP-8. It is not anticipated that full-field development would result in a combined air quality impact that would cause concentration levels to exceed NAAQS or the AAAQS.

APF-1 is an existing major source under Title V of the CAA operating permit requirements (Part 70), with an annual potential to emit of 2,711 tpy of regulated air pollutants. The applicant's proposed action would trigger a modification to the Part 70 operating permit.

APF-1 is subject to NESHAP under Section 112 of the CAA, specifically Subpart E for mercury for its existing sludge incineration plants. Alternative A, however, would not trigger a major source of hazardous air pollutants (HAP) (either 10 tpy of a single HAP or 25 tpy of a combination of HAPs), so additional NESHAPs would not apply.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation would have impacts similar to those for construction if gravel pads, roads and the airstrip at CD-3 are removed. Impacts would be short-term and transient and will not have a lasting impact on air quality.

TABLE 4A.2.3-6 FEDERAL AMBIENT AIR QUALITY STANDARDS

Air Pollutant	Federal Primary Standard Concentration/ Averaging Time	Most Relevant Effects
Ozone	0.12 ppm, 1-hr avg.,(235 µg/m^3)/ 0.08 ppm, 8-hr avg.[a] (157 µg/m^3)	(a) Short-term exposures: (1) Pulmonary function decrements and localized lung edema in humans and animals; (2) Risk to public health implied by alterations in pulmonary morphology and host defense in animals; (b) Long-term exposures: Risk to public health implied by altered connective tissue metabolism and altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans; (c) Vegetation damage; (d) Property damage
Carbon Monoxide	9 ppm, 8-hr avg. (10 mg/m^3)/ 35 ppm, 1-hr avg. (40 mg/m^3)	(a) Aggravation of angina pectoris and other aspects of coronary heart disease; (b) Decreased exercise tolerance in persons with peripheral vascular disease and lung disease; (c) Impairment of central nervous system functions; (d) Possible increased risk to fetuses
Nitrogen Dioxide	0.053 ppm, annual arithmetic mean (100 µg/m^3)	(a) Potential to aggravate chronic respiratory disease and respiratory symptoms in sensitive groups; (b) Risk to public health implied by pulmonary and extra-pulmonary biochemical and cellular changes and pulmonary structural changes; (c) Contribution to atmospheric discoloration
Sulfur Dioxide	0.030 ppm, annual arithmetic mean (80 µg/m^3)/ 0.14 ppm, 24-hr avg. (365 µg/m^3)	(a) Bronchoconstriction accompanied by symptoms which could include wheezing, shortness of breath and chest tightness, during exercise or physical activity in persons with asthma
Particulate Matter (PM_{10}) Particulate Matter ($PM_{2.5}$) [a]	50 µg/m^3, annual arithmetic mean/ 150 µg/m^3, 24-hr avg. 15 µg/m^3, annual arithmetic mean/ 65 µg/m^3, 24-hr avg.	(a) Excess deaths from short-term exposures and exacerbation of symptoms in sensitive patients with respiratory disease; (b) Excess seasonal declines in pulmonary function, especially in children
Lead	1.5 µg/m^3, calendar quarter	(a) Increased body burden; (b) Impairment of blood formation and nerve conduction

Sources: USEPA
Notes:
[a] The ozone 1-hour standard applies only to areas that were designated nonattainment when the ozone 8-hour standard was proposed in July 1997. This provision allows for a smooth, legal, and practical transition to the 8-hour standard. The ozone 8-hour standard and the $PM_{2.5}$ standards were recently promulgated after extended litigation and are included for information only until the USEPA can promulgate designations of attainment and nonattainment
Parenthetical value is an approximately equivalent concentration.

TABLE 4A.2.3-7 ALTERNATIVE A – EXPECTED OPERATIONAL PHASE IMPACTS FOR CD-3 AND CD-4 COMPARED TO PSD INCREMENTS

Pollutant	Averaging Time	Model Predicted Impact for CD-3 (µg/m^3)	Model Predicted Impact for CD-4 (µg/m^3)	PSD Class II Increment (µg/m^3)
NO_2	Annual	23.3	24.7	25
SO_2	3-hour	167	193	512
SO_2	24-hour	81.9	88.0	91
SO_2	Annual	8.0	8.0	20
PM_{10}	24-hour	21.1	23.9	30
PM_{10}	Annual	1.1	1.1	17

Notes:
Data from Revised Alpine Satellite Ambient Air Quality Impact Analysis for CD-3 and CD-4 (SECOR 2004) Tables 4-3 and 4-4.
Maximum impacts occur within immediate vicinity (<100 meters) of facility (generator, drilling rig, camp, pad).

TABLE 4A.2.3-8 ALTERNATIVE A – EXPECTED OPERATIONAL PHASE IMPACTS FOR CD-3 AND CD-4 COMPARED TO AAAQS/NAAQS

Pollutant	Averaging Time	Model Predicted Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	AAAQS/ NAAQS ($\mu g/m^3$)
NO_2	Annual	51.9	16	67.9	100
SO_2	3-hour	227	22	249	1,300
SO_2	24-hour	136	5	141	365
SO_2	Annual	9.13	0	9.1	80
PM_{10}	24-hour	53.4	33.6	87	150
PM_{10}	Annual	1.56	9.3	10.9	50
CO	1-hour	2,710	1,150	3,860	40,000
CO	8-hour	877	575	1,450	10,000

Notes:
Data from Revised Alpine Satellite Ambient Air Quality Impact Analysis for CD-3 and CD-4 (SECOR 2004) Tables 4-5 and 4-6.
Modeling includes offsite source inventory (existing facilities).
Maximum impacts occur within immediate vicinity (<100 meters) of facility (generator, drilling rig, camp, pad).

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON AIR QUALITY

Air pollutant emissions would be generated by two additional HPFs, possibly at the level of two times the current APF-1, which is permitted for 2,711 tpy of regulated pollutants. Modeling analysis of APF-1 demonstrated compliance with all applicable PSD increments and NAAQS. Additionally, the NSR regulatory framework administered by the ADEC would assure that activities performed under Alternative A – FFD would be in compliance with all applicable air quality regulations. Air quality impact analysis would be conducted under PSD preconstruction review, because the FFD expansion would trigger PSD emissions thresholds for NO_x and CO.

HAP emissions would also increase from installation of 22 drill site heaters and 22 emergency generators, along with the HAPs associated with the addition of two HPFs. Since HAPs are associated with total VOC emissions, it is unlikely that a single 10 tpy HAP source would result from implementation of Alternative A – FFD, so additional NESHAPS would not be required. Based on HAPs emissions from similar North Slope oil and gas production facilities, it is not anticipated that implementation of this alternative would be considered a major source of HAPs. Therefore, no NESHAP-related maximum achievable control technology (MACT) standards would apply.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON AIR QUALITY

Construction activities would contribute air emissions to the Plan Area. However, because they are short-term and transient in nature, they will not have a lasting impact to air quality. Aircraft landings and takeoffs would occur in all phases of either Alternative A or Alternative A – FFD, predominately during construction. Air quality impacts from aircraft trips, which would also be short-term and transient, are not regulated by the permitting process and are not expected to be significant. The ADEC requires that construction emissions meet all applicable NAAQS.

The applicant's proposed action would not emit consequential air pollutants under normal drilling and operating conditions. Impacts from Alternative A – FFD would be more substantial because of the addition of two HPFs and would be subject to critical non-source review (NSR) that requires demonstrated compliance with PSD increments, NAAQS, and USEPA emission control requirements.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR AIR QUALITY

Air quality impacts, including fugitive dust, would be limited through the permitting process, which ensures that no significant new air pollution sources contribute to a deterioration of the ambient air quality. Mitigation measures for limiting fugitive dust would include road watering, vehicle washing, covering of stockpiled material, ceasing construction during wind events, and the use of chemical stabilizers. These measures may vary for the frozen season and nonfrozen season. Dust may be reduced by utilizing sealing agents and chip-seal on pads, runways and heavily utilized portions of the road system. Watering of dust prone areas would also reduce dust associated with the project.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR AIR QUALITY

There are no stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS developed specifically for limiting air quality impacts. Agency permitting processes are designed to limit air quality impacts. The EIS has identified mitigation measures such as road watering, vehicle washing, covering of stockpiled material, ceasing construction during wind events, and the use of chemical stabilizers and sealing agents. These measures could greatly lessen impacts to air quality caused by fugitive dust that is generated during both the construction and operation phases of the project.

4A.2.3.3 Noise

The following noise analysis focuses on impacts to sensitive areas, which are defined at communities. Nuiqsut is the community nearest the proposed development. However, local residents travel widely over the Plan Area, pursuing subsistence activities. Additional information regarding the impacts of noise on subsistence users can be found in Section 4A.4.3.1.

Noise quality can be affected during construction, drilling, and operations phases of a project. The ambient sound level of a region is defined by the total noise generated, including sounds from both natural and artificial sources. The magnitude and frequency of environmental noise could vary considerably over the course of the day and throughout the week, in part because of changing weather conditions. Federal agencies use two measurements to relate the time-varying quality of environmental noise to its known effect on people: $Leq_{(24)}$ and Ldn. The $Leq_{(24)}$ is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a 24-hour period. The L_{dn} is the $Leq_{(24)}$ with 10 dBA added to nighttime sound levels between the hours of 10 p.m. and 7 a.m., to account for people's greater sensitivity to sound during nighttime hours.

The basis for evaluation of noise impact is an L_{dn} of 55 dBA, the level that protects the public from indoor and outdoor activity interference in residential areas. Noise impact must be mitigated if, during operations, noise attributable to the operation of the facility would exceed an L_{dn} of 55 dBA at nearby noise sensitive areas such as residences, or if applicable state and local noise regulations would be exceeded.

To assess noise impacts, an evaluation of the following significance criteria is conducted to determine if the applicant's proposed action would:

- Expose persons to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies
- Expose persons to or generate excessive groundborne vibration or ground-borne noise levels
- Create a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project
- Create a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project

- Expose people residing or working in the Plan Area to excessive noise levels for a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport
- Expose people residing or working in the Plan Area to excessive noise levels, for a project within the vicinity of a private airstrip

In community noise impact analysis, a long-term noise increase of 5 to 10 dBA is considered to impact the noise quality of the community to some degree. Most people begin to notice changes in environmental noise at about 5 dBA. Noise levels below 5 dBA cannot definitively be demonstrated as producing an adverse impact. Noise level increases above 10 dBA are generally considered to have a severe impact. For short-term noise increases (for example, construction activities), the typical severe threshold increase is 15 dBA, depending upon whether the noise level fluctuates, has a high frequency, or is accompanied by subsonic vibration.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN NOISE IMPACTS

CONSTRUCTION PERIOD

Construction is expected to be typical of other development projects in terms of schedule, equipment used, and other types of activities. It is expected that construction would increase noise levels in the vicinity of the Plan Area. Project construction noise levels would vary during the construction period, depending on the construction phase. Construction equipment would be operated on an as-needed basis during this period and would be maintained to manufacturer's specifications to minimize noise impacts. Although individuals in the immediate vicinity of the construction activities would experience an increase in noise, this effect would be local and temporary, lasting only during days of construction (primarily winter) and, other than drilling, usually occurring at a given location for only part of one winter season. Drilling for CD-3 would occur in five to seven successive winters, that at CD-4 over four successive summers, and other pads over approximately 1.5 years.

The construction of gravel roads, drilling and production pads, and pipelines would cause temporary increases in the ambient sound environment in the immediate vicinity of the construction sites. Typical construction equipment, such as a dump truck, backhoe, concrete mixer, and other trucks and cranes, creates noise levels of about 85 to 91 dBA at a distance of 50 feet (USEPA 1971). Grading activities, however, would mitigate noise caused by loud rattling of truck travel on potholed roads.

During drilling activities, excessive groundborne vibration or groundborne noise levels could be generated from drill rigs, where noise levels would be about 82 to 92 dBA at a distance of 82 feet (Hampton et al. 1988). However, drill rigs are totally enclosed with windwalls and arctic insulation, which provides adequate soundproofing to noise exposure outside the rig complex. Enclosure and winterization of rigs should reduce the drilling operation noise impacts to 70 dBA or below outside the operational area. The nearest sensitive area is the village of Nuiqsut, which is approximately 5 miles south of CD-4.

Noise would affect the local environment during construction or extension of the proposed access roads. Construction would proceed at rates ranging from several hundred feet to several miles per day. However, because of the assembly line method of construction, activities in any one area could last several weeks. Construction equipment would be operated on an as-needed basis during this period. Although individuals in the immediate vicinity of the construction activities could experience annoyance, the impact on the noise environment at any specific location along the route would be short-term.

Noise associated with the construction or extension of access roads and aboveground pipelines would be intermittent during the construction period at any single location and would vary from hour to hour depending on the equipment in use and the operations being performed. The overall impact would be temporary and would not be expected to be significant.

The development process for Clover, identified to provide gravel for road and pad construction associated with CD-5, CD-6, and CD-7, would include blasting and excavation of gravel. Blasting would result in a temporary increase of noise level. Typical noise levels for blasting would be approximately 94 dBA at a distance of 50 feet, and decreases to below 70 dBA at a distance of 800 feet (Jones & Stokes 2003). The nearest sensitive area is the village of Nuiqsut, which is about 6.5 miles east-southeast of the gravel source.

OPERATION PERIOD

During operational drilling, the potential noise impacts would be limited to the vicinity of the power generation engines and drilling rig engines, which would have equipment decibel ratings of about 85 dBA and 110 dBA, respectively. Principal noise sources would include the air inlet, exhaust, and casing of the engines or turbines. Secondary noise sources would include cooling fans, yard piping, and valves. Noise from relief valves and emergency electrical generation equipment would be infrequent.

Generally, the equipment in the Plan Area will operate at a decibel level of about 70 dBA from less than 1,000 feet if properly mitigated by noise minimization measures such as mufflers on the exhaust systems of engines and turbines. With noise mitigation there will not be long-term impacts to the nearby village of Nuiqsut. Workers in the Plan Area would be subject to Occupational Safety and Health (OSHA) standards for hearing protection as necessary.

Operation of the access roads after construction would not significantly exceed their use. The applicant's proposed action will utilize a small twin-engine aircraft. In 1997, the use of a small aircraft was evaluated versus a larger Boeing 737 for crew transport. The Boeing 737 could transport 120 passengers compared to 19 passengers onboard the small aircraft. However, the smaller aircraft was selected to mitigate noise impacts to residents in the nearby village of Nuiqsut. However, this noise mitigation measure requires more trips to transfer crew and materials.

The highest use of the CD-3 airstrip would occur during non-ice road months for material re-supply. During the summer, a small twin-engine fixed wing aircraft would be utilized to transport operation and maintenance personnel to the site. A higher frequency of use would occur during production start-up, after which it would decline at a steady rate. Twin-engine propellers at 1,000 feet emit a noise level of 69 to 81 dBA. Table 4A.2.3-5 indicates the estimated one-way aircraft flights per month. The noise impacts from the use of aircraft during construction would be considerably greater than during the operational phase, where 24 one-way aircraft flights per month are projected.

Noise levels from passing helicopters vary among aircraft models and atmospheric conditions. Typically, the noise from passing helicopters ranges between 68 to 78 dBA during a flyover (at about 1,300 feet) but is only detectable for 30 seconds.

ABANDONMENT AND REHABILITATION

Noise impacts are expected to be similar to those associated with construction, minus the impacts of drilling, which produces some of the greatest noise impact. Abandonment and rehabilitation noise would be intermittent at any single location and vary depending on the equipment in use and the operations being performed. The level of impact would be less than construction if gravel fill is not removed.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO NOISE IMPACTS

Additional construction and drilling at the two HPFs and the 22 HPs would extend the noise impacts over a longer period of time and over a wider area. Additional aircraft trips during construction would occur under the Alternative A – FFD Plan. Since the village of Nuiqsut is several miles from all but one of the HPs, noise impacts would be minimal.

ALTERNATIVE A – SUMMARY OF NOISE IMPACTS (CPAI AND FFD)

During peak periods of construction and drilling, noise levels would be considerably higher than during operations, but would be short-term, and would not occur for all HPs at the same time. The village of Nuiqsut is approximately 5 miles from the nearest proposed development, so noise impacts would be minor unless, under Alternative A – FFD, a development occurred much closer to the village.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR NOISE

No potential mitigation measures have been identified.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR NOISE IMPACTS

There are no stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS nor were potential mitigation measures developed in this EIS.

4A.3 BIOLOGICAL RESOURCES

4A.3.1 Terrestrial Vegetation and Wetlands

4A.3.1.1 Alternative A – CPAI Development Plan Impacts on Terrestrial Vegetation and Wetlands

Impact areas for vegetation and habitats under the CPAI Development Plan were calculated based on Geographic Information System (GIS) maps in ArcView® 8.3 (2003, ESRI, Redlands, California). Both direct and indirect impact areas were calculated. Placement of gravel fill for the constructions of roads, pads, and airstrips results in the direct loss of vegetation and habitat. This direct loss was estimated by overlaying the footprints (perimeter) of roads, pads, and airstrips for CPAI alternatives on the ABR, Inc. vegetation map (Figure 3.3.1.2-1) (Jorgenson et al., 1997, 2003c) and the habitat map (Figure 3.3.1.3-1) (Jorgenson et al. 2003c), and calculating the area of each vegetation class and habitat type within these footprints. Dust fallout, snow accumulation, changes to moisture or thermal regimes, and trenching result in indirect changes in the amount of cover or plant species composition. Indirect impacts due to dust fallout and changes to moisture and thermal regimes were calculated by using GIS to generate a 164 foot (50 meter) buffer area around the outside of the gravel footprint areas for CPAI alternatives (Hettinger 1992; BLM and MMS 1998a, 2003). Indirect impact buffers were then overlain on the vegetation and habitat maps, and the area of each vegetation class and habitat type were calculated. Under Alternative B, where power lines are proposed to be buried in the tundra next to pipelines, a 1-foot wide strip centered on the pipeline was generated and overlain on the vegetation and habitat maps to calculate the area of impact for vegetation classes and habitat types. Results of these analyses are presented in Tables 4A.3.1-1, 4A.3.1-2, 4B.3.1-1, 4B.3.1-2, 4C1.3.1-1, 4C1.3.1-2, 4C2.3.1-1, 4D.3.1-1, 4D.3.1-2, 4D.3.1-3, 4D.3.1-4, 4F.3.1-1, and 4F.3.1-2.

The project design would minimize the facility footprints to reduce the loss of vegetation and habitat from gravel placement and associated indirect impacts. Biologists, geologists, and facilities and reservoir engineers worked together combining information from waterbird distribution maps and wildlife habitat maps based on physical features (surface landforms, soil types, and vegetation types) to locate facilities in drier habitats avoiding impacts to aquatic, nonpatterned Wet Meadow, Patterned Wet Meadow, and Moist Sedge-Shrub Meadow habitats preferred by many waterbirds (CPAI 2004). Figures 4A.3.1-1 and 4A.3.1-2 show vegetation and habitat potentially affected, and Table 4A.3.1-1 and Table 4A.3.1-2 summarize the area of vegetation classes and habitat types affected under the Alternative A – CPAI Development Plan. All impacts under Alternative A would be to wetlands. Key wetland habitats correlated to those identified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b) are described in Section 3.3.1 and identified in Table 4A.3.1-2. Oil spills, should they occur, would also directly or indirectly affect vegetation and wetlands in the Plan Area. The impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

See Section 2.7 (Table 2.7-1) for a comparison of impacts to tundra habitats in the Plan Area among alternatives.

CONSTRUCTION PERIOD

The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling.

GRAVEL PADS, ROADS, AND AIRSTRIPS

Gravel facilities would be designed and constructed as described in Section 2. Under Alternative A, a total of approximately 241 acres of tundra vegetation would be covered with gravel fill for the construction of well pads (49 acres), approximately 26 miles of primary and spur roads (174 acres), and an airstrip runway and apron at CD-3 (16.3 acres). In addition to impacts from roads, pads, and an airstrip, approximately 1.5 acres of tundra vegetation would be lost for the construction of a boat launch ramp at CD-4 and the associated access road, and a floating dock and access road at CD-3 as described in Section 2.3.8. Gravel facilities would be constructed and maintained to hold their designed dimensions; however, some gravel slumping from side-slopes could occur, which could potentially increase the impact area by approximately 16 percent (assuming a maximum increase from a 2H:1V to a 3H:1V side slope). The type of impact from gravel slumping could range from direct loss of tundra vegetation to an alteration of vegetation communities depending on the thickness of gravel sloughed onto adjacent tundra. These potential impacts are included in the indirect impact area calculations from dust, gravel spray, snowdrifts, impoundments, and thermokarst discussed below. Abandonment of roads, pads, and airstrips is discussed in Section 2.3. Vegetation classes and habitat types lost under Alternative A due to gravel placement are summarized in Tables 4A.3.1-1 and 4A.3.1-2.

Gravel for the proposed development would be mined from two locations. The ASRC Mine Site is already permitted as a gravel source with a reclamation plan in place. The reclamation plan would be amended to reopen the mine to supply material for the CD-3 and CD-4 sites; however, no expansion to the existing permitting area is currently planned. Vegetation at the ASRC Mine Site is composed of Deep Polygon Complex and Wet Sedge Meadow Tundra with the following corresponding habitat types: Deep Open Water without Islands, Shallow Open Water without Islands, Aquatic Sedge with Deep Polygons, Patterned Wet Meadow, and Nonpatterned Wet Meadow. Gravel for the CD-5, CD-6, and CD-7 sites would be mined from Clover, approximately 6 miles southeast of CD-6, impacting approximately 65 acres of tundra vegetation. This is a maximum case scenario and the actual acres impacted from mining at Clover would be less because some of the gravel would be extracted from the currently permitted ASRC Mine Site for the CD-3 and CD-4 sites. Clover would require permitting and a reclamation plan (Appendix O) prior to development. The vegetation at Clover is composed primarily of Moist Sedge-Shrub Tundra and Tussock Tundra with less than 10 percent of Wet Sedge Meadow Tundra. Dominant habitat types include Moist Sedge-Shrub Meadow and Moist Tussock Tundra with less than 10 percent of Nonpatterned and Patterned Wet Meadow. Removal of gravel from the ASRC Mine Site and Clover would result in a permanent loss of tundra habitat while the mine sites are active, and an alteration from tundra to aquatic habitat when the gravel sites are reclaimed. Specific details on the changes in habitat resulting from gravel extraction at Clover are provided in the reclamation plan (Appendix O). These plans would be reviewed and approved by local, state (for ASRC), and federal agencies.

The type of gravel material used for pads, airstrips, and roads could also affect vegetation, especially if the material has a high salt concentration. Water (e.g., rain) draining off or leaching through saline pad material dissolves the salt and could cause physiological stress to nearby plants (Simmons et al. 1983, McKendrick 1996). Saline gravels have been identified as a source of tundra damage along the Tarn Road, south of the Kuparuk Oilfield (McKendrick 2003a). Salinity of soils adjacent to the road the first summer after construction (8.69 milli mhos per centimeter (mmhos/cm) or ~5 ppt) were reduced by 69 percent during the next fall (2.66 mmhos/cm or ~1.5 ppt) as was the visible impact to vegetation (McKendrick 2003a). These observations suggest that soluble salts from gravel fill will be flushed from tundra soils and that vegetation impacts, at least at these salinities, will be temporary (McKendrick 2003a). Salinity measurements taken from borings in the ASRC Mine Site and the Clover ranged from 0 to 3 ppt and 0 to 9 ppt, respectively.

TABLE 4A.3.1-1 CPAI ALTERNATIVE A – SUMMARY OF SURFACE AREA (ACRES) OF VEGETATION CLASSES AFFECTED

Vegetation Classes	Colville River Delta							NPR-A (Western Beaufort Coastal Plain)					Totals for Alternative A
	Direct Impacts					Indirect Impacts		Direct Impacts			Indirect Impacts		
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal	Totals for Delta	Primary Roads	Spur Roads	Well Pads	Dust, Moisture Regime, & Thermal	Totals for NPR-A	
Water	2.1				<0.1	17.7	19.8	0.2			4.2	4.4	24.1
Riverine Complex								0.5			3.6	4.1	4.1
Fresh Grass Marsh						1.6	1.6						1.6
Fresh Sedge Marsh								0.8			6.8	7.6	7.6
Deep Polygon Complex				5.3		10.0	15.3						15.3
Young Basin Wetland Complex								2.1		2.5	14.5	19.1	19.1
Old Basin Wetland Complex								5.0			37.9	42.9	42.9
Wet Sedge Meadow Tundra	16.5	1.6	21.9	11.0	0.1	159.7	210.8	15.4	0.4	6.2	107.5	129.5	340.4
Salt-killed Wet Meadow													
Halophytic Sedge Wet Meadow						0.5	0.5						0.5
Halophytic Grass Wet Meadow													
Moist Sedge-Shrub Tundra	9.0					60.8	69.8	29.2	0.4	0.8	176.8	207.1	276.9
Tussock Tundra	1.1						1.1	76.1	2.2	17.1	486	581.3	582.4
Dryas Dwarf Shrub Tundra													
Cassiope Dwarf Shrub Tundra													
Halophytic Willow Dwarf Shrub Tundra													
Open and Closed Low Willow Shrub	6.9				1.1	26.1	34.1	3.2		0.7	21.4	25.3	59.4
Open and Closed Tall Willow Shrub								0.2			1.3	1.5	1.5
Dune Complex													
Partially Vegetated					0.2	9.2	9.4						9.4
Barrens	1.1					7.0	8.1						8.1
Total Area	**36.6**	**1.6**	**21.9**	**16.3**	**1.5**	**292.5**	**370.4**	**132.6**	**2.9**	**27.4**	**859.9**	**1,022.8**	**1,393.2**

Notes:
Spur Roads are airstrip and/or well pad access roads that branch off of the primary road.
Calculation methods are described in text in Section 4A.3.1.1.
Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

TABLE 4A.3.1-2 CPAI ALTERNATIVE A – SUMMARY OF SURFACE AREA (ACRES) OF HABITAT TYPES AFFECTED

Habitat Types	Colville River Delta							NPR-A (Western Beaufort Coastal Plain)					Totals for Alternative A
	Direct Impacts					Indirect Impacts	Totals for Delta	Direct Impacts			Indirect Impacts	Totals for NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal		Primary Roads	Spur Roads	Well Pads	Dust, Moisture Regime, & Thermal		
Open Nearshore Water													
Brackish Water													
Tapped Lake with Low-water Connection													
Tapped Lake with High-water Connection						1.0	1.0						1.0
Salt Marsh*						0.5	0.5						0.5
Tidal Flat*													
Salt-killed Tundra*													
Deep Open Water without Islands*						1.3	1.3	<0.1			0.9	0.9	2.2
Deep Open Water with Islands or Polygonized Margins*	1.1					7.0	8.1				0.3	0.3	8.4
Shallow Open Water without Islands	0.3					1.4	1.7				0.2	0.2	1.9
Shallow Open Water with Islands or Polygonized Margins								0.1			2.2	2.3	2.3
River or Stream	0.7				<0.1	7.0	7.7	0.1			0.6	0.7	8.4
Aquatic Sedge Marsh								0.8			6.8	7.6	7.6
Aquatic Sedge with Deep Polygons				5.3		10.0	15.3						15.3
Aquatic Grass Marsh*						1.6	1.6						1.6
Young Basin Wetland Complex*								2.1		2.5	14.5	19.1	19.1
Old Basin Wetland Complex*								5.0			37.9	42.9	42.9
Riverine Complex*								0.5			3.6	4.1	4.1
Dune Complex													
Nonpatterned Wet Meadow	4.1	0.8	7.6	1.8		46.2	60.5	1.5		5.9	17.2	24.5	85.1
Patterned Wet Meadow	12.4	0.8	14.3	9.2	0.1	113.5	150.3	14.0	0.4	0.3	90.4	105.1	255.4

TABLE 4A.3.1-2 CPAI ALTERNATIVE A – SUMMARY OF SURFACE AREA (ACRES) OF HABITAT TYPES AFFECTED (CONT'D)

Habitat Types	Colville River Delta							NPR-A (Western Beaufort Coastal Plain)					Totals for Alternative A
	Direct Impacts					Indirect Impacts	Totals for Delta	Direct Impacts			Indirect Impacts	Totals for NPR-A	
	Primary Roads	Spur Roads	Well Pads	Airstrip Runway & Apron	Boat Launches, Dock, & Access Roads	Dust, Moisture Regime, & Thermal		Primary Roads	Spur Roads	Well Pads	Dust, Moisture Regime, & Thermal		
Moist Sedge-Shrub Meadow	9.0					60.8	69.8	32.3	0.4	1.5	197.9	232.1	301.9
Moist Tussock Tundra	1.1						1.1	76.1	2.2	17.1	486.0	581.3	582.4
Riverine Low and Tall Shrub*						1.2	1.2	0.3			1.6	1.9	3.1
Upland Low and Tall Shrub													
Upland and Riverine Dwarf Shrub*													
Riverine or Upland Shrub*	6.9				1.1	24.9	32.9						32.9
Barrens (riverine, eolian, or lacustrine)	1.1				0.2	16.1	17.3						17.3
Artificial (water, fill, peat road)													
Total Area	36.6	1.6	21.9	16.3	1.5	292.5	370.4	132.6	2.9	27.4	859.9	1,022.8	1,393.2

Notes:
Spur Roads are airstrip and/or well pad access roads that branch off of the primary road.
Calculation methods are described in text in Section 4E.3.1.1
Columns may not sum to exact numbers in the total row because of rounding, particularly when habitat types have impacts of <0.1.
* Represents key wetland habitats that were correlated to Bergman et al. (1977) habitats and riparian shrub habitats identified as key wetlands in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b)

DUST FALLOUT FROM ROADS

Although much of the traffic would occur during the construction season, most would be during the winter on ice roads. However, summer traffic during construction would be required for module hookups, pipeline work, and roadwork. Summer construction traffic, which would produce the most dust, is expected to decrease after the first construction season (Johnson et al. 2003a).

On gravel roads, vehicle traffic results in dust and gravel being sprayed over the vegetation within about 35 feet of the road as well as a noticeable dust shadow out to about 150 feet or more (Walker and Everett 1987, Hettinger 1992). Accumulated dustfall has no soil structure, is massive, and often has poor aeration and limited water filtration (McKendrick 2000b). Various studies on dust fallout have found early snowmelt, reduced soil-nutrient concentrations, lower moisture, altered soil organic horizon, and higher bulk density and depth of thaw in soils where dust shadows occur (Everett 1980, Walker and Everett 1987, Hettinger 1992, Auerbach et al. 1997). These studies reported reduced richness of plant species near the road especially in naturally acidic soils. Heavy dust accumulation can eliminate acidophilus mosses (Walker and Everett 1987, Hettinger 1992, Auerbach et al. 1997), and prostrate willow (McKendrick 2000b). Lichens are sensitive to dust and are often eliminated in high dust areas (Walker and Everett 1987). Within 35 feet of roads, the dust and gravel may smother the original vegetation, altering the plant communities, and at extreme levels may eliminate all vascular plants (Auerbach et al. 1997, McKendrick 2000b). Beyond about 35 feet, the effects of dust on vegetation decrease logarithmically with distance from the road out to about 1,000 feet. Multiple-year studies of the effects of a gravel oilfield road in Prudhoe Bay resulted in an increase in graminoid cover and a decrease in shrub and lichen cover within 164 feet (50 meters) of the road in response to increased moisture, a deeper active layer, and increased nutrients, but that few changes in flora were attributable to dust alone (Hettinger 1992). Areas beyond this distance are essentially undisturbed (Everett 1980).

Under Alternative A, indirect impacts from dust fallout, gravel spray, snow accumulation, impoundments, and thermokarst would result in alteration of about 1,152 acres of tundra vegetation, assuming that these impacts occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-1 and 4A.3.1-2 summarize the surface area by vegetation and habitat types within this impact area. The impacts from dust would be reduced by scheduling construction and associated traffic in the winter when dust from the road would be less, and watering roads during the summer (a standard North Slope practice) to keep dust down and maintain road bed integrity. Chip seal could also be used to minimize impacts to vegetation from road dust. Chip seal coated roads are an intermediate step between gravel and asphalt roads, which would minimize dust created by wind or vehicles driving over the road. Chip seal is applied by first applying a heavy layer of a bituminous binder that is sprayed on the road with an oil distributor. The chipper is filled with a special gravel mixture (aggregate) which spreads the chips evenly onto the binder. Rubber tired and steel packers are then used to compact the aggregate. When the oil is set, the loose chips are swept away to produce a finished surface. Impacts on roadside vegetation and water quality during the chip sealing process could potentially occur if it rains before the binder can cure (causing runoff into adjacent surface water), or with excessive application rates. These impacts are very unlikely when common construction practices are applied (EPA 2004). There are many precautionary measures that can be taken to avoid any impact on the surrounding environment:

- Obtain weekly forecast prior to planned sealing and try to time spraying so it does not coincide with rainfall during or immediately after sealing.
- Distribute hydrocarbon barriers and sediment bags for use immediately after sealing.
- Ensure correct bitumen application and spray rates to avoid over-spraying and waste.
- Sweep up loose materials immediately upon finishing, and routinely as required.
- Ensure that trucks carrying liquid asphalt, particularly hydrocarbon-thinned materials, carry absorbent spill kits.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Ice roads have been used to minimize damage to the tundra surface since the early 1970s. Construction of ice roads and subsequent use may disturb underlying vegetation. Shrubs, forbs, and tussocks may be damaged and occasionally killed. Compaction of tundra vegetation by ice roads and associated gravel hauling and other construction activities can affect tundra habitats for several years by crushing tussocks, breaking and abrading willow terminal ends, and by altering or destroying the intertussock plant community, particularly the mosses and lichens (Walker 1996). Compaction of vegetation could also alter drainage, cause impoundment of meltwater, alter the thermal regime, and cause thaw settlement (Felix et al. 1992). Overall, studies of ice roads have found impacts to tundra vegetation to be low, with sporadic patches of moderate-level impacts, and slight or no significant increases in thaw depths (Walker et al. 1987a, Payne et al. undated, Pullman et al. 2003). Habitats sensitive to compaction include Moist Tussock Tundra, Riverine or Upland Shrub, and Moist Sedge-Shrub Meadows (Felix and Raynolds 1989a, Emers et al. 1995, PAI 2002). Pullman et al. (2003) found that tussock tundra was the most sensitive to damage primarily due to the higher micro relief caused by tussocks and the subsequent potential for scuffing and crushing from heavy equipment. Vegetation with negligible or low-level impacts from ice roads remains greener longer in the fall and can be readily visible from the air as "green trails" (Pullman et al. 2003). This indicates the effects of late-melting ice, which delays the typical plant phenology (the relationship of climate and seasonal cycle) (McKendrick 2000a, 2003b). "Brown trails" associated with moderate-level damage due to scuffing and crushing of tussocks may be visible from the air for years; however, this disturbance has a good potential for full recovery (Pullman et al. 2003). In general, more significant damage from ice roads occurs on higher, drier sites, with little or no evidence of damage to wet or moist wetland sites (Payne et al. undated, BLM 2002). Shrubs and other woody species are affected the most by ice road construction (BLM 2002). Studies conducted on the effects of ice road river crossings on willow stands (McKendrick 2000a, 2003b) reported impacts such as delayed phenology from lingering ice cover, broken and dead limbs, and a few dead plants. Damaged willows recovered on their own from single-year ice roads (McKendrick 2000a, 2003b). Long-term vegetation modification could result from repeated use of the same location for ice road construction (BLM 2002). However, a pilot study conducted by the BLM found no apparent difference between single-year ice roads and an overlapping area from two subsequent years of ice roads (Yokel et al. undated [b]). Offsetting ice road paths, year after year, would create a greater surface area of disturbance. Tundra recovery rates are variable and depend on the initial level of disturbance and vegetation types (Yokel et al. undated, Jorgenson et al. 2003a). Evergreen shrubs (which generally are slow growing plants) in Dryas Dwarf Shrub and Moist Sedge-Shrub habitats and deciduous shrubs in Low Willow Shrub habitats tend to recover at slower rates (Jorgenson et al. 2003a, Jorgenson et al 2003b). All impacts from single-year ice roads are expected to completely recover over a twenty to twenty-four year period (Jorgenson et al. 2003b, Payne et al. undated [a]).

Under Alternative A, a total of about 239 miles of temporary ice roads would be constructed over the life of the project for construction-related activities, resulting in a maximum of approximately 1,159 acres of vegetation disturbed. This is a maximum-case scenario that assumes the ice roads would be built in a different location each year as required by existing stipulations on BLM-administered land. The actual surface area disturbed would likely be much less, especially if ice roads are overlapped in subsequent years to minimize impacts. Ice roads placed for the construction of gravel roads and pipelines would follow adjacent to the road/pipeline routes and would tend to affect the same habitat and vegetation types (see Tables 4A.3.1-1 and 4A.3.1-2). Winter ice roads would be designed and located to minimize the breakage, abrasion, compaction, or displacement of vegetation. To mitigate vegetation impacts by minimizing the surface area of disturbance, the most direct route would be taken and, when possible, shrub areas would be avoided.

In addition to ice roads, ice pads would be used as staging areas during pipeline construction. Approximately 74 acres of vegetation would be disturbed by ice pad staging areas for the construction of the pipeline. Ice pads may also be used to stockpile overburden material associated with the ASRC Mine Site. The ice pads would be constructed directly adjacent to the mine sites and would tend to affect the same vegetation types as would gravel extraction activities from the mine sites. The size of the ice pads would depend on the depth of overburden soils and the volume of underlying gravel to be extracted. As described in Section 2, overburden removed from the ASRC Mine Site during previous operations required about 1 acre for every 25,000 cg of overburden. Ice pads also would be constructed at each end of each proposed bridge to stage equipment. These ice pads used as staging areas would vary with the size of the bridge installation and equipment needs. Given the number of access road bridges proposed under the Alternative A–CPAI Development Plan , and assuming the maximum pad size would be 800 feet by 800 feet surrounding the abutment structure at each end of a bridge (see Section 2.3, Features Common to all Alternatives), then a maximum of 206 acres of vegetation would be affected by these ice pads. Ice pads could also be built for storage of drill rigs and other equipment at remote production pads. It is assumed that the effects of ice pads on vegetation would be similar in type to the effects of ice roads.

Snowdrifts or plowed snow that accumulates on tundra adjacent to roads, well pads, pipelines, and airstrips can be deep and may persist longer than snow in areas away from gravel structures. In areas where snow persists late into the growing season, vegetation growth would be delayed. As with ice roads, vegetation composition is typically not altered in areas with late-melting snow piles, but the vegetation tends to remain green later than usual at the end of the growing season (McKendrick 2000b). Pipelines elevated 5 feet or more prevent accumulation of snowdrifts during winter (Pullman and Lawhead 2002).

OFF-ROAD TUNDRA TRAVEL

Development and operation of oil facilities in the Plan Area may require access across tundra. Such access could be necessary to respond to spills or other emergencies, conduct pipeline maintenance and repair, facilitate ice road construction, or to transport supplies and equipment to roadless development sites. Winter tundra travel by ice roads is discussed above.

Off-road tundra travel, especially during the summer, could cause impacts to ground stability and vegetation, including compaction, disruption of the surface layer, damage to willow cover, and scarring of the surface layer (PAI 2002).

Impacts associated with tundra travel by low-pressure vehicles (e.g., Rolligons) range from low-level disturbances such as “green” trails caused by the compaction of dead plant material, to high-level disturbances indicated by scuffing and breakage of vegetation. The range of disturbance is generally dependent on vegetation type. An assessment of impacts associated with a heavily used Rolligon trail in the Northeastern National Petroleum Reserve-Alaska (Jorgenson et al. 2003b) showed low-level disturbances were common in moist sites such as Wet Sedge Meadow and Sedge-Shrub Tundra, moderate disturbances were more common in Tussock Tundra, and high-level disturbances occurred only in shrub-dominated vegetation types such as Low Willow Shrub and Dwarf Shrub Tundra. Sites with low to moderate-levels of initial disturbance are expected to recover in three to five years. Shrub-dominated sites with moderate to high-level initial disturbance could take up to twenty years to recover (Jorgenson et al. 2003b).

Most research on the effects of winter tundra travel focused on seismic exploration trails (Emers and Jorgenson 1997; Emers et al. 1995; Felix and Raynolds 1998a, 1989b; Jorgenson 2000; Jorgenson et al. 1996; Jorgenson et al. 2003a). Vehicles used for seismic exploration have been modified over the years to minimize impacts to the tundra and although *s*eismic exploration is not proposed for this project, the more recent studies can be used to show the type of impacts to tundra vegetation from modern winter tundra travel vehicles. Jorgenson et al. (2003a) used a rapid, semi-quantitative ranking approach to assess the levels of disturbance at sites associated with seismic exploration near the Colville Delta in 2001. During this survey, rubber-tired vehicles were used for vibrator lines, rubber-tracked vehicles were used for all surveying and receiver equipment, and three-tracked vehicles (D-7) and rubber-tracked tractors were used to pull the camp strings. The overall disturbance levels for the Colville Delta 2001 seismic survey were low. The degree of impact varied among both trail types and vegetation types. In particular there were few occurrences of moderate or higher level disturbances along the receiver and vibrator trails which used similar rubber-tired and rubber-tracked equipment that would be used with CPAI’s proposed action. Tundra that is shrub dominated or with tussocks or hummocks (Tussock Tundra, Low Willow Shrub, and Dryas Dwarf Shrub Tundra) has been shown to be more susceptible to initial disturbance than low-relief sedge-dominated tundra (Wet Sedge Meadow Tundra and Moist Sedge-Shrub Tundra) (Jorgenson et al. 1996, Jorgenson et al. 2003a, Jorgenson et al. 2003b). Jorgenson et al. (1996) showed that disturbance levels on winter seismic lines and camp-move trails decreased greatly over time and that the main long-term damage to tundra was from the heavier vehicles (10.5 pounds per square inch [psi]) used for camp-moves. Similar results have been reported for summer tundra travel (Lawson et al. 1978, Walker et al.

1977, Everett et al. 1985); however, the impacts from summer tundra travel can be more severe because the lack of snow makes the tundra more exposed to disturbance.

Impacts from off-road tundra travel during both summer and winter would be mitigated and avoided by limiting the number of vehicle passes in an area, and avoiding tight turns. Low-ground-pressure vehicles (less than 4 psi) approved for travel by state and federal regulators would be used. Low-pressure vehicles such as Rolligons, Tuckers, and Nodwells would conduct these activities from the nearest pad or road. Restrictions to tundra travel are implemented by state, federal, and local regulators. All applicable permits and approvals would be obtained prior to tundra travel, and the permit stipulations would be followed. Existing procedures for emergency summer tundra travel would be maintained onsite during construction and operation.

IMPOUNDMENTS AND THERMOKARST

Impoundments are created where gravel fill or overburden placed on the tundra surface blocks the downslope movement of water. Although drainage plans, project design, culvert installation, and maintenance have reduced the occurrence of impoundments or ponding on the North Slope, temporary blockages, especially during spring snow melt, are still possible. Some blockages simply increase soil moisture on the upslope side of the barrier, potentially causing the substrate to become drier on the downslope side, while others create ponds. Impoundments may be ephemeral and dry up early during the summer, or they may become permanent water bodies that persist from year to year (Walker et al. 1987a, Walker 1996). Wetland associated with ice-wedge polygons and low-lying, vegetated thaw-lake basins are more susceptible to impounding than higher, moist tundra (Walker et al. 1987a). Hydrological changes are reflected in the vegetation, with sharp contrasts in vegetation type from one side of a road to the other. Tundra plant communities have evolved under naturally changing moisture regimes, so are pre-adapted to accommodate analogous man-induced changes. Ice-wedge aggradation has dried out high centers of polygons and moistened polygon troughs for a millennia. Increased wetness encourages water-thriving plants such as *Arctophila fulva*, *Dupontia fisheri*, *Carex aquatilis*, and *Eriophorum angustifolium*. Increased dryness encourages plants needing less moisture such as *Puccinellia langeana*, *Festuca baffinensis*, *Trisetum spicatum*, *Dryas integrifolia*, and *Salix lanata* ssp. *Richardsonii* (McKendrick 2000b). These impacts would be mitigated and avoided by locating the road and pad on the highest portions of slopes where possible, and maintaining adequate cross-drainage by using culverts. Culverts would be maintained as needed to prevent ice-up.

Thermokarst is a localized thawing of ground ice resulting in a surficial depression and eventual erosion (Walker et al. 1987a). Thermokarst occurs naturally on the North Slope, contributing to the formation of frost polygon troughs, ponds, lakes, and other subsidence features. Surface disturbance that reduces the insulative value of vegetation and soil and/or landscape surface albedo (reflection) can lead to thermokarst because it enables the summer sun to thaw the soil to greater depths than usual (Truett and Kertell 1992). A study of road and culvert performance in Prudhoe Bay and Kuparuk showed that thin gravel roads (less than 5 feet) thaw completely, penetrating into the buried active layer. Thermokarst results in areas where this thaw exceeds the active layer (Brown et. al. 1984). Thick road berms and elevated pipelines would help prevent the melting of ground ice. However, in areas where there is a potential for a combination of surface disturbances from road dust, flooding, snowdrifts, and warming effects of the road, thermokarst may still occur (Walker et al. 1987a, Klinger et al. 1983b). Acceleration of thermokarst is probably initially due to the warming effects of impounded water adjacent to roads (Brown et. al. 1984). The loss of the moss layer from dust fallout may play a role in the development of roadside thermokarst. Vegetation cover, especially mosses, insulates permafrost from solar energy in the summer, and a decrease in vegetation cover may contribute to deepening of the permafrost thaw (Haag and Bliss 1974, Clymo and Hayward 1982). Generally, thermokarst of ice-rich tundra soil near the edges of gravel roads and pads may enhance plant productivity and species diversity because of increased thickness of the active layer and more available nutrients. An increase in the depth of the active layer may lead to an increase in graminoid and bryophyte production in wet habitats or a decrease in shrubs and lichens in moist or dry habitats (Hettinger 1992). Although, if the thermokarst expands and prolonged deep ponding or flooding results, adjacent vegetation communities may be lost completely (Walker et al. 1987b). At Prudhoe Bay, past practices resulted in thermokarst features that occur mostly within 80 feet of the road, but in some areas it can be seen at distances up to 330 feet (Walker et al. 1987b).

Indirect impacts from dust fallout, gravel spray, snow accumulation, impoundments, and thermokarst associated with roads, pads, and airstrips are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-1 and 4A.3.1-2 summarize the surface area of disturbance by vegetation classes and habitat types within this impact area.

The following operation measures would greatly reduce the amount of thermokarst from the levels associated with past practices: (1) summer watering of roads and conducting most transportation of equipment and materials during the winter to reduce impacts caused by dust; (2) proper culvert installation and annual maintenance would reduce impoundments and flooding impacts; and (3) the design of thick roads and elevated pipelines to reduce warming effects.

CROSS-DRAINAGE AND WATER FLOW

Although drainage plans, project design, culvert installation, and maintenance have helped prevent melting of the underlying permafrost and subsequent subsidence, gravel roads and pads may still intercept the natural flow of water, especially in drained thaw-lake basins, ephemeral streams, and floodplains. Impacts from cross-drainage and water flow would be greater in the Colville River Delta than in the National Petroleum Reserve-Alaska because the flow regimes are relatively more stable in the National Petroleum Reserve-Alaska and because ocean-induced storm surges would not occur near the proposed roads within the National Petroleum Reserve-Alaska. The disruption of sheet flow in the spring could dry up habitat on the downslope side of the roads and pads and cause the habitat on the upslope side to become wetter. These impacts would be avoided by locating the roads and pads on the highest portion of slopes where possible, and maintaining adequate cross drainage with culverts. Culverts would be maintained as needed to prevent ice-up. Bridges are also proposed for river and stream crossings and in all areas where a culvert or culvert batteries could not maintain the hydrologic regime.

AIR POLLUTION

Limited data is available on the sensitivity of arctic vegetation to air pollution. Previous studies have documented that plant life in general is affected by air pollution (Treshow and Anderson 1989, Unsworth 1982). Project construction would cause a localized and temporary impact on air quality. The sources of air pollution during the construction period would be fugitive dust from topsoil disturbance and gravel activities; exhaust from heavy construction equipment (earth movers, trucks, etc.) and drilling rigs; and emissions from electrical generators, portable light generators, small heaters, and similar temporary fuel burning equipment (PAI 2002). These sources are not expected to produce sufficient levels of pollutants to adversely affect vegetation. Studies at Prudhoe Bay have shown no consistent differences in cover of vascular plants and lichen in response to O_3, NO_2, NOx, and SO_2 deposition, although the levels encountered were not expected to be harmful to plants (Kohut et al. 1994). Conducting major construction activities in the winter when the topsoil is frozen and the ground would be covered with snow would minimize the generation of fugitive dust. Air quality impacts and applicable mitigation measures are discussed in Section 4A.2.3.2

PIPELINES

Beside the disturbance from ice roads and staging pads for the construction of pipelines (discussed above), the only other impact to vegetation from pipeline construction under Alternative A is from VSM borings. Given the maximum diameter of VSM borings and the projected number of VSMs to be constructed under Alternative A (presented in Section 2), and adding a 0.5-foot disturbance buffer to account for potential spoils and thermal impacts around the borings, about 0.5 acre of vegetation would be lost to VSM installation. The vegetation and habitat types affected would depend on the exact location of the VSM. An elevated pipeline design reduces impacts to vegetation and habitat types compared to buried pipeline designs.

POWER LINES

Power line design (suspended between CD-6 and CD-7 and on cable trays mounted on pipeline VSMs elsewhere) would reduce the effects of power lines on vegetation and habitats. Given the maximum pole diameter and the projected number of poles to be placed under Alternative A (presented in Section 2), and adding a 0.5-foot disturbance buffer to account for potential spoils and thermal impacts around the poles, approximately 670 square feet of vegetation would be lost from pole placement for the suspended power line between CD-6 and CD-7.

OPERATION PERIOD

The operation period includes continued drilling and day-to-day operations and maintenance once production has begun.

GRAVEL PADS, ROADS, AND AIRSTRIPS

Additional vegetation losses following construction could occur during the operational period during maintenance of gravel roads (such as snow removal) or if flood events wash out portions of roads or pads and deposit gravel on tundra.

Gravel that is inadvertently spread or sprayed on areas adjacent to roads and pads also affects vegetation. Impacts depend on site-specific conditions and the amount of gravel on tundra. Gravel spray that simply adds a scattering of stones to the tundra often stimulates the growth of vegetation, probably because of soil warming with the gravel cover, which increases the decomposition of organic matter and releases nutrients (McKendrick 2000b). The response may not appear for several years following disturbance and may persist for only a few years. Increasing thickness of gravel may kill plants; the prostrate and low-stature forms would be killed first. If gravel accumulates gradually in wet sedge meadows dominated by rhizomatous sedges, vegetation may persist even after the gravel has become 10 to 20 inches thick. The indigenous grasses and sedges keep pace with the buildup, rooting at stem bases and producing rhizomes at higher levels as the gravel thickness increases. But even in wet environments, 4 to 8 inches of gravel deposited at once may kill all plants, and recovery must occur either by invasion from the gravel margins or by seedling establishment (McKendrick 2000b). Effects of flood event washouts on vegetation would depend on site-specific conditions and the amount of gravel washed out onto tundra, but would be similar in type to the impacts described above. Vegetation in disturbed drier sites would not be able to compensate with vegetation growth, but many plants are adapted to colonize gravel areas by seeds. Impacts to vegetation from gravel and fill spreading would be mitigated by slope stabilization using revetments or soil binders (including road watering).

DUST FALLOUT FROM ROADS

During the operation period, effects of dust from roads, pads and airstrips are expected to be realized within the 164-foot impact zone. The effects of dust on vegetation are described in the Construction Period section above. Tables 4A.3.1-1 and 4A.3.1-2 summarize the surface area of disturbance by vegetation and habitat types within this impact area.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

In addition to ice roads required for construction-related activities, approximately 64 miles of ice roads would be needed for facility operations including well workovers and drilling activities at remote sites such as CD-3, resulting in approximately 310 acres of vegetation disturbed over the life of the facility. This is a maximum-case scenario that assumes the ice roads would be built in a different location each year. Ice pads would not likely be needed during operations. See the Construction Period discussion above for potential impacts.

As during the construction period, snowdrifts or plowed snow would accumulate on tundra adjacent to roads, well pads, and airstrips. Impacts would be similar to those discussed above in the Construction Period section.

OFF-ROAD TUNDRA TRAVEL

Some off-road tundra travel would continue during the operational period to respond to spills or other emergencies, to conduct pipeline maintenance and repair, to facilitate ice road construction, or to transport supplies and equipment to roadless development sites. See the Construction Period discussion above for potential impacts.

IMPOUNDMENTS AND THERMOKARST

Although there is a potential for some habitat loss and alteration to occur from thermokarst and the creation of impoundments during the operational period of the project, these impacts are more likely to be initiated during construction. Therefore, the factors causing vegetation loss and alteration are discussed above in the Construction Period section.

CROSS-DRAINAGE AND WATER FLOW

Disruption of cross-drainage and interception of sheet flow would continue to cause impacts to vegetation during the operational phase of this project. These impacts are initiated during the construction period and are discussed above.

AIR POLLUTION

Air pollution levels would increase during operations with the ACX upgrade of the existing APF-1 and increased emissions from traffic, drilling equipment, and well servicing and production equipment. However, this increase is not expected to generate levels of pollutants that would adversely affect vegetation. Air quality impacts resulting from emissions from well servicing and drilling equipment would be intermittent and localized. Air quality impacts and applicable mitigation measures are discussed in Section 4A.2.3.2.

Air quality monitoring and modeling data associated with the Central Compressor Plant (CCP), which has the greatest air emissions of any facility at Prudhoe Bay, showed that pollutant levels were not of sufficient concentration (in both long-term averages and maximum values) to represent a hazard to vegetation (Kohut et al. 1994). The vascular and lichen plant communities monitored during the Prudhoe Bay research did not reveal any changes in species composition that could be related to differences in exposure to pollutants, and no symptoms similar to those caused by air pollutants were observed on any of the plants examined. A pattern of change in the rates of photosynthesis along the dispersion gradient was detected in one year but did not appear to be directly related to changes in levels of foliar nitrogen. Laboratory tests were conducted during this same study to assess the effects of air pollution on plant physiology of selected species (*Eriophorum angustifolium* and *Salix arctica*). These species were found to be unaffected by acute exposure to NO_2 and NO_x (Kohut et al. 1994). The conclusions of this study, however, do not represent an assessment of potential impacts on vegetation from chronic, long-term exposure to air pollutant emissions impacts on the North Slope.

PIPELINES

Pipeline operation would not cause vegetation losses or alteration. However, occasional large-scale pipe repairs that may be required during the thawed season could result in additional damage to tundra from equipment needed to conduct the repair work. Tundra travel is discussed above. Additionally, indirect impacts (discussed above in the Construction Period section) associated with snow drifting and shading would continue to occur during the operational period. Effects of pipeline spills on tundra are described in Section 4.3.

POWER LINES

No additional impacts on vegetation would occur from power lines during the operational period.

ABANDONMENT AND REHABILITATION

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantlement of pipelines and power lines, and by disturbance to vegetation adjacent to VSMs and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill is removed; less if it remains in place. If roads and pads are left in place, and especially if cross drainage across roads is not maintained, impoundment will occur and could alter plant communities as described in the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation is covered with washed-out gravel. Roads and pads, if left in place would likely be required to be revegetated with plants native to gravel bars and ridges in the Arctic, i.e., different from the plant communities surrounding the proposed CPAI facilities. (Kidd et al. 2004) Revegetation activities may occur over several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and the CD-3 airstrip may be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, though this can take many years (more than a decade) and because thaw subsidence is difficult to predict, complete restoration to preexisting conditions is improbable (Kidd et al. 2004).

4A.3.1.2 Alternative A – Full-Field Development Scenario Impacts on Terrestrial Vegetation and Wetlands

Because the exact placement of FFD project components are unknown, the impact area for vegetation classes was assumed to be proportional to the distribution of vegetation classes within the circles surrounding each FFD facility for pads and airstrips (Figure 2.2.3-1) and within a 1-mile buffer around FFD roads. Habitat types were not assessed for FFD because habitat mapping does not cover the entire Plan Area (Figure 3.3.1.3-1) (Jorgenson et al. 2003c). Vegetation impacts due to gravel placement for pads and airstrips within the FFD circles were based on ABR, Inc. or BLM and DU mapping on Figure 3.3.1.2-1 (Jorgenson et al. 1997, 2003c, BLM and DU 2002). Acreages of each vegetation class within FFD circles were calculated and summed by Group. (Colville River Delta Facility Group, Fish-Judy Creeks Facility Group, and Kalikpik-Kogru Rivers Facility Group). Total acreage of each vegetation class was then converted to a proportion of the total area within the circles in each Group. Direct impact acreages were estimated using Tables 2.4.1-6, 2.4.1-7, 2.4.3-7, 2.4.4-8, and 2.4.4-11.. Indirect impact acreages were estimated using standard footprints of gravel facilities (well pads, airstrips, airstrip aprons, helipads, and storage pads) and calculating the impact area within a 164-foot (50-meter) area around these facilities using GIS. The area of each vegetation class that would be impacted was estimated based on the total impact area multiplied by the proportion of each vegetation class within each Group. Because FFD roads do not fall within the FFD circles (Figures 2.4.1.2-1, 2.4.2.2-1, and 2.4.4-2), a 1-mile wide buffer around FFD roads was overlain on the vegetation map (Figure 3.3.1.2-1). Acreages of each vegetation class within the 1-mile buffer were calculated and summed by Group. The acreage of each vegetation class by Group was then converted to a proportion of the total area within the buffer. Direct impact acreages for roads by Group were estimated using the length of FFD roads within each Group and a standard toe-to-toe road width of 54 feet. Indirect impact acreages by Group were estimated using the length of FFD roads within each Group and calculating the area using a 164-foot (50-meter) impact width on both sides of the road. The area of each vegetation class that would be directly or indirectly impacted by FFD roads was then estimated based on the total impact acreages and the proportions of each vegetation class by Group. Summaries of these FFD analyses are presented in Tables 4A.3.1-3, 4A.3.1-4, 4B.3.1-3, 4B.3.1-4, 4C-1.3.1-3, 4C-1.3.1-4, 4D.3.1-5, and 4D.3.1-6.

Under the Alternative A FFD scenario, direct and indirect impacts to vegetation related to gravel fill; dust fallout from roads; ice roads and snow stockpiles; impoundments and thermokarst; cross-drainage and water flow; air pollution; pipelines; and oil and brine spills in the three facility group areas would be the same types as those described under CPAI Development Plan Alternative A. In addition to the impacts of the CPAI Development Plan, under the FFD scenario for Alternative A approximately 1,262 acres of tundra vegetation would be covered with gravel fill for the construction of pads (well pads, APF pads, and storage pads), airstrips and associated aprons (462 acres), and approximately 122 miles of roads (800 acres). Approximately 5,662 acres of vegetation would be indirectly impacted by dust, gravel spray, snowdrifts, impoundments, and thermokarst. Tables 4A.3.1-3 and 4A.3.1-4 summarize the areas of vegetation classes affected under Alternative A – FFD Scenario . The effects of FFD on terrestrial vegetation and wetlands would depend on the location and extent of development in specific locations within each facility group area.

COLVILLE RIVER DELTA FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under the CPAI Development Plan Alternative A, approximately 216 acres of vegetation would be lost in the Colville River Delta Facility Group under Alternative A – FFD Scenario for the construction of pads (hypothetical production pads HP-4, 5, 7, 8, 12, 13, and 14 and storage pads) and airstrips (164 acres) and connecting roads (52 acres) (Table 4A.3.1-3 and Table 4A.3.1-4). The dominant vegetation class in the vicinity of the Colville River Delta is Wet Sedge Meadow Tundra. The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described above under the CPAI Development Plan Alternative A.

Gravel extraction for the hypothetical FFD would result in the destruction of approximately 346 acres of tundra vegetation. Specific gravel sources for the hypothetical FFD scenario have not been identified. The development process for any future gravel source would include planning, design, permitting, temporary staging areas, removal of overburden, blasting and excavation of gravel, and an approved rehabilitation plan. Analysis of impacts and appropriate mitigation measures would be examined before approval of future mine sites.

DUST FALLOUT FROM ROADS

Under Alternative A – FFD Scenario , indirect impacts, including dust impacts, are expected to occur within 164 feet (50 meters) of gravel facilities as described above, resulting in alteration of about 651 acres of tundra vegetation in the Colville River Delta Facility Group (Tables 4A.3.1-3 and 4A.3.1-4). The types of impacts to vegetation from dust fallout and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative A – FFD Scenario in the Colville River Delta Facility Group, approximately 155 miles of temporary ice roads would be constructed over the life of the project, affecting approximately 752 acres of vegetation. The maximum area in the Colville River Delta Facility Group covered by ice roads in a single year would be 165 acres, with an average of 125 acres per year. As with the CPAI Development Plan Alternative A, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

OFF-ROAD TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under the CPAI Development Plan Alternative A. The surface area affected would be expected to increase because of the increased length of pipeline, roads, and number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding would be the same as those described above under the CPAI Development Plan Alternative A. Indirect impacts from dust and changes to moisture or thermal regimes under Alternative A – FFD Scenario are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-3 and 4A.3.1-4 summarize the potential surface area of disturbance by vegetation class within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with disruption of cross-drainage and interception of sheet flow would be the same as those described previously for CPAI Development Plan Alternative A. These impacts would be greatest in the vicinity of the Colville River Delta because of unstable flow regimes and ocean-induced storm surges. In addition, roads would likely cross many ephemeral streams in the Colville River Delta area, and culverts would need to be installed. Gravel placement could potentially disturb sheet flow in the spring and could affect local moisture regimes. Culverts allow surface water flow, but they tend to ice-up and increase flow in a small area compared to typical sheet flow. Alteration of sediment deposition patterns during flood events may occur due to obstructions from roads and redirection of flood waters through culverts. These changes may result in alteration of vegetation succession and long-term alteration of habitat types.

AIR POLLUTION

No additional processing facilities would be built in the Colville River Delta area under Alternative A. However, the increased number of vehicles and equipment associated with the production pads and roads in FFD would potentially cause more air pollution. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

In addition to the impacts from the CPAI Development Plan Alternative A, a total of approximately 2 acres of vegetation would be lost to VSM installation under the Alternative A FFD scenario, of which approximately 0.4 acre would occur in the Colville River Delta Facility Group. The vegetation and habitat types affected would depend on the exact location of the VSM, which are generally spaced at 55 to 65 foot intervals. The types of impacts to vegetation associated with snow drifting or shading from the aboveground pipelines would be the same as those described above under the CPAI Development Plan Alternative A.

POWER LINES

Under Alternative A – FFD Scenario , power lines would be on pipeline VSMs and would not cause any additional disturbance to vegetation.

FISH-JUDY CREEKS FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under the CPAI Development Plan Alternative A, approximately 711 acres of vegetation would be lost in the Fish-Judy Creeks Facility Group under Alternative A – FFD Scenario for the construction of pads (a processing facility; production pads HP-1, 2, 3, 6, 9, 10, 11, 15, 16, 17, and 19; and storage pads), airstrips (166 acres), and connecting roads (545 acres) (Tables 4A.3.1-3 and 4A.3.1-4). Dominant vegetation classes in the Fish-Judy Creeks Facility Group are *Dryas* Tundra and Wet Sedge Meadow Tundra. The types of disturbances and effects on vegetation associated with gravel fill placement would be the same as those described above under the CPAI Development Plan Alternative A.

DUST FALLOUT FROM ROADS

In the Fish-Judy Creeks Facility Group, indirect impacts from dust, gravel spray, snowdrifts, impoundments, and thermokarst would alter approximately 3,577 acres of vegetation (Tables 4A.3.1-3 and 4A.3.1-4). The types of disturbances and effects on vegetation would be the same as those described above under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, approximately 209 miles of ice roads would be built over the life of the project, affecting about 1,013 acres of vegetation. The maximum area covered by ice roads in a single year would be 170 acres, with an average of 101 acres per year. As with the CPAI Development Plan Alternative A, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

OFF-ROAD TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under the CPAI Development Plan Alternative A. The surface area affected would be expected to increase because of the longer pipeline and roads and the number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding would be the same as those described above under the CPAI Development Plan Alternative A. The construction of more roads and pads would result in increased impacts and alteration of vegetation communities from thermokarst and ponding. These impacts are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-3 and 4A.3.1-4 summarize the potential surface area of disturbance by vegetation type within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with the disruption of cross-drainage and interception of sheet flow would be the same as those described above under the CPAI Development Plan Alternative A, although the construction of more roads and culverts would cause increased impacts to vegetation communities from disturbance of local water flow.

AIR POLLUTION

The construction of an additional processing facility in the Fish-Judy Creek Facility Group would result in a localized increase of air pollution levels. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

In the FFD scenario of Alternative A, VSM placement would cause the loss of approximately 1.1 acres of vegetation in the vicinity of the Fish-Judy Creeks Facility Group.

POWER LINES

Power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

TABLE 4A.3.1-3 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM PADS, AIRSTRIPS, APRONS, AND STORAGE PADS

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)
Riverine Complex	0	(0.0%)	0.0	0.0	30	(0.1%)	0.1	0.2	0	(0.0%)	0.0	0.0
Fresh Grass Marsh	56	(0.3%)	0.4	0.9	278	(0.6%)	1.0	1.7	49	(0.3%)	0.4	0.6
Fresh Sedge Marsh	3	(0.0%)	0.02	0.05	3,343	(7.5%)	12.4	19.9	1,483	(8.8%)	11.7	18.1
Deep Polygon Complex	550	(2.6%)	4.2	8.5	4,833	(10.9%)	18.0	28.8	1,493	(8.9%)	11.8	18.3
Young Basin Wetland Complex	0	(0.0%)	0.0	0.0	2,013	(4.5%)	7.5	12.0	721	(4.3%)	5.7	8.8
Old Basin Wetland Complex	0	(0.0%)	0.0	0.0	1,261	(2.8%)	4.7	7.5	0	(0.0%)	0.0	0.0
Wet Sedge Meadow Tundra	9,494	(44.1%)	72.2	147.2	9,856	(22.1%)	36.7	58.6	6,533	(39.0%)	51.5	79.9
Salt-killed Wet Meadow	1,633	(7.6%)	12.4	25.3	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Sedge Wet Meadow	1,210	(5.6%)	9.2	18.8	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Grass Wet Meadow	32	(0.1%)	0.2	0.5	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Moist Sedge-Shrub Tundra	782	(3.6%)	5.9	12.1	4,318	(9.7%)	16.1	25.7	0	(0.0%)	0.0	0.0
Tussock Tundra	139	(0.6%)	1.1	2.2	14,936	(33.5%)	55.6	88.9	5,452	(32.5%)	43.0	66.7
Dryas Dwarf Shrub Tundra	29	(0.1%)	0.2	0.5	238	(0.5%)	0.9	1.4	0	(0.0%)	0.0	0.0
Cassiope Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	395	(0.9%)	1.5	2.4	284	(1.7%)	2.2	3.5
Halophytic Willow Dwarf Shrub Tundra	8	(0.0%)	0.1	0.1	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Open and Closed Low Willow Shrub	1,929	(9.0%)	14.7	29.9	520	(1.2%)	1.9	3.1	1	(0.0%)	<0.1	<0.1
Open and Closed Tall Willow Shrub	0	(0.0%)	0.0	0.0	172	(0.4%)	0.6	1.0	0	(0.0%)	0.0	0.0
Dune Complex	0	(0.0%)	0.0	0.0	902	(2.0%)	3.4	5.4	185	(1.1%)	1.5	2.3

TABLE 4A.3.1-3 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM PADS, AIRSTRIPS, APRONS, AND STORAGE PADS (CONT'D)

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru FFD Circles		Gravel (Acres)	Dust & Thermal (Acres)
Partially Vegetated	1,183	(5.5%)	9.0	18.4	412	(0.9%)	1.5	2.5	154	(0.9%)	1.2	1.9
Barrens	4,487	(20.8%)	34.1	69.6	1,030	(2.3%)	3.8	6.1	411	(2.5%)	3.2	5.0
Totals	**21,536**	**(100.0%)**	**163.7**	**334.0**	**44,537**	**(100.0%)**	**165.8**	**265.0**	**16,768**	**(100.0%)**	**132.1**	**205.0**

Notes:
Calculation methods are described in text in Section 4A.3.1.2.
Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

Table 4A.3.1-4 Alternative A – FFD Scenario – Summary of Vegetation Impacts from Roads

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)
Riverine Complex	12	(0.5%)	0.3	1.6	65	(0.2%)	1.0	5.9	0	(0.0%)	0.0	0.0
Fresh Grass Marsh	12	(0.5%)	0.3	1.6	1,463	(4.0%)	21.9	133.0	1	(16.2%)	32.8	199.5
Fresh Sedge Marsh	0	(0.0%)	0.0	0.0	363	(1.0%)	5.4	33.0	0	(0.0%)	0.0	0.0
Deep Polygon Complex	11	(0.4%)	0.2	1.4	54	(0.1%)	0.8	4.9	0	(0.0%)	0.0	0.0
Young Basin Wetland Complex	43	(1.7%)	0.9	5.4	3,206	(8.8%)	48.0	291.5	0.47	(6.8%)	13.7	83.3
Old Basin Wetland Complex	73	(2.9%)	1.5	9.3	1,413	(3.9%)	21.2	128.5	0	(0.0%)	0.0	0.0
Wet Sedge Meadow Tundra	935	(37.7%)	19.7	119.4	6,584	(18.1%)	98.6	598.7	1	(12.4%)	25.1	152.5
Salt-killed Wet Meadow	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Sedge Wet Meadow	3	(0.1%)	0.1	0.4	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Halophytic Grass Wet Meadow	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Moist Sedge-Shrub Tundra	348	(14.0%)	7.3	44.4	4,387	(12.0%)	65.7	399.0	0	(0.0%)	0.0	0.0
Tussock Tundra	321	(12.9%)	6.8	41.0	8,766	(24.1%)	131.2	797.1	4	(53.7%)	108.6	659.4
Dryas Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	95	(0.3%)	1.4	8.6	0	(0.0%)	0.0	0.0
Cassiope Dwarf Shrub Tundra	231	(9.3%)	4.9	29.5	8,488	(23.3%)	127.1	771.8	0.45	(6.5%)	13.2	80.0
Halophytic Willow Dwarf Shrub Tundra	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0	0	(0.0%)	0.0	0.0
Open and Closed Low Willow Shrub	277	(11.2%)	5.8	35.4	842	(2.3%)	12.6	76.6	0.14	(2.0%)	4.1	25.2
Open and Closed Tall Willow Shrub	0	(0.0%)	<0.1	<0.1	78	(0.2%)	1.2	7.1	0	(0.0%)	0.0	0.0
Dune Complex	0	(0.0%)	0.0	0.0	232	(0.6%)	3.5	21.1	0	(0.0%)	0.0	0.0

TABLE 4A.3.1-4 ALTERNATIVE A – FFD SCENARIO – SUMMARY OF VEGETATION IMPACTS FROM ROADS (CONT'D)

Vegetation Classes	Colville Delta				Fish-Judy Creek				Kalikpik-Kogru			
			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts			Direct Impacts	Indirect Impacts
	Acres (%) in Colville Delta Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Fish-Judy Creek Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)	Acres (%) in Kalikpik-Kogru Road Buffer		Gravel (Acres)	Dust & Thermal (Acres)
Partially Vegetated	65	(2.6%)	1.4	8.3	131	(0.4%)	2.0	12.0	0	(0.0%)	0.0	0.0
Barrens	151	(6.1%)	3.2	19.2	259	(0.7%)	3.9	23.5	0.16	(2.4%)	4.8	29.2
Totals	**2,482**	**(100.0%)**	**52.2**	**316.9**	**36,426**	**(100.0%)**	**545.3**	**3,312.3**	**6.95**	**(100.0%)**	**202.3**	**1,229.1**

Notes:
Calculation methods are described in text in Section 4A.3.1.2.
Columns may not sum to exact numbers in the total row because of rounding, particularly when vegetation classes have impacts of <0.1.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

GRAVEL PADS, ROADS, AND AIRSTRIPS

In addition to habitat loss described under the CPAI Development Plan Alternative A, approximately 334 acres of vegetation would be lost in the Kalikpik-Kogru Rivers Facility Group for the construction of pads (a processing facility; production pads HP-18, 20, 21, and 22; and storage pads),airstrips (132 acres), and connecting roads (202 acres) (Tables 4A.3.1-3 and 4A.3.1-4). The dominant vegetation classes in this portion of the Plan Area are Tussock Tundra and Sedge/Grass Meadow. The types of disturbances and impacts to vegetation associated with gravel fill placement would be the same as those described above under CPAI's Development Plan Alternative A.

DUST FALLOUT FROM ROADS

The Kalikpik-Kogru Rivers Facility Group could result in indirect impacts from dust, gravel spray, snowdrifts, impoundments, and thermokarst potentially altering approximately 1,434 acres of vegetation (Tables 4A.3.1-3 and 4A.3.1-4). The types of disturbances and effects on vegetation would be the same as those described above under the CPAI Development Plan Alternative A.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

Alternative A – FFD Scenario area would result in approximately 167 miles of ice roads being built during construction and over the life of the project, affecting about 810 acres of vegetation. The maximum area covered by ice roads in a single year would be 252 acres, with an average of 203 acres per year. As with the CPAI Development Plan Alternative A, ice pads would be used as staging areas during pipeline construction, to stockpile overburden material associated with gravel mine sites, for equipment staging areas for bridge installation, and for storage of drill rigs and other equipment at remote production pads. The types of impacts to vegetation associated with ice roads and pads and associated mitigation measures would be the same as those described above under the CPAI Development Plan Alternative A.

The types of impacts to vegetation associated with snow stockpiles would be the same as those described above under CPAI's Development Plan Alternative A, although the construction of more roads, pads, and airstrips under the FFD scenario would result in potential increased impacts to vegetation.

TUNDRA TRAVEL

The types of impacts from off-road tundra travel and associated mitigation measures would be similar to those described under the CPAI Development Plan Alternative A. The surface area affected would be expected to increase because of the increased length of pipeline and roads and the number of remote facilities that may require off-road tundra travel for emergencies, pipeline maintenance and repair, ice road construction, or supply transport.

IMPOUNDMENTS AND THERMOKARST

The types of impacts to vegetation associated with thermokarst and ponding would be the same as those described above under the CPAI Development Plan Alternative A. The construction of more roads and pads would result in increased impacts and alteration of vegetation communities from thermokarst and ponding. These impacts are expected to occur within 164 feet (50 meters) of gravel facilities (Hettinger 1992). Tables 4A.3.1-3 and 4A.3.1-4 summarize the potential surface area of disturbance by vegetation type within this impact area for each facility group.

CROSS-DRAINAGE AND WATER FLOW

The types of impacts to vegetation associated with the disruption of cross-drainage and interception of sheet flow would be the same as those described above under the CPAI Development Alternative A, although the construction of more roads and culverts would cause increased impacts to vegetation communities from disturbance of local water flow.

AIR POLLUTION

The construction of an additional processing facility in the Kalikpik-Kogru Rivers Facility Group would result in a localized increase in air pollution levels. This increase is not expected to generate levels of pollutants that would adversely affect vegetation.

PIPELINES

Under the FFD scenario for Alternative A, VSM placement would cause the loss of approximately 0.6 acre of vegetation in the vicinity of the Kalikpik-Kogru Rivers Facility Group. The types of impacts to vegetation associated with snow drifting or shading from pipeline placement would be the same as those described above under CPAI's Development Plan Alternative A.

POWER LINES

Power lines would be placed on cable trays on pipeline VSMs and would not cause any additional disturbance to vegetation.

4A.3.1.3 Alternative A – Summary of Impacts (CPAI and FFD) on Terrestrial Vegetation and Wetlands

Impacts from the CPAI Development Plan Alternative A to vegetation and habitat types are summarized in Tables 4A.3.1-1 and 4A.3.1-2, respectively. Impacts from Alternative A – FFD Scenario are summarized in Tables 4A.3.1-3 and 4A.3.1-4.

Vegetation maps cover the entire Plan Area, and detailed wildlife habitat maps are available for the entire area affected by CPAI's proposed Alternative A (Figure 4A.3.1-2). Vegetation types and wildlife habitat types are cross-referenced in Table 3.3.1-3. Summary of impacts are presented as percentages of available vegetation type or habitat class within the Colville River Delta or the National Petroleum Reserve-Alaska portions of the Plan Area. Wildlife habitat mapping covers 100 % of the Colville River Delta, 24 % of the National Petroleum Reserve-Alaska portion of the Plan Area, and 37 % of the total Plan Area.

Under CPAI Alternative A, approximately 306 acres of tundra vegetation would be lost by gravel fill and extraction associated with roads, pads, airstrips, and gravel mines; and 2,968 acres would be altered or disturbed by ice roads and pads, dust, and changes to thermal or moisture regimes; combined representing less than one % of the Plan Area (Tables 4A.3.1-1 and 4A.3.1-2).

In the Colville River Delta portion of the Plan Area, the highest surface area impacts are to Wet Sedge Meadow vegetation (211 acres lost or altered; 0.5 % of what is available in the area) and Patterned Wet Meadow habitat (150 acres lost or altered; 0.5 % of what is available in the area). In the National Petroleum Reserve-Alaska portion of the Plan Area, the highest surface area impacts are to Tussock Tundra vegetation (581 acres lost or altered; 0.3 % of what is available in the area) and Moist Tussock Tundra habitat (581 acres lost or altered; 1.2 % of available mapped habitat in the area) (Tables 4A.3.1-1 and 4A.3.1-2).

Under Alternative A – CPAI, key wetland habitats that would be lost or altered in the 146,637 acre Colville River Delta are: riparian shrubland (34 of 7,575 acres); aquatic grass marsh (1.6 of 369 acres); deep open lakes (9.4 of 7,810 acres); basin-complex wetlands (0 of 2 acres); and coastal wetlands (less than 0.1 of 29,022 acres). Key wetland habitats that would be lost or altered in the 175,153 acres mapped in the National Petroleum Reserve-Alaska portion of the ASDP Plan Area are: riparian shrubland (6.0 of 4,741 acres); aquatic grass marsh (0 of 501 acres); deep open lakes (1.2 of 22,374 acres); basin-complex wetlands (62 of 16,297 acres); and coastal wetlands (0 of 36 acres). Thus impacts to all key wetlands, including those that contain *Arctophila* and *Carex aquatilis*, will be minor.

Under Alternative A – FFD, approximately 1,608 acres of tundra vegetation (less than one % of the Plan Area) would be lost by gravel fill and extraction associated with roads, pads, airstrips, and gravel mines; and 8,237 acres (less than one % of the Plan Area) would be altered or disturbed by ice roads, dust, snowdrifts and changes to thermal or moisture regimes (Tables 4A.3.1-3 and 4A.3.1-4). Habitat types were not assessed for FFD because habitat mapping does not cover the entire Plan Area (Figure 3.3.1.3-1) (Jorgenson et al. 2003c).

4A.3.1.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Terrestrial Vegetation and Wetlands

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and Alternative A – FFD Scenario .

GRAVEL PADS, ROADS, AND AIRSTRIPS

- Fill slopes would be stabilized by revetments or soil binders where necessary.
- Impoundments and thermokarst impacts would be mitigated and avoided by locating the road and pad on the highest portions of slopes where possible, and maintaining adequate cross-drainage by using culverts. Culverts would be maintained as needed to prevent ice-up.
- Apply sealing agents, chip seal, and water to dust prone areas.

DUST FALLOUT FROM ROADS

Impacts from dust would be reduced by scheduling construction and associated traffic in the winter when dust from the road would be less, and watering roads during the summer (a standard North Slope practice) to keep dust down and maintain road bed integrity. Chip seal could also be used to minimize impacts to vegetation from road dust.

ICE ROADS, ICE PADS, AND SNOW STOCKPILES

- The most direct ice road route across the least sensitive habitat types would be taken to minimize disturbance.
- Ice road routes would have slight variations yearly to avoid multi-year impacts to the same alignment.
- Shrub areas would be avoided where possible.

OFF-ROAD TUNDRA TRAVEL

- The numbers of vehicle passes in an area would be limited.
- Tight turns would be avoided.

4A.3.1.5 Alternative A – Effectiveness of Protective Measures for Terrestrial Vegetation and Wetlands

Stipulations from the Northeast National Petroleum Reserve-Alaska IAP/EIS will reduce impacts to terrestrial vegetation and wetlands. Stipulation 18 requires ice roads to be offset to reduce vegetative impacts. Stipulation 22 prohibits the clearing of willows in riparian zones. Stipulations 24 f, g, h, i, and l are designed to protect vegetation by requiring low pressure vehicles, limiting bulldozing, limiting the number of trips over the same area, insuring proper snow frost depths, and eliminating tight turns by tracked vehicles. Stipulation 46 protects wetland areas by avoiding the siting of facilities in key wetlands areas. In addition to these stipulations, mitigation developed in this EIS will reduce salinity concerns from gravel fill, and help stabilize fill slopes.

4A.3.2 Fish

The CPAI Development Plan Alternative A (Figure 2.4.1.1-1) involves constructing and operating a network of production pads, roads, pipelines and an airstrip to produce hydrocarbon reserves in the Colville River Delta and Fish Creek drainage. Within the Plan Area, the primary concern for fish is maintaining adequate winter habitat, which is the most crucial habitat to arctic fish (see Section 3.3.2). Other high priorities are maintaining suitable feeding and spawning areas and the ability to access these areas, which are often in different geographic locations (e.g., broad whitefish spawn in river channels whereas drainage and frequent flooding of perched lakes provide overwintering and rearing areas). Key issues on fish habitats and populations include the effects of water withdrawal; alteration of flow patterns; release of contaminants during the life of the project; alteration to water quality, especially during winter; and the impacts of oil spills. Special consideration should be given to certain crucial locations and habitats within the Plan Area (see Section 3.3.2.2).

Impacts of, and measures to prevent, control, and mitigate spills are not addressed in this section, but are discussed in Section 4.3. Further, that section includes an assessment of the project effects on marine fish and habitats. Normal construction and operation impacts for this alternative would not be expected to have measurable impacts on Harrison Bay and nearshore Beaufort Sea environments and biota. Most impacts are to freshwater and migratory species and impacts will be similar on all freshwater and migratory species.

4A.3.2.1 Alternative A – CPAI Development Plan Impacts on Fish

CONSTRUCTION PERIOD

Roads, airstrips, pipelines, and pads would be constructed during winter, and well drilling operations could occur year-round. If construction were to occur in high-density spawning or overwintering areas, or during summer in migratory corridors, it could affect a relatively large number of freshwater and migratory fish. Potential impacts of construction under those conditions would include degradation or loss of overwintering habitat, partially blocked access to and from summer feeding and wintering areas, and siltation in or near these habitats. The scope of such impacts may be quite variable but could result in spawning failure and/or unacceptable levels of fish mortality.

However, pad and road construction is likely to have no measurable adverse effect on arctic fish populations in general because construction is scheduled to occur in winter mostly in low-diversity areas (the Ublutuoch River is an exception) that are sparsely inhabited by large fish and not during times when migratory fish are moving through these habitats. Further, construction has been designed to minimize siltation effects and impacts on fish passage. Pad and road construction may impact some of the smaller resident fish (such as ninespine stickleback), but most fishes are likely to move into other areas during construction. Thus the overall effects are considered insignificant.

WATER WITHDRAWAL

The main potential effect of construction on fish would be from water withdrawal to support construction of drill pads, roads, and airstrips. Water would be needed for building ice roads along the proposed pipeline route, ice pads, and for camp operations. In addition to water withdrawal, CPAI will use frozen lakes for ice chips.

Water removal from lakes could potentially affect fish populations. Water removal is especially critical in late winter. Deep-water lakes provide important habitat for overwintering fish. Construction typically begins in December or January when ice thickness is around 4 feet, with ice growth continuing through the winter construction period. By late in the Arctic winter, fresh water may freeze 6 to 7 feet deep, eliminating all free water in shallow lakes and ponds and greatly reducing the unfrozen areas of deeper lakes. Lakes that are deeper than 4 feet are often suitable for water withdrawals early in the season, and thus lakes 5 to 6 feet can provide substantial volumes of water. Those lakes deep enough to permit under-ice withdrawals throughout the winter are also likely to support overwintering fish (Figure 4A.3.2-1). Bacterial respiration in decomposing lake sediments outstrips the limited oxygen production of algae and other plants. If dissolved oxygen depletion is too severe, fish are not able to survive. Consequently, it is important to protect the habitat that deeper lakes provide.

Excessive winter water withdrawal from lakes with water levels that are barely to moderately sufficient to support overwintering fish may further reduce the oxygen pool and potentially eliminate fish populations. Figure 3.3.2.2-1 shows the distribution of fish in the Plan Area lakes based on their sensitivity to habitat changes likely to be associated with project activities (e.g., water withdrawal).

The ADNR, Division of Mining Land and Water, Water Resources Section is the regulatory entity that approves water withdrawals from any surface and subsurface water bodies such as those that may be utilized by the proposed project: the ADNR, Office of Habitat Management and Permitting also has authority over water withdrawals from water bodies containing fish (Table 1.1.4-1). Table 4A.3.2.1 summarizes the fish presence and water available in lakes that CPAI has permitted for winter withdrawal. Other permitted lakes may also be used as water sources, and CPAI may request permits for additional lakes.

In the CD-3 area, 18 lakes have been identified as potential sources of winter water for ice road construction and other uses (Figure 4A.3.2-1 and Table 4A.3.2-1). Of these, 11 contain fish populations (Table 4A.3.2-1), and water withdrawal would thus be restricted.

In the CD-4 area, a total of six lakes have been identified as potential freshwater sources, with perched lakes L9323 and L9324 planned to be used for that purpose (Figure 4A.3.2-1 and Table 4A.3.2-1). All have low specific conductance (that is, they are freshwater lakes), and all have been confirmed as fish overwintering sites.

According to Figure 4A.3.2-1, two lakes in the vicinity of CD-5 (L9601 and N77097)(Figure 4A.3.2-1) have been permitted for water use. Lake L9601 is less than 2.5 feet deep and would ultimately freeze to the bottom by mid-winter (Table 4A.3.2-1); thus there will be no fish present, and there will be no impacts to fish due to winter water withdrawal. Lake N77097 (Oil Lake) is less than 7 feet deep (approximately 6 feet at deepest [Bill Morris 2004, pers. comm.]), and ninespine stickleback are found there (Table 4A.3.2-1). Lake N77097 probably does not freeze to the bottom during most winters. This is because its surface area is nearly 900 acres, and thus the lake has a fairly high thermal mass, and because bottom substrates produce some heat well into winter, thus inhibiting freezing of bottom water. Should the lake freeze in a particularly severe winter, ninespine stickleback from nearby lakes could recolonize the lake at break-up (Bill Morris 2004, pers. comm.).

Four lakes in the vicinity of the CD-6 production pad have been permitted for water use (Figure 4A.3.2-1 and Table 4A.3.2-1). Of these, Lake MC7917 is by far the largest and is known to support least cisco. A total of 12.4 million gallons of water can safely be removed from this lake, according to current ADNR permit criteria.

Thirteen lakes in the CD-7 area have been permitted for water use (Figure 4A.3.2-1 and Table 4A.3.2-1). Two of these have been reported to contain fish species that are not resistant to low dissolved oxygen concentrations that may result from water withdrawal (Figure 3.3.2.2-1): Arctic grayling (Moulton 2000, 2002) and least cisco (Moulton 2002) were reported from Lake M9910; and Lake M9914 was reported to have contained Arctic grayling (Moulton 2003, unpublished).

The BLM currently authorizes unlimited winter water withdrawals from any lake if it can be demonstrated that no fish inhabit the lake. Water withdrawals from fish-bearing lakes 7 feet or deeper is limited to 15 % of estimated under-ice free-water volume. Water withdrawals of up to 30 percent of under-ice free-water volume would be permitted from lakes with depths between 5 and 7 feet that contain only ninespine stickleback and/or Alaska blackfish. Removal of grounded ice would be permitted from lakes on a site-specific basis with the removed ice aggregate being included in the 15 or 30 percent limit, whichever is appropriate. Unlimited water may be withdrawn from any lake less than 5 feet in depth since it would freeze to the bottom during winter anyway and kill the resident fish.

TABLE 4A.3.2-1 SUMMARY OF FISH PRESENCE AND ESTIMATED AVAILABLE WINTER WATER IN LAKES IN THE CD-3, CD-4, CD-5, CD-6, AND CD-7 AREAS

Lake (see Figure 4A.3.2-1)	GIS Est. Acreage	Max Depth (feet)	Calculated Volume (mil gals)	15% Vol. >7 feet (mil gals)	Specific Conductance (µS/cm)	TDS (mg/L)	Volume Available (mil gals)	Fish Confirmed (codes below)
CD-3 Area								
M9713	14.5	11.0	17.3	0.1	3,302	1,640	17.3	No
M9712	52.5	8.1	46.2	0.0	3,767	2,180	46.2	No
M9313	140.2	25.1	415.1	19	764	370	19	LSCS
M0019	5.4	10.8	6.3	0.0	584	296	6.3	No
L9903	8.3	22.9	20.7	1.0	836	486	1.0	LSCS
L9905	7.4	12.4	10.0	0.1	5,860	3,470	10.0	No
L9904	12.5	25.3	34.4	2.0	622	354	2.0	BDWF, LSCS
L9210	134.7	29.1	452.4	28.2	281	200	28.2	LSCS
L9908	9.5	11.3	11.7	0.1	251	130	11.7	No
L9906	14.7	13.0	20.8	0.3	416	238	0.3	BDWF, LSCS
L9108	112.2	17.1	208.4	6.4	1,867	800	6.4	LSCS
L9907	11.2	10.1	12.3	0.1	1,405	128	12.3	No
M9709	64.6	18.9	132.5	5.0	302	4,254	5.0	LSCS
M9626	20.1	20.3	44.3	1.9	246	144	1.9	LSCS
M9522	19.9	9.0	19.5	0.0	4,290	2,482	19.5	No
L9281	43.8	13.5	64.2	1.1	346	202	1.1	BKFH, LSCS, NSSB
M9321	20.8	11.7	26.4	0.3	146	88	0.3	LSCS, NSSB
L9279	19.1	12.7	26.3	0.4	193	190	0.4	NSSB
CD-4 Area								
L9323	84.1	23.2	199.0	5.4	70	53	5.4	BDWF, BKFH, HBWF, LSCS, NSSB, RDWF, SLSC
L9324	126.1	13.0	231.6	1.2	60	95	1.2	ARCS, BDWF, BKFH, CHUM, DCHAR, GRAY, HBWF, LAMP, LNSK, LSCS, NSSB, RDWF
L9325	32.5	17.3	61.1	1.9	102	--	1.9	ns
M9524	147.2	17.6	352.0	7.7	115	--	7.7	ARCS, FHSC, HBWF, LSCS, NSSB
M9525	103.6	8.2	92.2	0.04	348	--	0.04	ARCS, BDWF, HBWF, LSCS, NSSB, RDWF
M9929	11.5	13.8	17.3	0.3	108	52	0.3	LSCS
CD-5 Area								
L9601	54.9	2.5	14.9	--	--	--		ns
N77097	869.8	6.0	566.9	--	200	--		NSSB
CD-6 Area								
M9912	34.8*	9.6*	61.9*	--	97*	55*	62	No
M9913	20.0	7.9	29.8*	0.02*	86	74*	?	No*
M9924	47.9	3.4	17.7	--	217	194		NSSB
MC7917	312.5	12.9	605.9	12	--	48	12	LSCS
CD-7 Area								
M0022	38.0	6.5	26.8	--	96	84	27	No
M0023	16.4	3.9	6.9	--	192	128	7	No

TABLE 4A.3.2-1 SUMMARY OF FISH PRESENCE AND ESTIMATED AVAILABLE WINTER WATER IN LAKES IN THE CD-3, CD-4, CD-5, CD-6, AND CD-7 AREAS (CONT'D)

Lake (see Figure 4A.3.2-1)	GIS Est. Acreage	Max Depth (feet)	Calculated Volume (mil gals)	15% Vol. >7 feet (mil gals)	Specific Conductance (µS/cm)	TDS (mg/L)	Volume Available (mil gals)	Fish Confirmed (codes below)
CD-7 Area (Cont'd)								
M0024	141.1	8.2	236.9	--	112	70		NSSB
M9903	70.2	22.1	168.5	8.1	87	126	168	No
M9904	25.2	9.3	25.5	0.1	210	61	25	No
M9905	24.6	11.3	30.2	0.2	85	112	30	No
M9910	146.5	9.0	306.4	2.5	127	84	2	GRAY
M9914	151.1	7.8	205.1	--	90	61		BKFH, GRAY, NSSB
M9915	30.6	7.1	33.7	0.01	89	120	34	No
M9922	195.9	6.1	246.9	--	159	140		NSSB
M9923	255.0	6.7	289.6	--	265	136		NSSB
R0070	114.1	3.6	44.6	--	266	--		ns
R0071	90.3	2.7	26.5	--	124	--		ns

Sources: Moulton 1996a, 1996b, 1999a, 2000, 2001, 2002; CPAI 2002; Moulton 2002; CPAI 2002; L.L. Moulton unpublished.
Notes:
Lake volumes for L9210 and M9313 updated with 2000 depth data.
Lake volumes for L9323 and L9324 updated based on contour mapping with 2001 data.
Water chemistry: some lakes have multiple years of measurements; most recent year is included.
-- = not calculated or no measurement taken
ns = not sampled
Fish Species Codes
ARCS = Arctic Cisco
BDWF = Broad Whitefish
BKFH = Alaska Blackfish
CHUM = Chum Salmon
DCHAR = Dolly Varden
FHSC = Fourhorn Sculpin
GRAY = Grayling
HBWF = Humpback Whitefish
LAMP = Arctic lamprey
LNSK = Longnose Sucker
LSCS = Least Cisco
NSSB = Ninespine Stickleback
RDWF = Round Whitefish
SLSC = Slimy Sculpin

The amount of lake water withdrawn for exploration, ice roads, and pads is typically well below the permitted volume (Bill Morris 2004, pers. comm.). Most research has clearly shown that typical withdrawal volumes (less than 5 % of the water below 7 feet of ice, with few exceptions) do not significantly impact the lake (Michael Baker Jr., Inc. 2002e, 2002h). Cases in which more substantial volumes of water have been withdrawn from lakes, rigorous water quality data are not available for comparisons or analyses. CPAI will monitor each water withdrawal to ensure winter water use does not exceed permit limits. Depending on the proposed level of use (e.g., the same lake used year-round, year after year), water quality monitoring (e.g., temperature, dissolved oxygen, specific conductivity, and pH profiles) and lake recharge monitoring could be required by the permit(s). Annual fish monitoring may be required for heavily used lakes. Monitoring for these and potentially other parameters could be prescribed at individual water bodies on a site-specific basis (Bill Morris 2004, pers. comm.). Data from such monitoring and other future studies would be integrated with assessments of impacts to lake habitat to determine if modifications of permit stipulations are necessary (e.g., changes in water withdrawal limitations, additional water quality monitoring, or changes to existing lake observation programs, etc.).

In addition, to minimize impacts on fish, large and deep lakes would be targeted as water sources to allow a margin of safety for maintaining sufficient water volumes. Shallow lakes that do not contain fish also will be used as water sources before they freeze. No impacts to fish are expected if CPAI adheres to the water withdrawal permit conditions. Additionally, screened intake structures specially designed to eliminate the potential for fish being impinged, entrained, or entrapped by water pumps will be used at all fish-bearing water sources. Pursuant to State of Alaska standards, (1) screens must have appropriately sized mesh to ensure that all life stages of fish likely present during pumping cannot swim through the screen and (2) the velocity at any given point along the outer screen must be below the velocity of the weakest fish species and life stage burst swimming speed. Industry requires that each contractor use screened intakes certified by the ADNR (Bill Morris 2004, pers. comm.).

GRAVEL MINING

To provide road and pad material, gravel will be mined at locations to be determined. Mining related activities include gravel mine pits, blasting of frozen gravel (to allow loading and transportation), and gravel stockpiling. Such activities in or near overwintering and spawning habitat are likely to adversely affect fish by reducing the amount and quality of available habitat. Direct and indirect impacts to fish from gravel extraction are most likely to occur within the floodplains of rivers. Detrimental effects could include loss of spawning and overwintering habitat (if not identified before extraction); blocking and rerouting of stream channels; high silt concentrations resulting in reduced primary production, loss of invertebrate prey species; mortality of fish eggs and larvae; and disruption of feeding patterns for sight-dependent feeders (BLM 1989). If the aforementioned activities occur outside overwintering or spawning areas, little or no adverse effects on fish would be expected.

One of the potential beneficial aspects of mining in or near riverbeds and floodplains is that it creates deep-water pools. Extensive studies by the ADF&G have shown that these pools may subsequently be used by fish to overwinter and spawn once the active site is abandoned (Hemming 1988, 1990, 1991, 1993, 1994, 1995; Hemming et al. 1989). Site reclamation may include constructing or enhancing access channels from surrounding streams and rivers, subject to the approval of ADNR fisheries biologists. Such excavation would affect terrestrial biota. To be a viable candidate for fish habitat creation, these and any gravel mine sites that may be used for the project must be sufficiently near a fish-bearing body of water so that digging a connection between the gravel pit and the water body is not prohibitive.

The existing ASRC Mine Site and Clover are sites being considered as gravel sources. There is no evidence to suggest that noise and vibrations from activities at the existing ASRC Mine Site (Figure 4A.3.2-1) affect fish as it is not located close to fish bearing waters. It is also unlikely that the ASRC Mine Site will eventually yield additional fish habitat subject to reclamation. The existing ASRC Mine Site was not designed with post-operational fish habitat creation in mind. Converting the pits into fish habitat was deemed not feasible during the original permitting of the mine site in 1998 (Louise Smith 2003, pers. comm.). There already is an multi-agency/industry-approved rehabilitation plan for the ASRC Mine Site. Should a connection be made to the Colville River, approximately 0.15 mile away, the site would probably become saline at depth (Bill Morris 2003, pers. comm.) because the bottoms of the pits are higher than the mean water level of the Colville. Connecting the pits to the river would create a deep crater that would flood during break-up and end up trapping fish once surrounding water levels subsided (Louise Smith 2003, pers. comm.). Furthermore, a channel cut to the mine site may exacerbate the thermokarsting and erosion that is presently occurring along the east bank of the river (Louise Smith 2003, pers. comm.).

Clover (Figure 4A.3.2-1) would also be located outside overwintering and spawning areas and is not likely to be a threat to fish stocks. The proposed boundary of Clover is too far from both the Ublutuoch River and the small tributary that is heavily used by fish (Bill Morris 2003, pers. comm.) south of Clover to create potential fish habitat. The current rehabilitation plan for Clover (Appendix O) includs an inflow/outflow in the southwest corner of the pit, the area closest to the nearby tributary. The focus of restoration is the creation of waterbird resting, feeding, and nesting habitats (Appendix O).

PIPELINES

The pipeline crossing the Nigliq Channel and the Ublutuouch River will be on the road bridge, and bridges will carry the pipeline across three channels between CD-1 and CD-3; the potential impacts of bridges are discussed below. Other water crossings along the proposed pipeline alignment are not wide enough to require pipeline bridges. Pipelines will span the crossings on VSMs. The construction of pipelines on VSMs at waters supporting fish may displace small numbers of fish short distances as a result of temporary disturbance from equipment working on the ice. However, those fish affected could soon reoccupy that habitat upon completion of the activities and would be otherwise unaffected. Given that construction activities are in the winter and overwintering habitats would be largely avoided, it is expected that pipeline construction under Alternative A would have no measurable effect on arctic fish populations in the Plan Area.

PADS, ROADS, AND AIRSTRIPS

Gravel placed for production pads, roads, and airstrips has the potential to eliminate some fish habitat. Generally, proposed pads and gravel roads have been situated to avoid lakes and drainages in the Plan Area.

Near CD-3, the primary fish habitats that are likely to be affected include a small pond and wetland that would be crossed by the airstrip and potentially Lake M9313, which is immediately north of the pad and airstrip facilities (Figure 4A.3.2-1). The pond and wetland areas are too shallow to be used year-round, but ninespine stickleback may use the area during summer. The area covered by gravel fill would be lost as stickleback habitat.

Construction of an ice road or an airstrip on fish overwintering areas may cause water to freeze to the bottom and form a barrier to water circulation that in turn may reduce dissolved oxygen levels, even if water were not withdrawn. This could have lethal effects on overwintering fish affected by the barrier. To guard against this possibility, regulations require that ice road water crossings be sited where the ice in the watercourse naturally becomes bottom fast (grounded) each winter (i.e., where the flow would naturally be blocked even if the ice bridges were not present). Alternatively, if the crossing were to occur where ice does not ground naturally, the crossing would be permitted only if it would not thicken the ice to the point that it does become bottom fast (Bill Morris 2004, pers. comm.). AS41.14.840 requires fish passage be maintained. General Conditions 5 and 34 outline some of the specific requirements that must be met. Therefore, to mitigate impacts, ice roads and airstrips should avoid known fish overwintering areas if these requirements cannot be met.

Fish movement is minimal in most of the Plan Area during winter because most of the access channels between deep water bodies are frozen to the bottom. Watercourses that may support overwintering fish (such as the Nigliq Channel and Ublutuoch River) will be spanned by bridges. Therefore, winter construction of production pads, roads, and pipelines is not expected to result in any obstructions to fish passage. The Nigliq bridge would, however, have multiple large piles and ice-breaking piers installed in the channel during winter (see further discussion below under "Bridges").

Another impact related to production pads, roads, and airstrip construction is erosion and subsequent in-stream sedimentation. This is addressed in detail in the Pads, Roads, and Airstrips subsection under Operation Period below.

BRIDGES

Shallow lakes and connecting small waterways are used by fish in summer as migration corridors and feeding habitat. Because of this, a combination of culverts and bridges has been incorporated in the road design of this alternative to ensure free passage of fish within area waterways and habitats. These water crossings are integral features to road development. Culverts are addressed in the following subsection. CPAI has proposed to install bridges at seven sites where roads would cross water bodies (Figure 2.4.1.1-1):

- A 1,200-foot bridge across the Nigliq Channel between CD-2 and CD-5;
- An 80-foot bridge across Lake 9305, between CD-2 and CD-5;
- A 40-foot bridge approximately 1.3 miles south of CD-5, between CD-5 and CD-6, across a channel extending north from Oil Lake (N77097, Figure 4A.3.2-1);
- A 120-foot bridge across the Ublutuoch River, between CD-5 and CD-6;
- A 40-foot bridge approximately 0.8 mile west of the Ublutuoch River, between CD-5 and CD-6, across an unnamed beaded stream that flows into Lake L9824 (Figure 4A.3.2-1) and connects to the Ublutuoch River;

- A 40-foot bridge approximately 1.1 miles east of CD-6, between CD-5 and CD-6, across an unnamed beaded stream that flows into Lake MC7917 (Figure 4A.3.2-1) and connects to Fish Creek;
- A 40-foot bridge approximately 1.4 miles east of CD-7, between CD-6 and CD-7, unnamed beaded stream and small pond that flows from a small unsampled lake to Lake M0024 (Figure 4A.3.2-1) .

These bridges would be constructed in winter when most of the water bodies that would be crossed are frozen, and fish would therefore not be present when construction occurs. Furthermore, for all road bridges except the Nigliq Channel and Ublutuoch River crossings, in-channel piers are not required. Because of this, at those locations, no fish habitat losses or alterations are expected from bridge construction at these sites.

The Nigliq Channel and the Ublutuoch River do not completely freeze. Fish winter both upstream and downstream from both bridge crossing sites, and the locations are likely spawning sites for multiple species (Bill Morris 2003, pers.comm.). If impacts were to occur due to winter construction, they could be substantial. However, at the Nigliq Channel and Ublutuoch River, the bridges span only the main channel and the gravel approaches are in the floodplain terrace(s), Fish habitat would be altered and fish movements could be disrupted during flood events when the river rises above the level of the main channel and flows on the floodplain.

Figures 2.3.9.1-8 and 2.4.1.1-14 show that the preliminary design of the Nigliq Channel Bridge would have two instream piers, with icebreaking structures. Borings required for pier installation would be required and would produce cuttings consisting of all soil materials encountered during drilling. The cuttings would be hauled by truck back to the location of gravel sources used for gravel road construction and placed in the waste-material area of the pit. Whereas most of the cuttings from the pier borings would be collected and hauled away by truck, it is likely that some fraction would escape and produce temporary turbidity plumes in at least the bottom to mid-depth water layers. Review of salinity data presented in Moulton (2001) shows a pronounced density gradient separating lighter water above from denser water below. This density gradient can be present in this region of the channel at about the 0.5- to 1-meter water depth from the overlying ice, and it can be strong enough to prevent mixing of dissolved oxygen levels throughout the water column. Turbidity plumes from the drilling of the support piers could suspend oxygen-demanding materials in the bottom and mid-depth water layers, potentially decreasing dissolved oxygen to levels stressful or lethal to fish. These materials would not be swept away because there is expected to be no or only minimal flow in the Nigliq Channel in winter. At the Kuparuk River east bridge during April 2001, suspended solids were still present in the water column from construction in late October 2000 (Bill Morris 2003 pers. comm.). Thus, increased sediment loads will likely remain elevated in the Nigliq Channel throughout the winter until flows return in spring.

Because the Nigliq Channel bridge spans the main channel but not the floodplain; a substantial portion of the floodplain terrace to the west of the channel would be bisected by gravel fill. Because construction will be in winter, the floodplain will be under neither water nor ice, and thus no impacts of gravel placement are expected.

At the Nigliq Channel Bridge, if a region of low dissolved oxygen were to develop at the bottom and mid-water depths due to construction (from drilling of pilings and suspension of sediments), this anomaly could create a physiological barrier and temporarily obstruct winter fish movement through the area. Fish from downstream areas might not be able to move upstream and vice versa; this may result in overcrowding, with potential adverse effects over time as fish use up dissolved oxygen (since water is not flowing). Construction noise may also pose a barrier to fish movement during the winter of construction.

This area of the Nigliq Channel has emerged as a highly important fishing area. Effort has gradually shifted downstream in the Nigliq Channel during 15 years of monitoring (Moulton 2001). In 1993, fishing effort in the middle part of the Nigliq Channel exceeded that in the upper Nigliq area for the first time, and in 2000 about 37 % of the total Nigliq Channel fishing effort was in the middle Nigliq Channel near the proposed bridge site. If dissolved oxygen levels were depleted in this region, a substantial amount of the available winter habitat may be rendered unusable and result in a temporary displacement of the fishery and/or temporary loss of important subsistence fishery resources. Impacts of winter bridge construction would not affect the end of the fall under-ice fishery that runs from late September through late November. One of the fishing hot spots is in the Nanuk area of the Nigliq Channel close to the proposed bridge location. This is the major fishery of the year and targets Arctic cisco, least cisco, humpback whitefish, broad whitefish; species taken incidentally include Bering cisco, Arctic grayling, rainbow smelt, round whitefish, Dolly Varden, burbot, Arctic flounder, and fourhorn sculpin.

CULVERTS

Culvert Batteries

CPAI has proposed to install culvert batteries instead of bridges at five sites where roads would cross water bodies (Figure 2.4.1.1-1):

- Across the narrow portion of Lake 9323 (Figure 4A.3.2-1) just north of CD-4;
- Across a wet sedge meadow adjacent to Oil Lake (N77097 in Figure 4A.3.2-1) and an old basin wetland complex, approximately 1 mile south of CD-5;
- Across an unnamed beaded stream that flows into the Ublutuoch River approximately 1.8 miles west of the Ublutuoch River, between CD-5 and CD-6;
- Across a small tundra drainage area that flows north approximately 3 miles west of the Ublutuoch River, between CD-5 and CD-6;
- Across a small tundra drainage area that flows into Lake M0254 approximately 2 miles southwest of CD-6.

Culvert designs (See Section 2.3.9 and Figures 2.3.9.1-9 through 2.3.9.1-11) and locations will meet the objectives of maintaining water flow/connectivity and ensuring freedom of fish movement. CPAI intends to incorporate into its culvert designs the Culvert Installation Standards in the Alaska Administrative Code (5 AAC 94.260). Proper design would require knowledge of fish species present and the water velocities at flood stage of each watercourse.

The gravel bed supporting the 32-foot-wide road would place fill in the waterbody at each culvert battery crossing (Figure 2.4.1.1-1). At Lake 9323 (Figure 4A.3.2-1) near CD-4, this corridor would be approximately 90 feet wide (the width of the base of the road bed). This filled area constitutes a negligible portion of the total fish habitat available in this lake.

Bottom disturbance during culvert installation, plus sediments associated with the gravel, would increase suspended sediments (see above for discussion of sedimentation impacts) and possibly decrease dissolved oxygen levels. Reduced dissolved oxygen from the combination of water withdrawal and culvert installation could potentially eliminate the fish residing in water bodies during the two winters of construction if they cannot avoid the sediments. Visual interference is not expected to be significant, as these fish are not feeding during winter. Lake 9323 (Figure 4A.3.2-1), which contains fish, would be impacted during two winters by construction of the proposed road to CD-4. These temporary disturbances would be localized and have no measurable effect on fish populations in general within the Planning Area.

Cross-drainage Culverts

CPAI will install cross-drainage culverts (Section 2.3.9) in road beds to maintain natural surface drainage patterns.

OPERATION PERIOD

PIPELINES

The normal operation of the pipelines should have only negligible effects on fish habitat or fish movement corridors. Fish habitat would not be lost or altered by the presence of VSM-mounted pipes. Because most planned maintenance and repair activities would occur in the frozen season to allow ground access to pipelines even where there are no adjacent roads, little impact would be expected. Should urgent repairs be needed when the ground is not frozen, impacts should be negligible where the pipeline is adjacent to the road (that is, to CD-4, CD-5, CD-6, and CD-7). Along the pipeline to CD-3, which would not be adjacent to a road, vehicular access for emergency maintenance would necessitate traveling over unfrozen tundra and three river channels; however, effects on fish would still be expected to be minimal and short term (e.g., minor sedimentation as low-ground-pressure vehicles passed through drainages)

PADS, ROADS, AND AIRSTRIPS

During periods of high water, fish may use low-lying areas that are covered with water. Therefore, even at locations remote from defined watercourses, gravel production pads, roads, and airstrips potentially may alter water flow patterns on a landscape scale and thus impede fish passage to and within water bodies. They can also interfere with migrations to spawning, feeding, and overwintering sites if improperly designed. Waters flowing out into the floodplain could pond against the solid-fill roadways. Excessive ponding might lead fish to move into and area and be stranded once water levels subside. Installation of bridges or culverts in roadbeds in low-lying areas to ensure fish passage during high water conditions could mitigate this concern.

Least cisco have been documented to use Lake M9313 (Figure 4A.3.2-1) near CD-3, and ninespine stickleback likely use the pond and wetland area crossed by the airstrip. The main route of fish migration into and out of Lake M9313 is thought to be through a small channel on the northeast side of the lake. A connection between the lake and the West Ulamnigiaq Channel in this area is established when the river channel complex in this region is over-topped during high water. Because this area is remote from the proposed production pad and road, it is not likely that there would be any impacts on fish movements into or out of the lake and wetland area. Access to the wetland area in question is likely from the north through the same wetland complex connecting Lake M9313 to the river channel.

The proposed road and production pad in the CD-4 area could alter some flow entering or leaving three nearby perched lakes—M9524, L9323, and L9324 (Figure 4A.3.2-1)—and thus affect movements of fish including broad whitefish and least cisco. Thus, any changes in flow patterns that disrupt migration routes, particularly during break-up, could reduce or increase the number of broad whitefish and least cisco entering or leaving the lakes for the duration of the project. Therefore, to prevent impacts to overwintering fish, ice roads and airstrips should be constructed to avoid known overwintering areas.

Additional threats to fish and fish habitat associated with gravel-base structures are erosion and subsequent in-stream sedimentation. Destructive effects from erosion and subsequent instream sedimentation may occur when silt/clay-laden water flows out of roads, pads, and airstrips made out of poor quality (e.g., high clay content) gravel. Maintenance of road surfaces at or near lake crossings could increase the amount of suspended sediments in the lakes, resulting in degradation of water quality and fish habitat. Failure of any portion of a road within a lake and subsequent repairs also would be expected to degrade water quality and fish habitat within the lake. Heavy sediment loads could silt out spawning areas and smother eggs, or interfere with respiration of newly emergent fry (Cairns 1968 cited in DenBeste and McCart 1984a). Heavy sedimentation could also affect invertebrate communities that serve as food sources for fish, and interfere with visual feeding in fishes. Sublethal impacts to fish from sedimentation are a further concern in streams. Effects such as avoidance, reduced feeding (e.g., from visual interference), gill damage (Lake and Hinch 1999), and lessened tolerance to disease can combine to reduce fitness and survival. Habitat fouling would be especially detrimental if it occurred in a critical habitat segment of a river.

Determining if the sediment loads attributable to pad and roadway erosion are sufficient enough to adversely affect invertebrate and fish communities is problematic. DenBeste and McCart (1984a, 1984b) found that the excessive introduction of sediments from pipeline related activities in Atigun Pass did not appear to have any detrimental effect on Atigun River benthic invertebrate communities or local fish communities. With the exception of a seasonal shift in the density in the stonefly *Podmosta*, the invertebrate benthic communities in the North Fork Chandler River were unaffected by heavy sediment loads associated with pipeline activities (DenBeste and McCart 1984a, 1984b). In fact, Chironomid larvae, which are the dominant food item for fish in the North Fork Chandler River, were actually more abundant in turbid waters than correspondingly clear tributaries. Given that high sediment loads characterize many North Slope rivers and streams during breakup and flooding, it is likely that fish and benthic invertebrate communities inhabiting them are somewhat adapted to regular exposure to heavy sedimentation. CPAI would remove snow from the road surface to minimize runoff, road erosion, and tundra silting during the spring melt. It also is important that gravel with low silt and water content be used; roads, pads, and airstrips made of gravel with high silt and water content may simply spread laterally onto the tundra as the water thaws in spring (e.g., the Meltwater road and pad). Silt fencing is not a practical mitigation solution for several reasons: it would block passage of waterfowl, and in particular the young and the flightless would become extremely vulnerable to predators (e.g., foxes); anchoring the bottom of silt curtains to ensure effective sediment filtration and allow them to stand up to wind and water forces would most certainly kill the tundra where they were anchored; and silt curtains at bridges and other drainage crossings in all likelihood would wash out during the flood events or be torn up by bears, foxes, and high winds and ultimately become a litter problem (Steve Schmitz 2004, pers. comm.).

BRIDGES

If bridges do not span the Nigliq Channel and Ublutuoch River floodplains, but rather include in their design gravel bridge approaches across the floodplain terraces, the normal flood-stage hydrology of the two watercourses would be altered.

At the Nigliq Channel, hydrologic constraints have been considered for constructing the floodplain segment of the road (on the west side of the channel). The road has been designed to accommodate a 200-year return flood event, plus 1 foot of freeboard. Other hydrologic factors that are being considered in bridge design include scour protection, ice jams, and storm surges. The considerations should prevent bridge or road failure. However, if the bridge or road in this area did fail, the primary impacts would be related to oil spills. Potential impacts from spills are addressed in Section 4.3. Also, debris resulting from a bridge failure potentially could be an additional flow disruption and could obstruct fish movements in the main channel.

Extending the road's bridge approaches across the floodplain terrace on the west side of the Nigliq Channel would constrict the channel, which would result in increased flows and likely scouring of the bottom during flood events. This could severely alter floodplain vegetation. Scouring might actually have beneficial effects by increasing overwintering habitat locally. This has occurred at spur dikes constructed along the upper reaches of the Sagavanirktok River (Martin et al. 1993).

The constriction of the channel may also increase the likelihood of ice jams, followed by flooding, then by pulse floods down the channel when the ice jams break up. These events would adversely alter fish habitat in the vicinity of the bridge. If ice jams occur, fish could be dispersed over the floodplain as water levels rose and then be stranded when the ice jam broke up. Substantial numbers of fish could be affected because the Nigliq Channel is a major overwintering site.

Features such as bridge piers often attract and hold fish. However, the instream piers at the Nigliq Channel bridge would alter water flow resulting in bottom scour at and around the bridge. If scour is significant enough you could see some concentrations of saltier water within the scour hole and possibly some effects to the upstream migration of the saltwater front. This could alter the arctic cisco distribution in the channel during the early winter fishery that occurs below the ice. Furthermore, the persistence and extent of saltwater intrusion could change during the summer months when freshwater fish are harvested from the channel. There is potential to decrease the freshwater habitat by allowing more saline water intrusion, which would result if the stream-bed were lowered. (Saltwater intrusions in coastal rivers tend to move upstream to where the riverbed becomes higher than sea level.) Freshwater fish would be displaced to other habitats within the river if this were to occur. If enough material is scoured from the bridge location and deposited downstream (thus raising the bed of the river below the bridge) alterations to upstream movement of saline water and fish could occur. This is a common occurrence at undersized crossing structures. During some flow conditions, some rivers lose surface water flow as water flows below the material deposited downstream from scour. The proposed bridge design makes it likely that flow restriction and potentially some of the above-described impacts will occur during some floods. Modifying the Nigliq bridge design to be least restrictive to flow during high water events would result in little expected impact (Bill Morris 2004, pers. comm.).

Impacts to the floodplain at the Ublutuoch River crossing, where there are terraces on either side of the main channel would be similar to those at the Nigliq Channel bridge. Building the Nigliq Channel and Ublutuoch

River bridges so that they span the floodplain terrace(s) in addition to the main channel would mitigate these impacts. If flow alterations at bridges were to cause significant erosion, the resulting sedimentation may affect fish passage; also, salinity regimes at the Nigliq Channel may be altered, as described above. Bridges appear to produce far less bank and stream erosion than do culverts; and when bridges are sufficiently large, bank erosion should be very minimal (Bill Morris 2004, pers. comm.). See the following subsection (Culverts) for additional discussion on effects of sedimentation. Disruptions at the Nigliq Channel during the summer would affect the broad whitefish fishery, which operates in various sections of the Nigliq Channel (other species taken incidentally during summer are Dolly Varden, humpback whitefish, pink salmon, and chum salmon). Summer impacts also could affect the fall fishery, as described above in the Construction subsection.

Should bridge approaches wash out, effects of sedimentation would be similar to those described above for pads, roads, and airstrips.

CULVERTS

Current concerns related to pad and road placement include diverting or eliminating flow from small tributaries that connect lakes or that connect lakes and rivers. Potential loss of migratory capacity could stress or kill fish if the fish were unable to migrate to food-rich habitat in the summer, reach spawning areas, or move into overwintering habitat. Proper placement of culverts is critical in minimizing impacts to fish.

CPAI will design the culverts proposed for this project to maintain adequate water flow and fish passage. Obstructions to fish movement are most common when culverts or low water crossings are not properly sized to allow for the passage of fish during critical migration periods (Elliott 1982). Culverts also should be designed to avoid clogging which would cause impounding upstream of the structure. In addition, culverts on the North Slope have frequently caused downstream channel morphology changes. This has the potential to eliminate considerable habitat downstream of the culverts.

Given the 30-year history of culvert construction on the North Slope, design features should adequately address the above concerns. However, long-term problems will likely arise at culvert crossings of the relatively deep (very low width/depth ratio), highly sinuous, slightly entrenched streams typical of the National Petroleum Reserve-Alaska and the North Slope in general. The high discharges of many of these streams are too great for culverts to accommodate, given the fill required for culvert pipes at many of the streams in the National Petroleum Reserve-Alaska (Bill Morris 2004, pers. comm.). This only will be a fish issue if culverts are used in streams with significant fish use. The ADNR permitting process will work to avoid this.

Should culverts fail to be properly maintained or meet their intended goals, access by fish to critical summer rearing grounds could be restricted or lost. If culverts were to cause significant erosion, fish passage may be compromised. Increased sedimentation would likely impact the Ublutuoch River more than any of other streams or rivers crossed by the proposed facilities and roads in Alternative A. The river below and around the Ublutuoch crossing is deep and slow moving, and it has a gravel substrate. Increased sedimentation from erosion of the bed and banks could cover the gravel substrate to some extent, thereby reducing the productivity of the river to rearing fish and reduce the amount of gravel available for spawning. It is likely that deposited material would be persistent on the streambed (Bill Morris 2004, pers. comm.).

HUMAN ACCESS

The project could create a limited number of new jobs, which may attract new residents from Barrow or other North Slope villages to reside permanently in Nuiqsut and use local fishery resources. The expected small magnitude of the potential increase in subsistence users that would be attributable to the development makes it unlikely that there would be adverse effects on the subsistence fishery. Furthermore, the project would not increase fishing competition between residents and local non-residents because CPAI has agreed to apply a no-fishing/hunting policy to non-resident workers.

Construction of roads during winter could encourage local fisherman to fish the Ublutuoch River fish overwintering area as well as Fish and Judy creeks. This could result in a more than negligible increase of fishing pressure on overwintering fishes.

Theoretically, the new roads (gravel and ice) could provide easier access from the Colville River Delta to the area of new development. However, there is no road access from Nuiqsut to the new roads. There is potential for increased access to the lower Ublutuoch River during winter when fish are concentrated in the lower river for wintering and spawning (Morris 2003, pers. comm.). However, the no-fishing or hunting policy for non-resident workers would prevent others from using fish resources along or near the new roads. Therefore, we do not expect that the new roads would result in increased human access and harvest of fish. Conversely, because local subsistence users tend to avoid areas near industrial activity, there may be some decreased use of some traditionally used areas because of the proximity to oilfield facilities. Even should local residents take advantage of the new roads, the extent to which subsistence harvests and thus pressures on certain species, especially whitefish in the subsistence fishery may increase is uncertain. Fishing effort and yield can fluctuate in conjunction with natural perturbations in the abundance of target species. For example, the size of the Arctic cisco population that overwinters in the Colville Delta may vary drastically over the course of several years based solely on meteorological conditions that occurred 5 to 7 years earlier. Strong stocks and good yields may prompt fisherman to expend more fishing effort, whereas weak stocks and low yields may discourage fishing. As with many fisheries, assessing the effect of varying fishing pressure and exploitation rates that are exerted on the resources is less a matter of prediction than it is a matter of constant monitoring. Fisheries within the Plan Area would be no different. Presumably, the Colville River Delta fisheries are presently managed on a sustained yield principal. The BLM manages subsistence, commercial, and sports fish harvests on BLM lands, the State manages commercial and sports fisheries on state lands, and the USFWS manages subsistence fisheries. Continued monitoring should provide the mechanisms for preventing overfishing regardless of cause.

ABANDONMENT AND REHABILITATION

Water withdrawal and removal of bridges, culverts, and bridge approaches could have impacts on fish similar to those described for construction activities. Additional fish habitat may be created by allowing gravel pits to be colonized by fish from nearby streams or if they are within the floodplain of nearby streams.

4A.3.2.2 Alternative A – Full-Field Development Scenario Impacts on Fish

Types of impacts of future development in the Plan Area generally will be similar to those described above for the five-pad CPAI proposal (Section 4A.3.2.1). However, development on the scale postulated will, depending on precise siting, destroy or alter fish habitat substantially more than CPAI's proposed plan. Overwintering, rearing, migration, and spawning habitats would be affected.

The road and pipeline network could subtly alter flows of waterways on a landscape scale that could lead to unexpected shifts in drainage and loss of fish resources. Impacts to fish passage would be minimized by installation of culverts or bridges as determined during future permitting efforts. However, culvert failure (Section 4A.3.2) could cause widespread habitat alteration and obstruction of fish movement.

The extent of road development under this scenario, including a possible road to or near Nuiqsut, suggests that there would be increased potential for human access to fish resources throughout the Plan Area, thus creating greater pressure on fish populations. Conversely, some traditional users of the area may choose other locations to avoid industrial activity altogether.

State-of-the-science construction and operation approaches would be used to minimize impacts, and human access to resources could be controlled as described in Section 4A.3.2. Withdrawal of fresh water necessary to support this scale of infrastructure development, plus well drilling, should not affect fish if withdrawals are done in compliance with permit restrictions. The effects of this FFD scenario are expected to be similar to effects from similar current developments.

The following subsections summarize concerns specific to facility groups.

COLVILLE RIVER DELTA FACILITY GROUP

In the Colville River Delta, seven new production pads are hypothesized. Of particular note are production pads HP-12 and HP-14, on the eastern side of the outer Delta, which are in the vicinity of the commercial (Helmericks) fishery as well as subsistence fisheries. Spills, addressed in Section 4.3, would be a major concern of these two hypothetical facilities.

No roads are hypothesized in this part of the Plan Area. Pipelines would be constructed over several major watercourses including the Elaktoveach Channel, Kupigruak Channel, Tamayayak Channel, and the main stem of the Colville River. Instream construction activities at these water bodies would have the potential to cause impacts as described in Section 4A.3.2.

FISH-JUDY CREEKS FACILITY GROUP

Eleven new pads plus one new processing facility in the Fish Creek watershed (including Judy Creek and the Ublutuoch River) are hypothesized.

Several facilities would be situated in sensitive areas designated by the BLM and the MMS (1998a): hypothetical production pads HP-4, HP-16, HP-17 and processing facility HPF-1 in the Fish and Judy creeks drainages and HP-11 near the Colville River. Fish habitats in these drainages are important for spawning, migration, rearing, and overwintering for anadromous and resident species. This may affect subsistence fishing, because local subsistence users do not like to fish near development, especially industrial development. Thus, they do not want oil company structures near where they fish.

The road network of this hypothetical development is extensive. If roads are not routed along high ground to the extent possible, relatively large areas of fish habitat may be affected during road construction. The roads from CD-7 to HP-18 and from CD-6 to HP-15 are perpendicular to the primary drainage flow and thus may function as dams on a landscape scale, disrupting natural hydrology and obstructing fish movement over a wide area. Bridges or culverts installed in low-lying areas might mitigate this effect.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Four new pads and one new processing facility in the Kalikpik-Kogru rivers drainages are hypothesized.

As with the Fish-Judy Creeks Facility Group, the road network of this hypothetical development is extensive. Therefore, relatively large areas of fish habitat could be affected during road construction if roads are not routed along high ground to the extent possible. The road from HP-18 to HPF-2 is perpendicular to the primary drainage flow and thus may function as a dam on a landscape scale, disrupting natural hydrology and obstructing fish movement over a wide area. Bridges or culverts installed in low-lying areas might mitigate this effect.

4A.3.2.3 Alternative A – Summary of Impacts (CPAI and FFD) on Fish

Within the Plan Area, the primary impacts of concern are those that affect winter habitat, as well as those affecting feeding and spawning areas and access to these areas. Water withdrawal for winter construction could create overcrowding and reduce the available pool of dissolved oxygen in a water body, possibly resulting in fish mortality. Permit limits on amounts of water withdrawn are set to avoid such impacts.

Gravel mining could have adverse effects on fish if located within the floodplains of rivers near natural overwintering and spawning areas. Proper siting to avoid these habitats could easily minimize this problem. Sedimentation from erosion could affect fish and other aquatic organisms by interfering with respiration and vision or by smothering benthic habitat (Cairns 1968 cited in DenBeste and McCart 1984a). These impacts would tend to be localized downstream of the site. Again, proper siting away from major river channels would further localize adverse effects to fish. In general, limited mining would not have a measurable affect on fish population within the Planning Area. Mining in main migratory channels should be avoided. There also is potential for future gravel mines within floodplains to result in new deep lakes that provide valuable fish habitat, however implementation of such a strategy may be problematic.

As designed, the bridge approaches at the Nigliq Channel, other major Colville River channels, and the Ublutuoch River extend into the floodplain terrace(s), and thus would alter river flow during flood stages. Funneling would occur but only in years of unusually high flooding. In such cases, increased flow rates could affect fish movement. The effect on fish movements and migrations would be temporary and intermittent and not likely to have a long-term impact. Scouring caused by flow effects around bridge piers may cause sedimentation and alteration of salinity regimes, in turn displacing fish to other habitats. Low dissolved oxygen may also result from suspension of oxygen-demanding materials during construction of the Nigliq Channel bridge.

If culverts (proposed in five locations; see Figure 2.4.1.1-1) are improperly sized, water may be impounded during periods of high flow upstream of the passage thereby increasing flow velocity within and downstream of the structure. Fish migrations could be affected. Improperly engineered culverts can also impair fish movement during periods of low water flow (Elliott 1982). Culverts should therefore be designed and constructed to be large enough to avoid the restriction of fish passage or adversely affect natural stream flow. Stream morphology changes may occur downstream of culverts as a result of altered flow.

The long network of roads may result in alteration of regional surface hydrology, including interruption of fish movements. Construction of ice roads or airstrips on fish overwintering areas may cause freezing to the bottom and block fish movement if state requirements to maintain fish passage are not met. The new road system–both ice roads in the winter and gravel roads in the summer–may facilitate increased human access to fishing areas, potentially increasing subsistence fishing pressures.

Release of contaminants over the project duration and the impacts of oil spills are important concerns to fish resources; these issues are addressed in Section 4.3.

The potential impacts described above, should they occur, are likely to be localized and temporary and thus would have negligible effects on fish populations within and adjacent to the Plan Area. Given the total amount of construction proposed, the collective effects of development and production will have some effect on fish and fish habitats in the region. Whether those effects are measurable and distinguishable from naturally occurring population perturbations is unknown. Minor shifts in habitat or population integrity, especially if they are of a temporary nature, could reasonably be absorbed by the ecosystem. Furthermore, careful planning, appropriate engineering specification and design, and rigorous safety measures should minimize impacts and ensure the reproductive sustainability of stocks overall. Localized impacts could pose a more serious threat to localized (e.g., within a single drainage) stocks if they were to occur in or near prime spawning, nursery, or overwintering sites. For example, large number of broad whitefish winter in the lower Ublutuoch River, upstream and downstream from the proposed bridge; substantial impacts to that area during winter could cause a loss of the majority of Fish Creek drainage broad whitefish, as many of the spawners and most age classes would be represented at the same place and the same time (Bill Morris, pers. comm.). Continued monitoring of fisheries resources is vital to the long-term stability of the region. Monitoring and mitigation plans should be finalized and ready to address any signs that development may be having a truly detrimental effect on local fish populations.

ESSENTIAL FISH HABITAT

The primary EFH concerns in Alternative A include potential effects on salmon associated with water withdrawal, alteration of flow patterns (e.g., by bridge approaches in floodplains), release of contaminants, project-induced erosion, and oil spills. The only fresh water bodies identified as EFH (chum and pink salmon only) within the Plan Area are Judy Creek, Fish Creek, the Ublutuoch River, and the Colville River. Estuarine and marine waters bordering the Plan Area are EFH for all five species of salmon.

Potential impacts of oil spills are addressed in Section 4.3. Effects of water withdrawal have been mitigated by restricting the withdrawals to permitted levels established to afford protection to resident fish. Further, monitoring of these withdrawals is planned to ensure that permitted levels are not exceeded.

Bridges would be used at the major stream and lake crossings as described in Section 2.3.9, and culverts would be installed in other areas.

Assuming that culverts are properly designed and sized, these actions should ensure accessibility among area habitats. While contaminants likely would be released in conjunction with normal operations, a strong commitment to spill and emissions control and rigorous spill response protocols should prevent EFH water bodies from being adversely affected. Salmon would not be expected to be present in the Nigliq Channel in winter; therefore, construction of the Nigliq Channel bridge would not be expected to affect EFH. Winter construction of the bridge across the Ublutuoch River could impact chum or pink salmon if they use the immediate area for overwintering or spawning.

Project-induced erosion would be minimized by construction methods and design. Project facilities such as pads and roads would be situated on high ground to the extent possible and designed to minimize potential erosion (armoring, wing-walls at bridge abutments, etc. (see Section 2). However, roads, culvert failure, and bridge approaches within river terraces could alter hydrology.

Because most activities and development will occur within the Plan Area, estuarine and marine EFH areas are not likely to be affected.

4A.3.2.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Fish

- At project completion, gravel mines should be converted to fish habitat if practicable and consistent with an approved mine rehabilitation plan and the design of the mine.
- The Nigliq Channel and Ublutuoch River bridges should be constructed so that they span the floodplain terrace(s) in addition to the main channel.
- Ice roads and airstrips should avoid fish overwintering areas where possible, and in all cases maintain fish passage.
- CPAI should perform fish surveys and hydrologic modeling for water bodies at proposed culvert sites. The results of these surveys and modeling should be incorporated into the site-specific designs of culverts.
- CPAI should install bridges or culverts in roadbeds in low-lying areas to ensure fish passage during high water conditions.
- CPAI should continue fish monitoring studies in the Plan Area to ensure that the health of regional and locally important fish stocks is maintained. CPAI's mitigation plan should include remedial measures to be taken should monitoring detect adverse impacts due to the project.
- Instead of installing a culvert battery in Lake L9323, CPAI should avoid the lake and instead use a road alignment to the east (similar to Alternate Access Road 2S that CPAI previously evaluated [CPAI 2002a] in early planning stages of this project); bridges should be used to cross two watercourses east of Lake L9323.
- CPAI should monitor all culverts on a schedule to be approved by the ADF&G to ensure that they are properly maintained and are ensuring access by fish to critical summer spawning and rearing grounds. CPAI will promptly repair any culverts that are not meeting these intended fish passage goals.
- Intake structures specially designed to eliminate the potential for fish being impinged, entrained, or entrapped during withdrawal of water should be used at all fish-bearing water sources.
- CPAI should route roads and pipelines to avoid the 3-mile Fish Creek buffer to the extent practicable.

4A.3.2.5 Alternative A –Effectiveness of Protective Measures for Fish

Stipulations 15, 16, and 20 from the Northeast National Petroleum Reserve-Alaska IAP/EIS are the most likely to have a beneficial effect on arctic fish. Others that may benefit arctic fish include Stipulations 5, 9, 11, 12, and 41. With these stipulations in place, there is an increased probability that (1) spawning and overwintering fish would be unaffected by activities associated with Alternative A, (2) fish passage and streamflows would be maintained, and (3) the effects of accidental fuel spills would be minimized. These stipulations may benefit arctic fish populations. In addition to these stipulations, potential mitigation identified in this EIS could create new fish habitat at gravel mine sites, reduce scouring and erosion concerns at certain bridge crossings, and help reduce siltation of rivers and streams.

4A.3.3 Birds

Impacts to birds associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The operation period includes continued drilling and day-to-day operations and maintenance once production has begun. Site specific nest densities for bird species and species groups (Table 3.3.3-5 and Table 3.3.3-7) were used to estimate the number of nests exposed to each alternative. Gravel footprint acreage and habitat alteration acreage (see Tables 4A.3.1-1, 4A.3.1-2, 4A.3.1-3, 4A.3.1-4, 4B.3.1-1, 4B.3.1-2, 4B.3.1-3, 4B.3.1-4, 4C-1.3.1-1, 4C-1.3.1-2, 4C-1.3.1-3, 4C-1.3.1-4, 4C-2.3.1-1, 4C-2.3.1-2, 4D.3.1-1, 4D.3.1-2, 4D.3.1-3, 4D.3.1-4, 4F.3.1-1, 4F.3.1-2) were multiplied by nest densities (Table 3.3.3-5 and Table 3.3.3-7) to estimate the total number of bird nests affected by habitat loss or alteration. In addition waterfowl, loon, ptarmigan and seabird nests lost due to disturbance by air traffic were estimated using a maximum of a 67 % reduction in nests within a 500-meter buffer around each airstrip or helipad. This %age was derived from review of Figures 15 to 17 for greater white-fronted geese in Johnson et al. (2003a). No disturbance affect from the Alpine airstrip was demonstrated for shorebirds or passerines (Johnson et al. 2003a), so no impacts were calculated for these groups. No additional loss due to disturbance from vehicle traffic was calculated because losses within 50 meters of roads were considered sufficient to account for disturbance as well as habitat alteration impacts. Habitat loss due to ice roads was estimated using the average number of acres per year covered by ice roads during construction and operations (Tables 2.4.1-2, 2.4.1-9, 2.4.2-2, 2.4.2-8, 2.4.3-4, 2.4.3-10, 2.4.4-2, 2.4.4-6, and 2.4.4-10). Results of these analyses are presented in Tables 4A.3.3-2, 4A.3.3-4, 4A.3.3-5, 4B.3.3-1, 4B.3.3-3, 4B.3.3-4, 4C-1.3.3-1, 4C-1.3.3-3, 4C-1.3.3-4, 4C-2.3.3-1, 4C-2.3.3-2, 4D.3.3-1, 4D.3.3-2, 4D.3.3-4, 4D.3.3-5, 4D.3.3-6, 4F.3.3-1, 4F.3.3-3. Preferred nesting habitats (Table 3.3.3-6 and Table 3.3.3-8) were also considered in evaluating impacts for bird species or species groups. Oil spills also may directly or indirectly affect birds in the Plan Area. Impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

Before we describe the individual alternatives, there are general patterns of effects that the proposed actions would have on birds and their habitats; these are described under Alternative A for each species or species group and are summarized in Table 4A.3.3-1. In most cases, effects would be localized and no adverse effects to North Slope populations would be expected. Habitat loss does not involve the direct loss of active nests because winter gravel placement, ice road construction, snow dumping, and snowdrifting take place when nests are not active. In some cases, nesting sites covered by gravel may have been reused in subsequent years; when this occurs, birds would be displaced to adjacent suitable habitats if available (Troy and Carpenter 1990, Johnson et al. 2003a).

4A.3.3.1 Alternative A – CPAI Development Plan Impacts on Birds

Table 4A.3.3-2 presents the estimated number of nests displaced by habitat loss, alteration and disturbance for CPAI Development Plan Alternative A by bird species and species group.

WATERFOWL AND LOONS

Studies conducted in the CD-3 area found that white-fronted geese, tundra swans, long-tailed ducks, and red-throated loons nested in the area of the proposed production pads and airstrip (Johnson et al. 2003b). White-fronted geese, tundra swans, northern pintails, Pacific loons, and yellow-billed loons nested in the CD-4 area (Burgess et al. 2003a). Studies conducted in the National Petroleum Reserve-Alaska found that white-fronted geese, northern pintails, and long-tailed ducks nested in the CD-5, CD-6, and CD-7 areas (Burgess et al. 2003b). Yellow-billed loons in the National Petroleum Reserve-Alaska portion of the Plan Area are concentrated in the

Fish Creek drainage and are generally not associated with the CD-5 and CD-6 sites (Burgess et al. 2003b). A yellow-billed loon nest was located in a lake northeast of the CD-7 site (Burgess et al. 2003b; ABR, unpublished data). White-fronted geese, king eiders, long-tailed ducks, northern pintails, and Pacific loons nested along the proposed road routes to the CD-5, CD-6, and CD-7 sites (Burgess et al. 2002b, 2003b). No waterfowl or loon nests were reported at the Clover Potential Gravel Source (Burgess et al. 2003b).

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter mining and placement of gravel during construction would account for most of the direct habitat loss for Alternative A. Approximately 306 acres would be mined or covered by gravel and lost as potential nesting, brood-rearing, and foraging habitat for waterfowl and loons during the construction of the project. Habitat losses from gravel fill would be long-term. An estimated 9.5 waterfowl nests and 1.2 loon nests would be directly affected by gravel placement (Table 4A.3.3-2). Habitats important to waterfowl and loons that would be covered by gravel are presented in Table 4A.3.3-3. Clover would add aquatic habitat after reclamation that may be suitable for use by waterfowl and loons (Appendix O).

Tundra adjacent to gravel fill would also be affected by snowdrifts, gravel spray, dust fallout, thermokarst, and ponding (Walker et al. 1987b, Walker and Everett 1987, Walker 1996, Auerbach et al. 1997). Snowdrifts or plowed snow that accumulates on tundra adjacent to roads, well pads, and airstrips would cause a temporary loss of waterfowl foraging habitat and would preclude waterfowl nesting if snow persists beyond normal nest initiation dates. Dust deposition and associated early snowmelt can cause early green-up on tundra adjacent to roads, providing foraging habitat available for early-arriving waterfowl (Murphy and Anderson 1993, TERA 1993, Noel et al. 1996). This snow-free band of tundra may be approximately 30 to 100 meters in width with changes in vegetation type within 35 feet and alteration in moisture and thermal regimes out to 164 feet (Hettinger 1992, Auerbach et al. 1997, Klinger et al. 1983,Walker and Everett 1987).

TABLE 4A.3.3-1 SUMMARY OF POTENTIAL EFFECTS OF THE PROPOSED DEVELOPMENT ON BIRD GROUPS

	Waterfowl	Loons	Ptarmigan	Raptors and Owls	Shorebirds	Seabirds	Passerines
Habitat Loss, Alteration or Enhancement							
Loss from gravel placement	N, BR, F, St	N, BR, F, St	N, BR, F, W	N, BR, F	N, BR, F, St	N, BR, F, St	N, BR, F
Loss or gain from dust fallout	Loss- N Gain - F		Loss- N Gain - N, F	Loss- N Gain - F	Loss- N Gain - F	Loss- N Gain - F	Loss- N Gain - F
Temporary loss from ice roads	N, F	N, F	N, F	N, F	N, F	N	N, F
Change from structures	Loss - predator gain	Loss - predator gain	Loss - predator gain	Gain - Perches	Loss - predator gain	Both loss and gain	Both loss and gain
Alteration by garbage resources	Loss - predator gain	Loss - predator gain	Loss - predator gain	Loss - predator gain	Loss - predator gain	Loss – N Gain - F	Both loss and gain
Disturbance and Displacement							
Air traffic	Loss - N, BR, F, St	Loss - N, BR, F, St		Loss - N, BR, F, St		Loss - N, BR, F, St	
Vehicle traffic	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, W		Loss - N, BR, F	Loss - N, BR, F, St	Loss - N, BR, F
Intentional hazing	Loss - N, BR, F, St	Loss - N, BR, F, St				Loss - N, BR, F, St	
Facility noise	Loss - N, BR, F, St	Loss - N, BR, F, St				Loss - N, BR, F, St	
People on pads and tundra	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, W	Loss - N, BR, F	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, St
Obstruction of Movements							
Roadways	Loss - BR, M	Loss - BR	Loss - BR		Loss - BR	Loss - BR	
Mortality							
Collisions	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, W	Loss - N, BR, F	Loss - N, BR, F, St	Loss - N, BR, F, St	Loss - N, BR, F, St
Depredation	Loss - N, BR, M	Loss - N, BR	Loss - N, BR, F, W	Loss - N, BR	Loss - N, BR	Loss - N, BR	Loss - N, BR

Notes:
BR = brood-rearing
F = foraging
M = Molting
N = nesting
St = Staging
W = Winter

TABLE 4A.3.3-2 CPAI ALTERNATIVE A – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Species	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
Waterfowl											
Greater white-fronted goose	2.1	5.8	0.8	15.9	24.7	4.2	20.0	3.6	0.0	27.8	52.5
Snow goose	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Canada goose	0.0	0.1	0.0	0.1	0.2	0.9	4.8	0.9	0.0	6.6	6.8
Brant	0.2	0.5	0.0	2.0	2.7	0.4	2.1	0.4	0.0	2.9	5.6
Tundra swan	0.1	0.4	0.1	0.4	1.0	0.0	0.0	0.0	0.0	0.0	1.0
Mallard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern shoveler	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Northern pintail	0.2	0.6	0.1	0.3	1.2	0.3	0.4	0.1	0.0	0.8	2.0
Green-winged teal	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1	0.2
Greater scaup	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Lesser scaup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King eider	0.0	0.0	0.0	0.1	0.1	0.4	2.4	0.4	0.0	3.2	3.3
Long-tailed duck	0.2	0.7	0.1	2.0	3.0	0.4	1.4	0.2	0.0	2.0	5.0
Waterfowl Total[b]	**2.8**	**8.5**	**1.2**	**21.0**	**33.5**	**6.7**	**31.2**	**5.6**	**0.0**	**43.5**	**77.0**
Loons											
Red-throated loon	0.1	0.3	0.0	0.8	1.2	0.1	0.3	0.1	0.0	0.5	1.7
Pacific loon	0.2	0.7	0.1	1.3	2.3	0.6	3.1	0.6	0.0	4.3	6.6
Yellow-billed loon	0.1	0.2	0.0	0.4	0.7	0.1	0.3	0.1	0.0	0.5	1.2
Loon Total[b]	**0.4**	**1.2**	**0.2**	**2.5**	**4.3**	**0.8**	**3.8**	**0.8**	**0.0**	**5.4**	**9.7**
Ptarmigan											
Willow ptarmigan	0.3	0.8	0.2	0.4	1.7	0.5	1.4	0.2	0.0	2.1	3.8
Rock ptarmigan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ptarmigan Total[b]	**0.3**	**0.8**	**0.2**	**0.4**	**1.7**	**0.5**	**1.4**	**0.2**	**0.0**	**2.1**	**3.8**
Seabirds											
Parasitic jaeger	0.0	0.1	0.0	0.1	0.2	0.1	0.7	0.1	0.0	0.9	1.1
Long-tailed jaeger	0.0	0.1	0.0	0.0	0.1	0.1	0.3	0.1	0.0	0.5	0.6
Glaucous gull	0.1	0.2	0.0	0.6	0.9	0.4	2.4	0.4	0.0	3.2	4.1
Sabine's gull	0.0	0.1	0.0	0.6	0.7	0.2	0.7	0.1	0.0	1.0	1.7
Arctic tern	0.2	0.6	0.1	1.1	2.0	0.4	2.4	0.4	0.0	3.2	5.2
Seabird Total[b]	**0.3**	**1.1**	**0.2**	**2.4**	**4.0**	**1.1**	**6.5**	**1.2**	**0.0**	**8.8**	**12.8**
Shorebirds											
Black-bellied plover	0.5	2.0	0.4	0.0	2.9	0.9	6.7	1.2	0.0	8.8	11.7
American golden-plover	0.6	2.5	0.5	0.0	3.6	0.9	4.4	0.8	0.0	6.1	9.7
Bar-tailed godwiit	0.1	0.5	0.1	0.0	0.7	0.4	1.7	0.3	0.0	2.4	3.1
Semipalmated sandpiper	5.3	23.2	4.5	0.0	33.0	5.8	38.4	7.1	0.0	51.3	84.3
Baird's sandpiper	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.4	0.4
Pectoral sandpiper	10.0	43.9	8.5	0.0	62.4	10.3	37.3	6.6	0.0	54.2	116.6
Dunlin	0.4	1.5	0.3	0.0	2.2	1.0	5.4	1.0	0.0	7.4	9.6
Stilt sandpiper	0.5	2.0	0.4	0.0	2.9	0.9	6.1	1.1	0.0	8.1	11.0
Buff-breasted sandpiper	0.0	0.0	0.0	0.0	0	0.2	2.7	0.5	0.0	3.4	3.4

TABLE 4A.3.3-2 CPAI ALTERNATIVE A – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE (CONT'D)

Species	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
Long-billed dowitcher	0.8	3.4	0.7	0.0	4.9	3.5	17.4	3.1	0.0	24.0	28.9
Red-necked phalarope	2.5	10.9	2.1	0.0	15.5	6.2	19.0	3.3	0.0	28.5	44.0
Red phalarope	1.7	7.5	1.4	0.0	10.6	1.9	9.9	1.8	0.0	13.6	24.2
Shorebird Total[b]	22.2	97.4	18.9	0.0	138.5	31.8	149.6	27.0	0.0	208.4	346.9
Passerines											
Yellow wagtail	0.1	0.5	0.1	0.0	0.7	0.1	1.0	0.2	0.0	1.3	2.0
Savannah sparrow	0.6	2.5	0.5	0.0	3.6	1.6	6.5	1.2	0.0	9.3	12.9
Lapland longspur	10.1	44.4	8.6	0.0	63.1	19.4	86.1	15.6	0.0	121.1	184.2
Common redpoll	0.1	0.5	0.1	0.0	0.7	0.7	4.7	0.9	0.0	6.3	7.0
Passerine Total[b]	**10.9**	**47.8**	**9.3**	**0.0**	**68.0**	**21.8**	**98.3**	**17.9**	**0.0**	**138.0**	**206.0**

Notes:
[a] See Section 4A.3.3 Birds for analysis method
[b] Totals rounded to include birds with <0.1 nests/km^2

Ponding created by gravel structures, ice roads, or snowdrifts may become permanent water bodies that persist from year to year or they may be ephemeral and dry up early during the summer (Walker et al. 1987b, Walker 1996). Ponding may create new nesting, feeding and brood-rearing habitat that may be used by some waterfowl and loons, although nests established on impoundments that drain before hatch had higher depredation rates than nests on natural ponds (Kertell 1993, 1994). Placement and maintenance of culverts in roadways eliminates or mitigates the formation of ponding. Habitat alterations resulting from dust fallout, snow drifting and alteration in moisture and thermal regimes would affect an estimated 39.7 waterfowl nests and 5 loon nests (Table 4A.3.3-2). Ice roads and ice pads built during the winter to support construction and drilling activities would affect habitat for nesting waterfowl by delayed melt and altered surface water flow and reducing the availability of tundra nesting habitat. This loss of habitat would be temporary, and its effect on nesting birds would not last longer than the summer after construction and use of the ice road. Ice road construction would average 210 acres per year affecting an estimated 6.8 waterfowl nests and 1.0 loon nests (Table 4A.3.3-2). Habitat alterations from use of low-ground-pressure vehicles during summer or winter may include changes in tundra vegetation, these changes are most pronounced in moist and dry habitats (Jorgenson et al. 2003) and are unlikely to affect wet and aquatic habitats used by waterfowl and loons.

Water withdrawal from permitted water sources for the construction of ice roads could affect nesting, brood-rearing or foraging habitats for waterfowl and loons by altering surface water elevations or water quality resulting in nest sites left far from the water's edge, reduced invertebrate populations due to changes in bottom saturation, or reduced fish populations due to changes in water quality. Water surface elevations increased to above pre-pump levels in all lakes studied due to snowmelt runoff in spring (Baker 2002). Water withdraw has not been shown to result in lowered spring surface water elevations, or significant changes in water quality parameters which could impact invertebrate or fish populations. State of Alaska permitting restrictions regulating the volume of water that may be withdrawn from each lake and recharge of ponds and wetlands by snowmelt runoff in spring has been shown to more than replenish surface water elevations (Rovansek et al. 1996, Burgess et al. 2003b, Baker 2002).

TABLE 4A.3.3-3 CPAI ALTERNATIVE A – SUMMARY OF AFFECTED HABITAT TYPES USED BY WATERFOWL, LOONS AND SEABIRDS

Habitat Types	Colville Delta						NPR-A				
	Acres in Colville River Delta[b]	Loss or Alteration[c] (Acres and % of Available Habitat)		Species[a] (16)			Acres in NPR-A[d]	Loss or Alteration[c] (Acres and % of Available Habitat)		Species[a] (20)	
				Nesting (16)	Brood-rearing (13)	Staging (3)				Nesting (20)	Brood-rearing (15)
Open Nearshore Water	1,162					1	0				
Brackish Water	1,807			2		2	2				
Tapped Lake with Low-water Connection	5,397					1	412				
Tapped Lake with High-water Connection	5,146	1.0	<0.1%	5			7				
Salt Marsh*	4,473	0.5	<0.1%	2	1	1	36				
Tidal Flat*	18,187					1	0				
Salt-killed Tundra*	6,362			5	1	1	0				
Deep Open Water without Island*s	5,650	1.3	<0.1%	4	5		12,386	0.9	<0.1%	1	3
Deep Open Water with Islands or Polygonized Margin*	2,160	8.1	0.4%	12	8	1	9,988	0.3	<0.1%	3	6
Shallow Open Water without Islands	547	1.7	0.3%				1,744	0.2	<0.1%	5	3
Shallow Open Water with Island or Polygonized Margins	155			4	4		2,877	2.3	0.1%	11	7
River or Stream	20,306	7.7	<0.1%			1	1,456	0.7	<0.1%		
Aquatic Sedge Marsh	32						3,037	7.6	0.3%	10	2
Aquatic Sedge with Deep Polygons	3,275	15.3	0.5%	12	3		66				
Aquatic Grass Marsh*	369	1.6	0.4%	2			501			2	
Young Basin Wetland Comple*	0						624	19.1	3.1%	9	3
Old Basin Wetland Comple*x	2						15,673	42.9	0.3%	12	4
Riverine Complex*	0						698	4.1	0.6%	3	1
Dune Complex	0						1,889				
Nonpatterned Wet Meadow	11,162	60.5	0.5%	7	2		5,697	24.5	0.4%	4	
Patterned Wet Meadow	27,969	150.3	0.5%	8	4		19,861	105.1	0.5%	7	1
Moist Sedge-Shrub Meadow	2,927	69.8	2.4%	2			42,071	232.1	0.6%	8	1
Moist Tussock Tundra	525	1.1	0.2%				49,647	581.3	1.2%	3	1
Riverine Low and Tall Shrub**	1,270	1.2	<0.1%				1,803	1.9	0.1%		1
Upland Low and Tall Shrub	419						735				
Upland and Riverine Dwarf Shrub*	0						2,240				
Riverine or Upland Shrub*	6,305	32.9	0.5%	2			0				
Barrens (riverine, eolian, or lacustrine)	20,993	17.3	<0.1%	2			1,552				
Artificial (water, fill, peat road)	38						150				
Total Area	**146,638**	**370.4**	**0.3%**				**175,152**	**1023.0**	**0.6%**		

Notes:
[a] Numbers of species using habitats by life history stage (Johnson et al. 2004). Species included are: greater white-fronted goose, snow goose, Canda goose, brant, tundra swan, northern pintail, green-winged teal, greater scaup, spectacled eider, king eider, long-tailed duck, red-breasted merganser, red-throated loon, Pacific loon, yellow-billed loon, parasitic jaeger, long-tailed jaeger, glaucous gull, Sabine's gull, Arctic tern.
[b] Habitat type mapped for the Colville River Delta (Jorgenson et al. 1997) within the Plan Area boundaries
[c] Total includes gravel for pads and airstrips and area indirectly affected by dust, snowdrifts, and alteration in thermal or moisture regimes (see Table 4A.3.1-2)
[d] Habitat type mapped for the National Petroleum Reserve-Alaska area (Jorgenson et al. 2003a) within the Plan Area boundaries
* Key Wetlands

Under Alternative A, approximately 36 miles of pipeline would be installed for transfer of production oil, gas, and water. New pipelines would be elevated a minimum of 5 feet above the tundra, and pipeline construction would occur during the winter when loons and waterfowl are not present in the Plan Area. Snowdrifts downwind from the pipeline would alter habitat by later melt and potential alteration of surface flow. Elevated pipelines would not be expected to contribute significantly to direct habitat loss, although they would cross areas used by nesting and brood-rearing greater white-fronted geese (Figure 3.3.3.2-2 and Figure 3.3.3.2-3), brant (Figure 3.3.3.2-4 and Figure 3.3.3.2-5), tundra swans (Figure 3.3.3.2-7 and Figure 3.3.3.2-8), long-tailed ducks (Figure 3.3.3.2-14), king eiders (Figure 3.3.3.2-12 and Figure 3.3.3.2-13) and loons (Figure 3.3.3.3-4 and Figure 3.3.3.3-5).

Alternative A includes seven bridges and five culvert batteries to be constructed over several rivers, lakes, and unnamed drainages, the largest of which would span the Nigliq Channel of the Colville River. In the CD-4 area, a road crossing may affect some nesting waterfowl at a lake north of the site where tundra swans (Figure 3.3.3.2-7) and yellow-billed loons have nested.

Disturbance and Displacement

Disturbance related to Alternative A would likely displace some nesting waterfowl and loons near the proposed airstrip at the CD-3 site. Studies at the Alpine Field indicate that greater white-fronted geese may move to adjacent habitats if suitable habitat is available (Johnson et al. 2003a). Disturbance and displacement related to vehicular traffic would affect waterfowl and loons along the proposed road system connecting CD-4 with CD-1. Disturbance related to vehicular traffic would also affect waterfowl and loons along the roadway to the CD-5, CD-6, and CD-7 sites (Figure 3.3.3.2-3). In the CD-5 area, the white-fronted goose is a common nesting species near the site of the proposed road, along with small numbers of ducks, including king eiders (Figure 3.3.3.2-3 and Figure 3.3.3.2-13). Nest densities of waterfowl and loons were 15.3 nests/km^2 in the wetlands in the CD-5 area; in contrast, few waterfowl and loon nests were reported in the CD-6 (2.7 nests/km^2) and CD-7 (4.6 nests/km^2) areas (Table 3.3.3-5) (Burgess et al. 2003b, Johnson et al. 2004). Disturbance due to air traffic would displace an estimated 21.0 waterfowl nests and 2.5 loon nests (Table 4A.3.3-2).

Because gravel will be placed during the winter when waterfowl and loons do not occur on the Arctic Coastal Plain, no waterfowl or loon nests would be disturbed by this activity. Some waterfowl and loons would be disturbed during the summer breeding season by vehicular, aircraft, and boat traffic; noise from equipment on roads or at facilities; and pedestrian traffic. Disturbance by vehicles, equipment activities such as road grading and compaction or aircraft during summer would decrease the numbers of waterfowl nesting, brood-rearing or foraging in areas adjacent to roadways and airstrips (Ward and Stehn 1989, Murphy and Anderson 1993, Johnson et al. 2003a).

On the North Slope, vehicular traffic, including large trucks hauling cranes and other equipment, and road maintenance equipment had greater effects on geese feeding close to roads than on geese feeding farther away (Burgess and Stickney 1992, Murphy et al. 1988, Murphy and Anderson 1993). Disturbances to bird activity occur most often during the pre-nesting period, when birds gather to feed in open areas near roads, and during brood-rearing and fall staging. A small %age of birds may walk, run, or fly to avoid vehicular disturbances (Murphy and Anderson 1993). Disturbance reactions occur most often within 50 meters of roads (Murphy and Anderson 1993). Disturbance from vehicular traffic may affect activity and energy budgets of waterfowl and loons and could have negative impacts on nesting success for some birds by increasing the length of time birds are away from the nest during incubation (Johnson et al. 2003a). Successful tundra swan nests average further from roads than unsuccessful nests (Ritchie and King 2000). Brood-rearing greater white-fronted geese have been found to avoid areas within 200 meters of roads (Murphy and Anderson 1993). Speed limits for vehicular traffic would help to minimize the effects of disturbance, particularly during brood-rearing when birds are flightless.

Noise and visual stimuli associated with helicopter and fixed-wing air traffic would disturb waterfowl and loons near the proposed airstrip at the CD-3 site. The potential for aircrafts to elicit reactions in waterfowl is well documented (Gollop et al. 1974a, Schweinsburg 1974, Ward and Stehn 1989, Derksen et al. 1992, McKechnie and Gladwin 1993, Johnson et al. 2003a). Responses of birds to aircrafts include alert and concealment postures, interruption of foraging behavior, flight, and decreases in nest attendance (Johnson et al. 2003a). While some studies have suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircrafts, others have indicated that both may elicit disturbance reactions (Gollop et al. 1974b, Johnson et al. 2003a). Nesting greater white-fronted geese took more and longer recesses from incubation as the number of airplanes increased - at nest sites closer to the airstrip (Johnson et al. 2003a). Of the various disturbance types, helicopters were the least predictable because they did not have a restricted flight pattern. Incubating greater white-fronted geese and tundra swans reacted more often to fixed-wing aircrafts than to helicopters, although monitored nests were closer to the airstrip than to the helipad. Airplanes and pedestrians elicited the highest rates of response from incubating geese, and vehicles elicited the lowest. These behavioral responses to disturbances did not appear to affect nest outcomes (Johnson et al. 2003a). Greater white-fronted geese shifted nests from areas within 1 km of the airstrip at the Alpine Development Project to areas within 1 to 1.5 km during a period of heavy construction activity (Johnson et al. 2003a). Because brood-rearing birds can move away from disturbances, disturbance may cause further displacement of brood-rearing flocks.

Waterfowl hazing may be necessary in the vicinity of the airstrip to reduce bird-aircraft collision hazards. Hazing would cause additional disturbance, and depending on intensity and timing may cause birds to abandon areas near the airstrip during nesting, foraging and brood-rearing. The area disturbed would be within the 500 meter disturbance buffer used to calculate air traffic disturbance impacts.

Disturbance effects during construction of the Alpine Development Project did not cause changes in nest site selection by tundra swans or yellow-billed loons (Johnson et al. 2003a). The distance of swan nests from the airstrip did not change from pre-construction to construction periods, and nesting success was not negatively affected by proximity of the airstrip. Two swan nests were incubated successfully within 500 meters of the airstrip during construction, and one of these remained 450 meters from the airstrip for at least 6 years, from pre-construction through the operational phase. Analysis of 15 years of tundra swan nest and brood distributions in the Kuparuk Oilfield indicate that there was no significant relationship between the intensity of disturbance and nest or brood densities within 1 km of roads (Anderson and Stickney 2004). Nesting yellow-billed loons also did not exhibit any measurable changes during construction of the Alpine Development Project, but only a few pairs nested in the area and all nests were more than 700 meters from the airstrip.

Other studies have also indicated the potential for noise-related disturbance to affect birds near the noise source. Anderson et al. (1992) reported that most waterfowl experienced no detrimental effects from noise near the GHX at Prudhoe Bay, although pre-nesting Canada geese and nesting spectacled eiders appeared to use areas farther away from the facility noise. Gollop and Davis (1974) reported that feeding behavior of snow geese was adversely affected in the vicinity of an experimental gas compressor noise simulator and that some birds detoured around the experimental disturbance. Johnson et al. (2003a) reported that annual changes in greater white-fronted goose nest distribution reduced the average noise exposure at nest sites around the Alpine Development Project airstrip, but by a small and insignificant amount. Aircraft noise had inconsistent effects on incubation behavior and probably did not affect nesting outcome (Johnson et al. 2003a). Noise levels from helicopters and airplanes at CD-3 are likely to be less than at the Alpine Development Project airstrip because of fewer flights and use by twin-engine planes rather than the noisier four-engine planes (Johnson et al. 2003a).

Obstructions to Movement

In general, the infrastructure associated with Alternative A, including roads and production pads, the airstrip, buildings, elevated pipelines, power lines, bridges, and culverts, should not cause physical obstructions to most movements of waterfowl and loons except during brood-rearing. Usually, birds can easily fly over or around these structures except during brood-rearing. Birds would be most likely to collide with structures during periods of poor visibility such as foggy conditions or at dusk. These structures may present some temporary obstructions to movements of waterfowl and loons during brood-rearing and molting periods when birds are flightless, particularly if traffic levels are high (Murphy and Anderson 1993). However, loons (Kertell 1994) and snow goose broods (Johnson 1998, 2000) have crossed roads in active oilfields, although they initially may have been impeded (Burgess and Ritchie 1991).

Mortality

Some waterfowl and loon mortality would result from collisions with vehicles, elevated pipelines, buildings, or power lines, particularly under poor visibility conditions. Collisions with vehicles was the greatest source of bird mortality, primarily for ptarmigan and passerines, associated with the TAPS, particularly along the Dalton Highway where birds were attracted to roadside areas of early green-up caused by dust shadows (TAPS Owners 2001a). Mortality of a few individual birds would be associated with collisions with aircrafts during takeoff and landing. Mortality of a few individuals or small flocks would be associated with birds that collide with structures such as elevated pipelines, buildings, communications towers, power lines, or bridges. Some waterfowl and loons would be expected to collide with power lines, although collisions would be infrequent (Murphy and Anderson 1993). Collisions with power lines could be minimized by marking lines with bird flight diverters.

Some predators, such as ravens, glaucous gulls, arctic foxes, and bears, may be attracted to areas of human activity where they find human-created (anthropogenic) sources of food and denning or nesting sites (Larson 1960, Eberhardt et al. 1982 Day 1998 Burgess 2000 USFWS 2003b). The availability of anthropogenic food sources, particularly during the winter, may increase winter survival of arctic foxes and contribute to increases in the arctic fox population. Anthropogenic sources of food at dumpsters and refuse sites may also help to increase populations of gulls and ravens above natural levels. Increased levels of depredation resulting from elevated numbers of predators could adversely affect nesting and brood-rearing success for waterfowl and loons. Arctic foxes, glaucous gulls, and common ravens prey on eggs and young of waterfowl and loons (Murphy and Anderson 1993, Noel et al. 2002b, Rodrigues 2002, Johnson et al. 2003a, USFWS 2003b). The NRC, in their review of the cumulative effects of oilfield development on the North Slope (NRC 2003), concluded ". . . high predation rates have reduced the reproductive success of some bird species in industrial areas to the extent that, at least in some years, reproduction is insufficient to balance mortality." At a more recent workshop on human influences on predators of ground-nesting birds on the North Slope, sponsored by the USFWS, participants concluded that common ravens have increased in response to developments, but that increases in arctic fox and glaucous gull populations were uncertain (USFWS 2003b). There was further uncertainty in the link between increased predator populations and resulting population level impacts to ground-nesting birds. The numbers of foxes and most avian predators in the Alpine Field did not appear to increase during construction of the project, with the exception of common ravens, which nested on buildings at the Alpine Field (Johnson et al. 2003a). There was no indication that the presence of this pair of ravens caused an increase in nest depredation within about 2 miles of the Alpine Field (Johnson et al. 2003a). There is direct evidence, however, that common ravens nesting at Alpine Field, Nuiqsut and Meltwater reduced nesting success up to 26 miles away at the Anachlik nesting colony by as much as 80 % (J. Helmericks 2004, pers. comm.). Predator observations throughout the Plan Area documented jaegers and glaucous gulls as the most common nest predators followed by common ravens (Johnson et al. 2004). Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

Addition of overhead power lines may increase mortality to waterfowl and loon nests by providing raptors and common ravens with perches that could enhance their ability to locate and depredate nests. In recent years, The NSB has installed predator-proof dumpsters at camps and implemented refuse-handling techniques to minimize the attraction of predators to the landfill. Oilfield workers continually undergo training (and receive notifications from the CPAI Environmental group during the summer) to increase their awareness of the problems associated with feeding wildlife. These practices would minimize impacts related to increased levels of depredation and would be continued in the ongoing development of the ASDP.

Researchers conducting studies on bird nesting density and success may inadvertently attract predators to nests and broods (Bart 1977, Götmark 1992, Strang 1980). Birds that are flushed from their nests during surveys are more susceptible to nest depredation. Ongoing activities by researchers would cause some mortality to waterfowl and loon eggs and chicks. Mitigation plans that reduce human activity near nesting eiders were effective in reducing eider mortality during the nesting period (Johnson et al. 1987).

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Dust fallout would be expected to be less than during the construction period because of reduced traffic, but would be greatest during the operation period over the life of the project. Ice roads and ice pads built during the winter to support drilling activities would affect habitat for nesting waterfowl by delayed melt and altered surface water flow and reducing the availability of tundra nesting habitat. Habitat alterations from use of low-ground-pressure vehicles during summer or winter may include changes in tundra vegetation. These changes are most pronounced in moist and dry habitats (Jorgenson et al. 2003b) and are unlikely to affect wet and aquatic habitats used by waterfowl and loons.

Disturbance and Displacement

Disturbance and displacement from aircraft and vehicle traffic and facility noise would be similar to during the construction phase. Disturbance would be reduced from the construction phase because of reduced levels of both air and ground traffic. Disturbance types, along with the general reactions of waterfowl and loons, were discussed under the Construction Period heading.

Boat traffic during oil spill drills, equipment checks, and boom deployment, especially airboat traffic, may be disruptive to pre-nesting, nesting, foraging, brood-rearing, and staging waterfowl and loons. Long-tailed ducks in Beaufort Sea lagoons did not show effects of disturbance by either seismic exploration or boat traffic on movement, habitat use, or foraging (Flint et al. 2003). Boat traffic will cause disturbance to large flocks of brood-rearing and staging flocks of geese and tundra swans within the Colville River Delta. These activities are expected to be of short duration and would probably cause temporary displacement.

Obstructions to Movement

Obstructions to movements from roadways would continue into the operation period and would be similar to the construction phase. Obstruction would be reduced from the construction phase because of reduced levels of traffic.

Mortality

Some waterfowl and loon mortality would result from collisions with aircraft, vehicles, elevated pipelines, buildings, communications towers, power lines, or bridges, particularly under conditions of poor visibility. Collisions would generally be limited to a few individuals, although small flocks could collide with power lines. Collision frequency with vehicles and aircrafts would be expected to be less than during construction because of decreased traffic levels. Collision impacts with structures and power lines would be greatest during project operation over the life of the field.

Waterfowl nesting success in the Plan Area was generally low (approximately 26 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for waterfowl and loons. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as long-tailed ducks (Mallek et al. 2003) and red-throated loons (Larned et al. 2003); and to colonial nesting species which concentrate in specific locations providing an abundant and predictable protein source. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

PTARMIGAN

Ptarmigan nest in the areas proposed for development under Alternative A. Several ptarmigan nests were reported during ground searches for nesting birds near the area proposed for the airstrip and production pad in the CD-3 site (Johnson et al. 2003b). At the CD-4 site, ptarmigan nests were reported near the proposed site of the production pad and access road to CD-1 (Burgess et al. 2003a). At the CD-5 site, ptarmigan nested near the access road south of the proposed pad (Burgess et al. 2003b). At the CD-6 site, a ptarmigan nested near the proposed site of the production pad. The closest ptarmigan nest to proposed infrastructure at the CD-7 site was north of the proposed access road. Gravel placement at the CD-3, CD-4, CD-5, and CD-6 sites could displace some nesting ptarmigan and birds probably would nest in adjacent areas.

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter mining and placement of gravel during construction would account for most of the direct habitat loss for Alternative A. Approximately 306 acres would be covered by gravel and lost as potential nesting, brood-rearing, and foraging habitat for ptarmigan. An estimated 0.8 willow ptarmigan nest would be affected by gravel placement and mining (Table 4A.3.3-2).

Tundra adjacent to gravel fill would also be affected by snowdrifts, gravel spray, dust fallout, thermokarst, and ponding. Snowdrifts or plowed snow would cause a loss of ptarmigan nesting and foraging habitat, while dustfall and early meltout near roads would provide foraging habitat during early spring. As with waterfowl, ptarmigan make use of forage in early green-up areas next to roadways created by dust deposition. An estimated 2.2 willow ptarmigan nests would be affected by habitat alteration (Table 4A.3.3-2). Ptarmigan would use some structures, such as pipelines, for perches.

Ice roads and ice pads built during the winter would reduce the availability of habitat for nesting ptarmigan due to delayed melting and altered surface-water flow affecting an estimated 0.4 willow ptarmigan nests (Table 4A.3.3-2).

Disturbance and Displacement

Few studies have been conducted to determine the effects of disturbances on nesting or brood-rearing ptarmigan. Ptarmigan sit very tightly during incubation, and disturbance by vehicular and air traffic, machinery, and facility noise would have little impact on nesting ptarmigan. Pedestrian traffic would also have little impact on nesting ptarmigan, because low nesting densities will limit the effect of disturbance. Some ptarmigan may remain on the Arctic Coastal Plain during winter, and a few birds would be disturbed or displaced during winter construction. Ptarmigan would be attracted to gravel fill sites because they provide grit and dust for bathing. An estimated 0.4 ptarmigan nests would be displaced due to disturbance from air traffic in the Colville River Delta (Table 4A.3.3-2).

Obstructions to Movement

Movements of ptarmigan are unlikely to be affected by gravel placement for roads, well pads, and airstrips because ptarmigan can walk or fly over or around such structures. Likewise, buildings, pipelines, and bridges should pose little obstruction to movements of ptarmigan.

Mortality

Ptarmigan could suffer mortality from collisions with vehicular traffic, machinery, buildings, bridges, and pipelines during the construction phase of the development. This is a likely cause of mortality for ptarmigan in the early spring when they are drawn to roadways by early green-up and access to grit. Ptarmigan were among the species of birds most often struck by traffic during the TAPS project, although the number of birds lost was likely low compared to area populations (TAPS Owners 2001a). Five ptarmigan were killed in a single incident by a collision with an aircraft on the Kuparuk airstrip in early spring. This is the only reported mortality to ptarmigan since 1987.

Any increase in predator populations would result in increased adult mortality and decreased reproductive success for ptarmigan. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which aggregate in predictable locations year to year, and with low total population sizes.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation.

Disturbance and Displacement

Little disturbance or displacement of ptarmigan is expected, because this species appears to tolerate human activity. Potential disturbance would be lower during project operation than during construction because traffic levels would be reduced.

Obstructions to Movement

Obstructions to the movements of ptarmigan would be similar to those during construction but would be reduced because of reduced traffic levels during project operation.

Mortality

Collisions with vehicles in the proposed development could cause a few ptarmigan deaths. Losses are most likely during spring when ptarmigan are attracted to areas of early green-up near roads and during the summer when more ptarmigan are likely to be present in the Plan Area. Reduced speed limits along roads, particularly during periods of poor visibility, may help to minimize the potential for collisions of ptarmigan with vehicles. The potential for mortality of ptarmigan from collisions with elevated pipelines, bridges, power lines, and buildings would be limited to a small number of individuals.

Ptarmigan nesting success in the Plan Area was 50 % (Johnson et al. 2004). Increased numbers of arctic foxes, common ravens, and glaucous gulls attracted to developed areas would increase mortality of adult ptarmigan, eggs, and chicks. Proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife have minimized effects at the Alpine Development Project.

RAPTORS AND OWLS

Raptors and owls are generally uncommon visitors and occasional nesters in the Plan Area. Potential nesting species on the Arctic Coastal Plain include peregrine falcon, rough-legged hawk, northern harrier, short-eared owl, and snowy owl. In the Plan Area, a peregrine falcon nest was reported on a bank of Fish Creek approximately 3.5 miles from the CD-7 site (Figure 3.3.3.5-1) (Burgess et al. 2003b). Northern harrier and short-eared-owl nests have been found at CD-4 (Burgess et al. 2003a). These species and other raptors that occur in the area are occasionally observed foraging and passing through during migration. Juvenile golden eagles use the Arctic Coastal Plain for foraging and are often observed during the caribou calving period. Golden eagles do not nest in the Plan Area.

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Habitat loss and disturbance resulting from winter mining and gravel placement for the proposed development is unlikely to affect the few raptors and owls occurring in the Plan Area. Snowdrifts or plowed snow would cause a temporary loss of nesting habitat for northern harriers, short-eared owls, and snowy owls. Short-eared owls, snowy owls, and northern harriers are attracted by aggregations of waterfowl and ptarmigan in green-up areas created by dustfall and early meltout near roads.

Towers, pipelines, and power lines would provide perches, which would improve foraging efficiency, and would provide potential nesting habitat for raptors. Although rough-legged hawks and peregrine falcons use abandoned infrastructure for nesting, it is unlikely that they would nest in active oilfield areas. There have been no reported raptor nests in the Prudhoe Bay oilfield area.

Disturbance and Displacement

The small numbers of raptors and owls present in the Plan Area are not likely to be disturbed during nesting by the proposed development. Peregrine falcons forage on juvenile and staging shorebirds in the lower Colville River Delta, disturbance by air traffic during late summer would potentially effect their foraging efficiency.

Obstructions to Movement

Gravel roads, buildings, pipelines, power lines, and bridges are unlikely to obstruct movements of raptors.

Mortality

It is unlikely that the small number of birds that occur in the Plan Area would suffer any mortality from collisions with vehicular traffic, air traffic, buildings, bridges, or pipelines. Increased numbers of arctic foxes, common ravens, and glaucous gulls attracted to developed areas would decrease productivity of nesting raptors and owls. Because so few raptors and owls nesting in the Plan Area effects would be minor. Proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife have minimized effects at the Alpine Development Project.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat alteration from dust fallout would continue during project operation and would continue to attract raptors to aggregations of waterfowl and ptarmigan next to the roadways. Towers, pipelines, and power lines would continue to provide perches, which would improve foraging efficiency for raptors.

Disturbance and Displacement

The small numbers of raptors and owls present in the Plan Area would not be likely to be disturbed by the proposed development during nesting. Airboat-based oil-spill drills, equipment checks, and boom placement along river channels may disturb raptors or disrupt their foraging, however these activities will be located north of known nesting locations. Nesting occurs along riverbanks south of the proposed development. Any boat-based traffic in these nesting areas may disturb nesting raptors. Air traffic in the lower Colville River Delta may interrupt peregrine falcon foraging on juvenile and staging shorebirds.

Obstructions to Movement

Gravel roads, buildings, pipelines, power lines, and bridges are unlikely to obstruct raptor movements.

Mortality

It is unlikely that the small number of birds that occur in the Plan Area would suffer any mortality from collisions with vehicular traffic, air traffic, buildings, bridges, or pipelines. Increased numbers of arctic foxes, common ravens, and glaucous gulls attracted to developed areas would decrease productivity of nesting raptors and owls. Because so few raptors and owls nest in the Plan Area, effects would be minor. Proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife have minimized effects at the Alpine Development Project.

SHOREBIRDS

The following shorebird species may be most affected by the proposed developments in Alternative A, based on abundance of more than 2 nests/km^2 as presented in Table 3.3.3-7:

- Colville River Delta – pectoral sandpiper, semipalmated sandpiper, red-necked phalarope, red phalarope, long-billed dowitcher, and American golden-plover
- CD-5 – pectoral sandpiper, red phalarope, long-billed dowitcher, semipalmated sandpiper, stilt sandpiper, red-necked phalarope
- CD-6 – pectoral sandpiper, semipalmated sandpiper, long-billed dowitcher
- CD-7 – pectoral sandpiper, semipalmated sandpiper, long-billed dowitcher
- The National Petroleum Reserve-Alaska Area – semipalmated sandpiper, pectoral sandpiper, red-necked phalarope, long-billed dowitcher, red phalarope

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Under Alternative A, winter mining and placement of gravel during construction would account for most of the direct habitat loss. Approximately 306 acres would be covered by gravel or mined and lost as potential nesting, brood-rearing, foraging and staging habitat for shorebirds during the construction of the project. Habitat losses from gravel fill would be long-term. An estimated 54.0 shorebird nests, including 20.3 pectoral sandpiper and 11.1 semipalmated sandpiper nests, would be affected by gravel fill and mining.

Dust shadows leading to early snowmelt and green-up may also increase nesting and foraging habitat availability for shorebirds. Construction of gravel roads may result in alteration of habitat by the development of ponds and thermokarsting of soils at the edges of roads and pads. For species such as dunlin, plovers, and buff-breasted sandpipers that generally prefer drier habitat types (Derksen et al. 1981, Lanctot and Laredo 1994; Troy 2000), these impacts would result in a small amount of habitat loss. For species such as pectoral sandpipers, long-billed dowitcher, stilt sandpiper and phalaropes (Derksen et al. 1981, Troy 2000) that prefer to nest and rear young near water, these alterations would result in a small increase in habitat. Alterations in habitats near roads, including interruption of surface flow and thermokarst, create very wet and emergent tundra that is preferred by red-necked phalaropes (Rodrigues 1992, Noel et al. 1996).

Habitats important to nesting and brood-rearing shorebirds that would be lost or altered by gravel placement in the Colville River Delta include Aquatic Sedge with Deep Polygons (0.5 % of available habitat altered), Nonpatterned Wet Meadow (0.5 % of habitat altered), and Patterned Wet Meadow (0.5 % of habitat altered). Habitats important to nesting and brood-rearing shorebirds that would be affected by gravel placement in the

National Petroleum Reserve-Alaska area include Aquatic Sedge Marsh (0.3 % of available habitat altered) and Old Basin Wetland Complex (0.3 % of habitat altered). Avoidance of key wetland habitats, and preferential placement of facilities on moist and dry habitat types results in a disproportionate impact on these habitats preferred by dunlins, plovers and buff-breasted sandpipers. Under CPAI Alternative A, in the Colville River Delta 19 % of habitat impacts affect moist habitats and in the National Petroleum Reserve-Alaska portion of the Plan Area 79 % of habitat impacts affect moist habitats (Moist Sedge-Shrub Meadow and Moist Tussock Tundra). Gravel mining would result in a loss of tundra habitats while the mine sites are active and creation of aquatic habitat after reclamation (Appendix O).

Ice roads and ice pads built during the winter to support construction and drilling activities would affect habitat for nesting shorebirds by delayed melt and altered surface water flow and reduced availability of nesting habitat on the tundra. Shorebirds should be into incubation before the ice roads melt and would be displaced by ice roads. The average of 210 acres of ice road would displace an estimated 45.9 shorebird nests (Table 4A.3.3-2). Water withdrawal for construction of ice roads would not affect nesting shorebirds. Habitat alterations from use of low-ground-pressure vehicles during summer or winter may include changes in tundra vegetation; these changes are most pronounced in moist and dry habitats (Jorgenson et al. 2003b) and may decrease habitat quality for nesting shorebirds by compression of tussocks and standing dead vegetation.

Disturbance and Displacement

Winter construction activities would not disturb shorebirds. Increased human activity along roads (primarily vehicles), at production pads (vehicles and pedestrians), and at the CD-3 airstrip (fixed-wing aircraft, vehicles, and pedestrians) to facilitate construction of infrastructure at the production pads during the summer would potentially disturb or displace some shorebirds.

Construction activities on the production pads, vehicle traffic along the roads, and aircraft activities at CD-3 would result in localized high noise levels. Johnson et al. (2003a) did not find that nesting shorebirds moved farther from the Alpine Field during summer construction activities. Semipalmated sandpipers nested significantly more frequently in areas closer to the Alpine airstrip than in areas farther from the airstrip, but annual variability in nest locations was high. Pectoral sandpipers and red-necked phalaropes nested slightly more often near the airstrip than away from it. Other North Slope studies designed to assess the impacts of disturbance from oil and gas activities on nesting birds have reported mixed results. In the Prudhoe Bay field, Troy (1988) found that nesting semipalmated sandpipers and dunlin were less common adjacent to spine roads than away from roads, but there was little difference in numbers of these species near less-trafficked access roads and roadless areas. In the same study, red-necked phalaropes were more common near roads than away from roads.

Because of the proximity of CD-3 to the salt marshes and coastal silt barrens of the Colville River Delta, shorebirds gathering in coastal areas of the Colville River Delta to build fat reserves for migration (Andres 1994) may be displaced from feeding areas near CD-3 in response to increased human activities and noise levels during construction. Primary species included in post-breeding foraging flocks of shorebirds include dunlin, semipalmated sandpipers, red-necked phalaropes, western sandpipers, and pectoral sandpipers (Andres 1994). A total of 37 acres of Barrens, River or Stream and Salt-killed Tundra habitats used by staging shorebirds are within 500 meters of the airstrip at CD-3. Based on a staging period density of 150 shorebirds/km^2 in the lower delta (Andres 1994) an estimated 313 shorebirds, primarily dunlin, would potentially be disturbed by air traffic within 500 meters of the CD-3 airstrip. Displacement of large flocks of shorebirds from these important and limited habitats could adversely affect the migrant shorebird population passing through the Delta (Andres 1994).

Obstructions to Movements

The construction of gravel roads and pads is not anticipated to obstruct shorebird movements because most birds can fly. However, shorebird broods attempting to move from nesting sites to brood-rearing areas may be obstructed by the presence of roads and pads and traffic volumes associated with construction activities.

Mortality

A few individual shorebirds and small flocks may die if they fly into infrastructure on production pads, pipelines, or power lines or if they collide with vehicles or aircraft as they fly or walk (with broods) across roads, pads, or airstrips. Potential mortality from vehicles may be mitigated by slower speed limits on roads during brood-rearing periods. Addition of overhead power lines between CD-6 and CD-7 may increase mortality to shorebirds and their nests by providing raptors and common ravens with perches that could enhance their ability to locate and depredate incubating individuals and nests. Shorebirds may also collide with power lines. More than 15 red phalaropes collided with power lines in Barrow during a 2-day period in fall 2003 (R. Suydam, NSB, pers. comm.).

Overall shorebird nesting success in the Plan Area was generally high, 60 % in 2003 (Johnson et al. 2004) and 64 % in 2002 (Burgess et al 2003b), but nest success was variable among species ranging from 86 % for long-billed dowitchers to 26 % for black-bellied plovers (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for shorebirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as buff-breasted sandpipers (Lanctot and Laredo 1994) and dunlin.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Dust fallout would be expected to be less than during the construction period because of reduced traffic, but would be greatest during the operation period for the life of the project. Nesting habitat would be lost to shorebirds during the operation period as a result of annual ice road construction. Impacts from ice road construction would be similar to those discussed for the construction period. However, if ice roads are placed in the same location annually, impacts to the tundra could be longer-term.

Habitat alterations from use of low-ground-pressure vehicles during summer or winter during the operation period are most pronounced in moist and dry habitats (Jorgenson et al. 2003b) and may decrease habitat quality for nesting shorebirds by compression of tussocks and standing dead vegetation. Impacts from habitat alterations during operations would be detrimental to some shorebird species but may be beneficial to others. Phalaropes have been reported nesting in association with thermokarst.

Disturbance and Displacement

Disturbance and displacement of shorebirds during operation activities would be similar to that during construction activities except that most human activities and noise levels would be lower during operations. Disturbances related to the Alpine Development Project facilities did not appear to effect shorebird nesting densities near the facility (Johnson et al. 2003a). In addition, oil-spill drills and boom placement will cause additional disturbance along the river channels and in the Delta. Noise from airboat traffic would temporarily displace shorebirds. Air traffic in the lower Colville River Delta associated with CD-3 would disturb an estimated 313 staging shorebirds.

Obstructions to Movements

Obstructions to movements would be similar to that during the construction phase, although lower traffic levels may reduce obstruction to shorebirds with broods.

Mortality

Direct mortality of a few individuals or small flocks of shorebirds would occur during operational activities from collisions with structures or vehicles. Shorebirds may also collide with power lines. More than 15 red phalaropes collided with power lines in Barrow during a 2-day period in fall 2003 (R. Suydam, NSB, pers. comm.). Any increase in predator populations would result in decreased reproductive success for shorebirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as buff-breasted sandpipers (Lanctot and Laredo 1994) and dunlin.

SEABIRDS (GULLS, JAEGERS, AND TERNS)

The following seabirds may be affected by the proposed developments in Alternative A, based on abundance of more than or equal to 0.3 nests/km^2 as presented in Table 3.3.3-5:

- CD-3— arctic tern, Sabine's gull, glaucous gull
- CD-4—arctic tern, long-tailed jaeger
- CD-5—glaucous gull, arctic tern
- CD-6—no seabirds
- CD-7—Sabine's gull, arctic tern
- The National Petroleum Reserve-Alaska Area—arctic tern, glaucous gull

CONSTRUCTION PERIOD

Habitat Loss, Alteration, and Enhancement

Winter mining and placement of gravel during construction would account for most of the direct or indirect habitat loss or alteration for Alternative A. Approximately 306 acres would be covered by gravel or mined and lost as potential nesting, brood-rearing, and foraging habitat for seabirds, primarily gulls, jaegers, and arctic tern. Habitat losses from gravel fill would be long-term. An estimated 1.4 seabird nests would be affected by gravel placement (Table 4A.3.3-2). Habitats important to seabirds that would be covered by gravel include Aquatic Sedge with Deep Polygons, and Patterned and Nonpatterned Wet Meadows.

Loss of seabird habitat under Alternative A would be similar to that described above for waterfowl and loons. Use of areas near gravel roads, pads, and airstrips by seabirds is less well documented than for waterfowl and loons, and some of the effects of habitat alterations associated with gravel placement, such as snowdrifts, dust fallout, thermokarst, and ponding, may be less likely to affect seabirds than waterfowl. Ponded areas would be attractive to seabirds, particularly glaucous and Sabine's gulls and arctic terns, that nest on islands or along shorelines of lakes and other wetlands. An estimated 7.6 seabird nests would be affected by habitat alteration and 1.4 seabird nests would be affected by ice roads (Table 4A.3.3-2). Water withdraw for ice road construction would not affect seabird habitat because spring snowmelt runoff will restore water surface levels.

Disturbance and Displacement

Disturbance related to Alternative A would displace an estimated 2.4 seabird nests near the proposed airstrip at CD-3. Seabirds may be particularly responsive to pedestrian traffic. Incubating glaucous gulls, Sabine's gulls, arctic terns, and jaegers leave the nest with the approach of humans on foot in the same manner as for approaching mammalian or avian predators. These species use mobbing activity to try to discourage such intrusion by humans or predators. Incubation recesses caused by pedestrian traffic would make seabird nests more susceptible to depredation (Noel et al. 2002b).

Glaucous gulls are attracted to gravel structures and associated facilities and human activity because of the potential availability of anthropogenic sources of food. Glaucous gulls that nest in the project area could forage at the landfill in Nuiqsut. Glaucous gulls could key into human-related disturbances to nesting waterfowl that leave nests unattended, allowing gulls to feed on the eggs (Noel et al. 2002b). This attraction can be minimized by implementing and monitoring the proper handling of refuse in approved dumpsters and by providing workers with training on the problems associated with feeding wildlife.

Obstructions to Movement

Most movements by seabirds are not likely to be obstructed during construction of the proposed development under Alternative A. Brood-rearing seabirds may have difficulty crossing roadways and gravel airstrips.

Mortality

A few seabirds could die from collisions with vehicles along roadways. Glaucous gulls, in particular, would occasionally be struck by vehicles along roadways. Seabirds, especially gulls, are also particularly vulnerable to collisions with aircraft, and a few gulls would be expected to collide with aircraft. One glaucous gull has been killed by colliding with an aircraft since 1987 at the Kuparuk Oilfield airstrip (C. Rea, CPAI 2004, pers. comm.). Mortality from collisions with buildings, pipelines, power lines, or communication towers is also possible; however, that is expected to be limited to a few individual birds.

The potential for increased levels of depredation to affect seabird egg and chick mortality may be lower than that described for waterfowl, because seabirds at nest sites and with broods are generally aggressive toward predators. Seabird mobbing behaviors would reduce mortality by deterring predators. Any increase in predator populations, however, could result in decreased reproductive success for seabirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as jaegers and arctic tern (Mallek et al. 2003).

OPERATION PERIOD

Habitat Loss, Alteration, and Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Dust fallout would be expected to be less than during project construction because of reduced traffic, but would be greatest during operations over the life of the project.

Disturbance and Displacement

Disturbance and displacement from aircraft, vehicle and pedestrian traffic, and facility noise would be similar to that during project construction. Disturbance would be reduced because of reduced levels of both air and ground traffic. Seabirds may be either disturbed and displaced by or attracted to airboat-based spill drill, equipment check, and boom placement activities.

Obstructions to Movement

Most seabird movements would not be obstructed by the proposed development. Structures may present some temporary obstructions to movements of seabirds during brood-rearing, particularly if traffic levels are high.

Mortality

Some seabird mortality, limited to a few individuals, may be related to development under Alternative A. Glaucous gulls, in particular, would occasionally be struck by vehicles along roadways. Traffic levels are expected to be less during project operation than during construction, which would reduce potential mortality to seabirds from collisions. Seabirds, especially gulls, are also particularly vulnerable to collisions with aircraft and a few gulls would be expected to collide with aircraft. Mortality from collisions with buildings, pipelines, power lines, or communication towers are also possible; however these are expected to be limited to a few individual birds. Any increase in predator populations, however, could result in decreased reproductive success for seabirds. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining such as jaegers and arctic tern (Mallek et al. 2003). Biologists may cause additional mortality during intensive nest search activities (Noel et al. 2002b). This disturbance which flushes birds from nests would be beneficial to glaucous gulls and arctic foxes, which may key into these activities to increase their foraging efficiency.

PASSERINES

The following passerine species may be may be most affected by the proposed developments in Alternative A, based on abundance of more than 1 nests/km^2 or occurrence of common ravens in Table 3.3.3-7 and Section 3.3.3.8 Passerines – Plan Area:

- Colville River Delta – Lapland longspur, Savannah sparrow, common raven
- CD-5 – Lapland longspur
- CD-6 – Lapland longspur
- CD-7 – Lapland longspur, Savannah sparrow
- The National Petroleum Reserve-Alaska Area – Lapland longspur, Savannah sparrow, common redpoll

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter mining and placement of gravel during construction would account for most of the direct habitat loss for Alternative A. Approximately 306 acres would be covered by gravel or mined and lost as potential nesting and foraging habitat for passerines. Habitat losses from gravel fill would be long-term. An estimated 32.7 passerine nests, primarily Lapland longspur nests, would be affected by habitat loss due to gravel placement. Habitats used by passerines that would be lost or altered by gravel placement in the Plan Area include Moist Sedge-Shrub Meadow (2.4 % of habitat in the Colville River Delta; 0.6 % of habitat altered in the National Petroleum Reserve-Alaska), Moist Tussock Tundra (0.2 % in the Colville River Delta; 1.2 % altered in the National Petroleum Reserve-Alaska), Riparian Low and Tall Shrub (0.1 % altered in the National Petroleum Reserve-Alaska), and Riverine or Upland Shrub (0.5 % in the Colville River Delta). Removal of gravel from the ASRC and Clover gravel sites would result in loss of tundra habitat and creation of aquatic habitats when the gravel sites are reclaimed (Appendix O). Structures such as towers, buildings, and VSMs for pipeline support would provide additional nesting habitat for common ravens and snow buntings.

Development of ponds and thermokarsting of soils caused by gravel placement would negatively alter habitat for passerine species. An estimated 146.1 passerine nests, primarily Lapland longspur, would be affected by habitat alteration due to gravel fill (Table 4A.3.3-2).

The construction of ice roads to facilitate gravel road, pad, and pipeline construction would result in a temporary loss of nesting habitat because ice roads would melt later than surrounding areas, and passerines likely would be well into incubation before the ice roads melted. An average of 210 acres of ice roads per year would affect an estimated 27.2 passerine nests (Table 4A.3.3-2). Construction of ice roads also may temporarily disturb underlying vegetation and soils, reducing habitat quality for one or two additional nesting seasons. Of particular importance to passerines that prefer willow and other tall shrub habitat would be stream crossings where tall shrubs may be damaged by compacted ice (McKendrick 2000a).

Disturbance and Displacement

Winter construction activities would not disturb or displace most passerines. Common ravens are the only resident passerine species on the North Slope. They may be attracted to construction activities by access to human food, shelter from wind, and access to warm air vents.

During the spring and summer, increased human activity along roads (primarily vehicles), at production pads (vehicles and pedestrians), and at the CD-3 airstrip (fixed-wing aircraft, vehicles, and pedestrians) to facilitate summer construction of pad infrastructure may disturb or displace some passerines, primarily Lapland longspurs, which are the most abundant nesters.

Passerine nests were not displaced from the area around an airstrip at the Alpine Development Project (Johnson et al. 2003a). Lapland longspurs nested in higher densities near an active Alpine airstrip than they did away from the airstrip, although the trend was not significant. Other passerines nested in densities too low to evaluate (Johnson et al. 2003a). See other species group descriptions for a discussion of the range of responses to aircraft noise.

Obstructions to Movements

The construction of gravel roads and pads is not anticipated to obstruct movements of passerines because birds can fly and brood-rearing passerines raise their young in the nest until they are capable of flight.

Mortality

A few individual passerines may die if they fly into production pads, pipelines, buildings, or power lines or if they collide with vehicles as they fly across roads. Towers and building may provide nest sites and perching habitat for common ravens, which may increase nest depredation among tundra-nesting passerines (Johnson et al. 2003a, Murphy and Anderson 1993).

Nesting success for passerines averaged 68 % in the Plan Area (Johnson et al. 2004). Construction of oil development facilities may result in an increase in predator species such as foxes, bears, glaucous gulls, and common ravens. Any increase in predator populations could result in decreased reproductive success for passerines. The magnitude and extent of this potential decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining. Biologists may cause additional mortality during intensive nest search activities (Noel et al. 2002b). This disturbance which flushes birds from nests would be beneficial to glaucous gulls and arctic foxes, which may key into these activities to increase their foraging efficiency.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Some habitat loss or alteration from snowdrifts, gravel spray, dust fallout, thermokarst, and ponding would continue during project operation. Impacts from ice road construction would be similar to those discussed for construction. However, if ice roads are placed in the same location annually, impacts to the tundra and tall shrubs could be longer-term. Habitat alterations during the operation period may include changes in tundra vegetation from use of low-ground-pressure vehicles during summer or winter. Impacts from habitat alterations during operations would be similar to those on other bird species.

Addition of towers, buildings, and pipelines enhances nesting habitat for common ravens and snow buntings. Common ravens have increased in the Plan Area from a single pair in the late 1950s to about 20 individuals in 2003 (Helmericks 2004). Long-term storage of oilfield equipment provides nesting habitat for snow buntings in the Prudhoe Bay Oilfield, and construction of new facilities on production pads provides nesting habitat for common ravens.

Disturbance and Displacement

Disturbance and displacement of passerines during operational activities would probably have little to no impact on passerines. These activities did not appear to disrupt nesting at the Alpine Development Project during construction, and levels of most human activities are expected to be lower during operations (Johnson et al. 2003a).

Obstructions to Movements

Obstructions to movements would be the same during the operation phase as during the construction phase.

Mortality

Direct mortality of a few passerines would occur during operational activities as a result of collisions with infrastructure or vehicles. An increase in common ravens or other predators as a result of oilfield infrastructure could result in low-level increases of passerine mortality during nesting. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds. Researchers may cause nest success to decrease by disturbance of nesting birds thereby increasing depredation.

ABANDONMENT AND REHABILITATION

The impacts of abandonment and rehabilitation on birds would be similar in many respects to that incurred by construction activity. Activities that occur in the winter would cause little disturbance or displacement, because most species are absent from the area during the winter. However, ice roads may be delayed in melting compared to surrounding tundra, and impoundments of water may be caused by the persistence of ice roads after the snow had melted off the surrounding tundra. Delay in the melting of ice roads compared to the surrounding tundra could cause either complete loss of nesting habitat for a season, or compaction of vegetation, which would reduce the quality of the nesting habitat for that nesting season. Such impacts would only affect nesting in the summer following ice road use, and the impacts would be minor. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to birds similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips are not revegetated, they would remain lost habitat for birds. If they are revegetated without removing the gravel, the habitat would not return to its current utility for most birds of the area. If gravel is removed, habitat similar to that currently existing in the area could be created and used by birds, though the precise mix of rehabilitated habitat types would likely not be the same (Kidd et al., 2004). Foam insulating materials that could be used in pad construction may be broken up in the course of removal. Fine particles of foam that may not be removed from the environment could be ingested by some birds incidentally; depending on the material’s toxicity and the amount ingested, this could cause mortality, though the numbers are likely to be very small. Overall impacts of abandonment and rehabilitation activities would be localized with no adverse impacts to North Slope populations expected.

4A.3.3.2 Alternative A – Full-Field Development Scenario Impacts on Birds

Under the FFD scenario for Alternative A, the mechanisms associated with impacts related to habitat loss and alteration, disturbance and displacement, obstruction to movements, and mortality for birds in the three facility group areas would be the same as those described under Alternative A for the ASDP. Under Alternative A of the FFD, roads would link all production pads, except for four pads in the lower Colville River Delta and the HP-22 pad in the Kalikpik-Kogru Rivers Facility Group, to processing facilities and to the existing Alpine Development Project facilities. Airstrips would be constructed at the production pads in the lower Colville River Delta and at HP-22 in the Kalikpik-Kogru Rivers Facility Group for maintenance and operational support. Hypothetical development summarized by three facility groups, Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers, would be in addition to the development proposed under Alternative A of the ASDP, and the potential impacts described below would be in addition to those described under Alternative A for the ASDP. The effects of FFD on species within the various bird groupings would depend on the location and extent of development in specific locations within each area. Potential impacts might be less well understood for some portions of the ASDP area because less intense study has occurred.

COLVILLE RIVER DELTA FACILITY GROUP

No roads are hypothesized in this part of the Plan Area. Pipelines would be constructed over several major watercourses including the Elaktoveach Channel, Kupigruak Channel, Tamayayak Channel, and the main stem of the Colville River. In-stream construction activities at these water bodies would have the potential to cause impacts as described in Section 4A.3.3.1.

A summary of the essential numbers of bird nests affected by the hypothetical FFD in the Colville River Delta Facility Group based on nesting densities reported for the Colville River Delta are presented in Table 4A.3.3-4.

TABLE 4A.3.3-4 ALTERNATIVE A – FFD SCENARIO – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Bird Group	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total[a]
Colville River Delta Facility Group					
Waterfowl	4	14	3	33	54
Loons	1	2	0	5	8
Ptarmigan	1	2	0	4	7
Raptors and Owls	0	0	0	0	0
Seabirds	1	2	0	4	7
Shorebirds	72	217	41	0	330
Passerines	35	107	20	0	162
Total Nests	**114**	**344**	**64**	**46**	**568**
Fish-Judy Creeks Facility Group					
Waterfowl	39	131	3	15	188
Loons	5	16	0	2	23
Ptarmigan	2	5	0	1	8
Raptors and Owls	0	0	0	0	0
Seabirds	8	28	1	3	40
Shorebirds	187	631	18	0	836
Passerines	123	415	12	0	550
Total Nests	**364**	**1,227**	**34**	**20**	**1,645**
Kalikpik-Kogru Rivers Facility Group					
Waterfowl	12	53	7	30	102
Loons	2	5	1	4	12
Ptarmigan	1	2	0	1	4
Raptors and Owls	0	0	0	0	0
Seabirds	3	11	2	6	22
Shorebird	59	253	36	0	348
Passerines	39	167	23	0	229
Total Nests	**115**	**492**	**69**	**41**	**717**

Notes:
[a] See Section 4A.3.3 for assumptions and calculation methods

HABITAT LOSS, ALTERATION, OR ENHANCEMENT

In addition to habitat loss described under Alternative A – CPAI Development Plan for the ASDP, there would be additional habitat loss in the Colville River Delta for airstrips associated with the HP-7, HP-12, HP-13, and HP-14 sites. Gravel roads would connect HP-4, HP-5, and HP-8 to the Alpine Development Project.

Extensive nesting and brood-rearing surveys have been conducted in the Colville River Delta for loons and some waterfowl species (Johnson et al. 1999, Burgess et al. 2003a, Johnson et al. 2003a). Brood-rearing white-fronted geese have been reported in the vicinity of the HP-4, HP-5, HP-7, and HP-13 sites (Johnson et al.

2003b). A small brant colony and broods have been reported near the proposed HP-13 site, and the large Anachlik brant colony is near the HP-14 site (Johnson et al. 2003b). Fall-staging brant have been reported at the HP-7, HP-11, HP-13, and HP-14 sites (Johnson et al. 2003b). Tundra swan nests and broods are distributed throughout the Colville River Delta and have been reported in the vicinity of all the proposed FFD pads except HP-14 (Johnson et al. 2003b). These studies indicate that nesting yellow-billed loons could be affected by habitat loss and alteration at the HP-4, HP-5, HP-7, and HP-8 sites, and broods were reported near the HP-4 and HP-7 sites (Johnson et al. 2003b). Pacific loon nests and broods have also been reported in the general area of these proposed production pads as well as at the HP-13 site (Johnson et al. 2003b). During pre-nesting surveys, king eiders were recorded at numerous locations in the Colville River Delta including the proposed sites at HP-13 and HP-14, although king eiders were much more abundant in the transportation corridor between the Delta and the Kuparuk Oilfield (Johnson et al. 2003b).

Distribution information for gulls was available for four of the seven areas proposed for hypothetical FFD. Glaucous gulls used areas adjacent to HP-8, HP-4, HP-7 for nesting and brood-rearing, but did not use areas near HP-5 (Johnson et al. 2003b, Burgess et al. 2003a).

Ptarmigan, raptors and owls, seabirds, shorebirds, and passerines are expected to occur throughout the development area in numbers and distributions similar to the survey area covered for CPAI Development Plan alternatives in the Colville River Delta (Burgess et al. 2003a; Johnson et al. 2003a, 2003b). Densities for these species generated from intensive surveys were used to calculate the numbers of nests potentially affected by gravel placement. These bird groups use habitats in the Colville River Delta for brood-rearing, foraging, and migration staging.

DISTURBANCE AND DISPLACEMENT

Under Alternative A FFD in the Colville River Delta, aircraft traffic and noise would likely be a source of disturbance to birds, although disturbance related to vehicular traffic and machinery could also affect birds along the access roads to HP-4 and HP-5 and along the access roads from production pads to airstrips. The road from Nuiqsut could increase the potential for local traffic to affect birds along the access roads to the CD-2, CD-4, HP-4, HP-5, and HP-8 sites. The types of disturbances would be the same as those described above under Alternative A for the ASDP sites.

The density of nesting birds would be further reduced as a result of disturbance from the four additional airstrips in the lower Colville River Delta (Johnson et al. 2003a). Brood-rearing and staging waterfowl and loons in the lower Colville River Delta would also be disturbed and potentially displaced from the lower Delta by air traffic. Nesting and brood-rearing waterfowl occurring near the airstrips may need to be hazed from airstrips, increasing disturbance.

The few ptarmigan that nest in the lower Colville River Delta are not likely to be disturbed by the four additional airstrips. The few raptors and owls that nest in the Colville River Delta are not likely to be disturbed by the four additional airstrips in the lower Colville River Delta during nesting. A few foraging raptors may be disturbed or displaced by air traffic in the lower Colville River Delta when they concentrate to forage on staging shorebirds. Nesting, brood-rearing, and staging seabirds would be disturbed by the four additional airstrips in the lower Colville River Delta. The lower Colville River Delta is an important feeding area for post-breeding shorebirds. Foraging flocks of shorebirds would be disturbed and displaced from tidal habitats used in the lower Delta. An estimated 1,250 shorebirds would be potentially displaced by air traffic disturbance from 789 acres of Barrens, Tidal Flat, and Salt Marsh habitats within 500 meters of airstrips at HP-7, HP-12, HP-13 and HP-14. Nesting and foraging passerines would be disturbed by air and vehicle traffic and potentially displaced from adjacent habitats used in the Colville River Delta.

OBSTRUCTIONS TO MOVEMENTS

Under the FFD scenario for Alternative A in the Colville River Delta Facility Group, there would be little increase in the potential for the proposed development to obstruct bird movements. Most of the proposed sites are roadless, and there is little evidence that pipelines may present more than occasional, temporary obstruction to bird movements. Access roads would be constructed for the HP-4, HP-5, and HP-8 sites, and brood-rearing waterfowl and loons may have some difficulty crossing these roads, especially during the construction period. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, may help to mitigate the potential for roads to obstruct bird movements.

MORTALITY

Mortality of waterfowl and loons, ptarmigan, seabirds, shorebirds, and passerines would result from collisions with vehicular traffic, buildings, pipelines, and bridges. Under Alternative A FFD, traffic levels in the Colville River Delta would be minimal because of the roadless condition of most of the project. However, mortality from collisions with aircraft would be increased for all bird groups by the four airstrips in the outer Colville River Delta. Seabirds, especially gulls, are particularly vulnerable to collisions with aircraft. Mortality-causing impacts from aircraft collisions could be mitigated by hazing of waterfowl and seabirds away from active airstrips.

Increased depredation from predators attracted to the proposed development could increase mortality of tundra-nesting adult birds, eggs, and chicks. In particular, seabirds, especially glaucous gulls, are likely to be attracted to the area. Road access from Nuiqsut may allow for increased subsistence hunting pressure on waterfowl and increased bird mortality near the CD-2, CD-4, and hypothetical HP-4, HP-5, and HP-8 sites. Alternatively, subsistence hunting could decrease in areas with oilfield developments if hunters avoid these areas.

FISH-JUDY CREEKS FACILITY GROUP

A summary of essential numbers of bird nests affected by the hypothetical FFD in the Fish-Judy Creeks Facility Group is presented in Table 4A.3.3-4.

HABITAT LOSS AND ALTERATION

Nesting, brood-rearing, and staging waterfowl and loons would be affected by habitat loss and alteration resulting from gravel placement. The following species have been recorded at hypothetical pad and production facilities in the Fish-Judy Creeks Facility Group (Burgess et al. 2003b, Noel et al. 2002c):

- HP-1: greater white-fronted goose, Canada goose, tundra swan, Pacific loon, yellow-billed loon
- HP-2: greater white-fronted goose, Canada goose, Pacific loon, yellow-billed loon
- HP-3: greater white-fronted goose, Canada goose, snow goose, brant, Pacific loon
- HP-6: Canada goose, brant, tundra swan, Pacific loon
- HP-15: greater white-fronted goose, brant, Pacific loon
- HP-16: tundra swan, Pacific loon, yellow-billed loon
- HP-17: tundra swan, Pacific loon
- HPF-1: greater white-fronted goose, tundra swan, yellow-billed loon.

Ptarmigan, raptors and owls, seabirds, shorebirds, and passerines are expected to occur throughout the development area in numbers and habitats similar to the survey area covered for the CPAI Development Plan alternatives in the National Petroleum Reserve-Alaska (Burgess et al. 2003b).

DISTURBANCE AND DISPLACEMENT

Under Alternative A FFD in the Fish-Judy Creeks Facility Group, vehicular traffic and other activities associated with the road system would be the greatest source of disturbance. In addition, noise associated with hypothetical processing facility HPF-1 could also affect birds. The mechanisms of impacts would be the same as those described above under Alternative A for the ASDP sites.

Traffic along the road that runs parallel to and crosses Judy Creek in two places would disturb female buff-breasted sandpipers that use stream corridors for migration, rest breaks during nesting, and brood rearing. Buff-breasted sandpipers were recorded on plots northeast of the proposed HPF-1 location (Burgess et al. 2003a). The proposed development would affect small amounts of habitats potentially used by this species.

OBSTRUCTIONS TO MOVEMENTS

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, potential obstruction to bird movements could occur along the road system, particularly if traffic levels are high. Traffic levels are primarily the result of industry use and could increase if the roads are open to local traffic. In general, roads do not present obstructions to bird movements. High traffic levels or high speeds on roads could pose some obstruction to bird movements if birds were displaced by disturbance. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, may help to minimize potential for roads to obstruct bird movements.

MORTALITY

Other than mortality related to an oil spill, there would likely be little mortality related to the development under Alternative A FFD. Mortality of a few individual birds would result from collisions with vehicles. The potential for bird mortality associated with vehicular collisions under Alternative A FFD would be increased by the addition of 75 miles of road system. The level of mortality would probably be limited to a few individuals every year. Speed limits along roads, particularly during periods of poor visibility and during brood-rearing, may help to reduce the potential for collisions of birds with vehicles.

Some mortality to a few individuals or small flocks would result from collisions with structures such as elevated pipelines, communication towers, production modules, or bridges. The potential for bird mortality to result from collisions with structures under Alternative A FFD would be increased from CPAI Alternative A by the addition of 80 miles of pipelines.

Road access from Nuiqsut may increase the potential for subsistence hunting to affect birds along the entire road system for the Fish-Judy Creeks Facility Group. The potential for increased levels of depredation to affect tundra-bird nest success may increase under Alternative A FFD because of the increase in the amount of infrastructure. Studies at the Alpine Field have indicated that predators other than common ravens and glaucous gulls have not increased in response to the development (Johnson et al. 2003a). In recent years, oilfield operators have placed garbage that could attract predators into predator-proof dumpsters, and oilfield workers have been educated about the problems associated with feeding wildlife. Continuation of these practices in the FFD may help to minimize potential impacts to tundra-nesting birds.

There is evidence that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Götmark 1992). Birds that are flushed from their nests during surveys may be more susceptible to nest predation than undisturbed birds. Ongoing activities by researchers could cause some mortality to eggs and chicks of tundra-nesting birds. Increased aerial survey efforts from agency- and industry-sponsored studies to support development within the National Petroleum Reserve-Alaska may cause additional flushing and disturbance of pre-nesting waterfowl.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

A summary of the estimated number of bird nests affected by the hypothetical FFD in the area of the Kalikpik-Kogru Rivers Facility Group is presented in Table 4A.3.3-4.

HABITAT LOSS, ALTERATION, OR ENHANCEMENT

Habitat loss and alteration could occur in addition to that identified for the CPAI Development Plan Alternative A in the Kalikpik-Kogru Rivers Facility Group as a result of gravel placement for four well pads, a processing facility, one airstrip, and 40 miles of gravel access roads (Table 4A.3.3-4). Waterfowl and loon concentrations are expected to be similar to those in other areas surveyed for waterfowl in the National Petroleum Reserve-Alaska (Johnson et al. 2003b, Noel et al. 2002c).

DISTURBANCE AND DISPLACEMENT

Under Alternative A FFD for the Kalikpik-Kogru Rivers Facility Group, vehicular traffic and other activities associated with the road system would be a source of disturbance to birds. Road access from Nuiqsut may increase the potential for local traffic to disturb birds along the entire road system of the Kalikpik-Kogru Rivers Facility Group. In addition, noise associated the hypothetical HPF-2 and air traffic at the HP-22 airstrip would disturb birds. The types of impacts would be the same as those described above for the CPAI Development Plan sites.

OBSTRUCTIONS TO MOVEMENTS

Under Alternative A FFD for in the Kalikpik-Kogru Rivers Facility Group, potential obstruction to bird movements would be increased by the addition of the road system, particularly if traffic levels are high. Traffic levels are primarily the result of industry use and would increase if the roads were open to local traffic. In general, roads do not present obstructions to bird movements. However, high traffic levels or high speeds on roads could pose some obstruction to bird movements. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, could help minimize the potential for roads to obstruct bird movements.

MORTALITY

The potential of the Alternative A FFD to affect mortality of tundra-nesting birds in the Kalikpik-Kogru Rivers Facility Group would be similar to that discussed above for the Fish-Judy Creeks Facility Group. The potential impacts might be less than those for the Fish and Judy creeks area because of the reduced amount of infrastructure in the Kalikpik-Kogru Rivers Facility Group. Road access from Nuiqsut may increase access and the potential for subsistence hunting to affect birds in the Kalikpik-Kogru Rivers Facility Group. Air strikes could cause additional mortality at the coastal airstrip at HP-22, particularly for waterfowl and seabirds.

There is evidence that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Götmark 1992). Birds that are flushed from their nests during surveys could be more susceptible to nest predation than undisturbed birds. Ongoing activities by researchers could cause some mortality to tundra-nesting bird eggs and chicks. Increased aerial survey efforts from agency- and industry-sponsored studies to support development within the National Petroleum Reserve-Alaska could cause additional flushing and disturbance of pre-nesting waterfowl.

4A.3.3.3 Alternative A – Summary of Impacts (CPAI and FFD) on Birds

Impacts to birds associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Additional impacts due to lost productivity are not quantified by this analysis, including impacts due to increased nest depredation caused by increased predator populations. We estimated the number of nests effected by habitat loss, alteration or disturbance for each alternative, based on site specific nesting densities for bird species and species groups to compare alternative development scenarios.Effects would be localized, and no measureable effects to North Slope populations would be expected. CPAI Alternative A would reduce nesting by 2 % or less for Plan Area waterfowl, loon and seabird populations and less than 1 % for Plan Area shorebird and passerine populations. Alternative A – FFD Scenario would reduce nesting by 3 to 6 % for Plan Area waterfowl, loon and seabird populations and 1 % for Plan Area shorebird and passerine populations. Habitat loss does not involve the direct loss of active nests because winter gravel placement, iceroad construction, snow dumping, and snowdrifting occurs when nests are not active. Most impacts would be initiated during the construction period, including gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The effects of these activities on estimated bird production due to loss, alteration or disturbance of nesting habitat for Alternative A, CPAI Development Plan and the FFD, are presented in Table 4A.3.3-5.

4A.3.3.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Birds

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the FFD Plan Alternative A.

OBSTRUCTIONS TO MOVEMENTS

- Traffic speeds on roads would be reduced during brood-rearing.

MORTALITY

- Collisions with power lines could be minimized by marking lines with bird flight diverters.
- Waterfowl and seabirds would be hazed away from active airstrips to prevent collisions with aircraft.
- Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on tundra nesting birds.

TABLE 4A.3.3-5 ALTERNATIVE A (CPAI AND FFD) – ESTIMATED NUMBER OF BIRD NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Bird Group	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total
CPAI Alternative A Totals[a]					
Waterfowl	9	40	7	21	77
Loons	1	5	1	3	10
Ptarmigan	1	2	1	0	3
Seabirds	1	8	2	2	13
Shorebirds	54	247	45	0	346
Passerines	33	146	27	0	206
Total Nests	**99**	**448**	**83**	**26**	**655**
FFD Scenario A Totals[a]					
Waterfowl	55	198	13	78	344
Loons	8	23	1	11	43
Ptarmigan	4	9	0	6	19
Seabirds	12	41	3	13	69
Shorebirds	318	1,101	95	0	1,514
Passerines	197	689	55	0	941
Total Nests	**593**	**2,063**	**167**	**107**	**2,930**

Notes:
[a] See Section 4A.3.3 Birds for assumptions and calculation methods. Totals from Tables 4A.3.3-2 and 4A.3.3-4.

4A.3.3.5 Alternative A –Effectiveness of Protective Measures for Birds

Stipulations 18 and 22 from the Northeast National Petroleum Reserve-Alaska IAP/EIS would help reduce disturbance of birds from ground transport and other activities; protect essential habitat by offsetting iceroad location annually; and restrict vehicle use to minimize vegetation-damaging and erosion-causing activities.

Aircraft disturbance of birds would be mitigated by maintenance of seasonal minimum flight altitudes (stipulation 56).

In addition to these stipulations, potential mitigation identified in this EIS would reduce disturbance and mortality associated with ground transportation by limiting traffic and reducing speeds, and reduce aircraft associated mortality by hazing birds away from active airstrips.

4A.3.4 Mammals

4A.3.4.1 Terrestrial Mammals

In this section we describe the potential impacts of Alternative A, considering general impact categories as in other recent impact assessments (TAPS Owners 2001, BLM 2002a, PAI 2002a). These categories include direct habitat loss, alteration, or enhancement; obstruction of movement; disturbance and displacement; and mortality. Impacts are addressed for the construction period, operation period, and FFD. It is important to recognize that several factors besides those directly associated with oilfield development and operations can affect the number and distribution of terrestrial mammals. These include habitat condition, population density, immigration/emigration, predation, hunting by humans, and other disturbances (Cronin et al. 1997, 1998b; BLM and MMS 1998a). In addition, population numbers and distribution and range condition may change, so impacts are potentially variable over time. Background information on terrestrial mammals in the Plan Area is presented in Section 3.3.4.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON TERRESTRIAL MAMMALS

Important characteristics of Alternative A with regard to effects on terrestrial mammals include the following. Alternative A would include 26 miles of road and 36 miles of pipeline (Figure 2.4.1.1-1). The pipelines in Alternative A have an adjacent road, except the route to the CD-3 in the Colville River Delta. There would be one new airstrip in Alternative A at CD-3. The total gravel fill (pads, roads, airstrips) for Alternative A would be 240 acres. In Alternative A, pipelines would be elevated to 5 feet, and industry and local residents would use the roads.

CONSTRUCTION PERIOD

Much of the construction of the CPAI Development Plan Alternative A would occur in winter, although considerable activity will occur year-round (Table 2.3.10-1). The primary terrestrial mammal species that could be affected during the construction period are caribou, muskoxen, moose, foxes, and grizzly bear. Caribou, fox, and grizzly bears may be in the Plan Area year-round, although moose and muskoxen are uncommon in the Plan Area in winter. In winter, grizzly bears will be in dens and could be affected by noise from ice road and gravel road construction, Rolligon traffic, and pipeline installation within a mile of a den. Improperly stored garbage and direct feeding by people can cause food conditioning in foxes and potentially locally increase fox populations, although regulations prohibit such feeding.

Direct Habitat Loss, Alteration, or Enhancement

The construction phase of the ASDP is scheduled to occur between 2005 and 2010. Ice roads used for construction of roads, pads, and airstrips, and the areas covered with gravel, would comprise the areas of lost wildlife winter forage. Gravel fill has an impact on wildlife habitats in the Arctic because the loss of vegetation is long-term and revegetation of gravel sites may be difficult (PAI 2002a). Areas covered with gravel are effectively removed as foraging habitats for terrestrial mammals unless vegetation is restored. However, gravel fill may create insect relief habitat for caribou (Pollard et al. 1996a, 1996b) and possibly other species (such as muskoxen and moose).

Alternative A would result in construction of gravel roads from CD-1 to CD-4, and from CD-2 to CD-5, CD-6, and CD-7. Table 4A.3.4-1 lists the surface area that would be covered by gravel fill for pads, roads, and airstrips for the six action alternatives, and Table 4A.3.4-2 lists the miles of roads and pipelines for each of the six action alternatives. Table 4.A.3.1-2 lists total surface areas for each type of habitat in the Plan Area that would be replaced by gravel fill for the six alternatives. Road gravel would already be in place for production pad construction of CD-5. No road is planned to CD-3, so the pipeline would be constructed with access by ice road (about 35 feet wide).

TABLE 4A.3.4-1 APPROXIMATE ACRES OF GRAVEL FILL FOR PADS, ROADS, AIRSTRIPS, AND TOTAL FOR THE SIX ALTERNATIVES

Alternative	Pads and Airstrips	Roads	Total
A	67	174	241
B	135	69	204
C-1	47	276	323
C-2	49	275	324
D-1	221	0	221
D-2	71	0	71
F	69	182	251

TABLE 4A.3.4-2 MILES OF ROADS AND PIPELINES FOR THE SIX ALTERNATIVES

Alternative	Roads with Pipeline	Total Pipelines	Pipeline Without Road
A	26	36	10
B	10	36	26
C-1	42	42	0
C-2	37	41	4
D-1	0	33	33
D-2	0	33	33
F	28	37	9

The placement of gravel fill in Alternative A would reduce summer and winter forage available for caribou, moose, and muskoxen. It is not known if the numbers of these species on the North Slope are limited by forage in any season. However, the loss of forage habitat is a small part of the Plan Area, so this impact would be small in magnitude during the construction period. This could change as populations fluctuate and range conditions change. See the Operation Period subsection below for quantification of habitat types lost or altered beneath gravel fill.

Grizzly bears could lose some foraging habitat and den habitat beneath the gravel fill placed under Alternative A. Because bears on the North Slope generally use a den only once (Shideler 2000) avoiding old dens during construction would not necessarily mitigate impacts. In general, the entire Colville River Delta and well-drained areas west of the Colville River are considered potential den habitat for grizzly bears without specific high-concentration areas identified. The ADF&G has recently expanded surveys to include the Northeast National Petroleum Reserve-Alaska, and identified a number of dens used by both marked and unmarked bears in areas along Fish and Judy creeks and the Kalikpik River. This indicates these areas may be used considerably as den habitat. (Shideler, pers. comm. 2003). Potential loss of grizzly bear den habitat under Alternative A is discussed in the Operation Period subsection below.

There are few data on site-specific den densities in the Northeast National Petroleum Reserve-Alaska, but aerial surveys within the Fish-Judy Creeks Facility Group found five bear dens within a 425-mi^2 (1,100-km^2) area (Burgess et al. 2003b). All dens were within 2 miles of riparian areas. Three dens were near Fish Creek, and one den was near the Ublutuoch River. The dens were at least 3 miles apart. Good den habitat is probably scattered throughout the Plan Area, particularly in upland areas and river banks, and some dens could be affected by development. Most bears initially collared in the Kuparuk area, but re-collared in the National Petroleum Reserve-Alaska, were found in the Ocean Point area. Results from recent surveys by the ADF&G indicate that bears occur throughout the Plan Area, particularly in riparian areas (Shideler, pers. comm.). However, there are no data to suggest that the number or distribution of bears is limited by den habitat within the Plan Area, so impacts to the population during the construction period would probably be small in magnitude.

Fox dens also may be affected by construction activities, although they vary in activity annually and may not be relevant to long-term predictions. Within the Colville River Delta Facility Group in Alternative A, the road from CD-1 to CD-4 could be close to one inactive (summer 2002) red fox den (Johnson et al. 2003a). Within the vicinity of the Fish-Judy Creeks Facility Group, the pipeline/road complexes may be close to or may cover one inactive arctic fox den between CD-2 and CD-5, one inactive and two active arctic fox dens between CD-5 and CD-6, and three inactive and one active arctic fox den between CD-6 and CD-7. Sites suitable as potential denning habitat would likely be covered by gravel, but den site availability on the North Slope probably does not limit fox populations (Burgess 2000). Red foxes and arctic foxes have made dens in culverts and other oilfield structures on the North Slope (Burgess et al. 2002b) so a small amount of artificial habitat suitable for use as den sites may be created. Arctic foxes generally do not avoid human activity where they are not harassed or hunted. Arctic foxes may be particularly attracted to human activity or developed sites in winter when food is scarce or they are seeking shelter (NRC 2003). Aggregations of foxes have been found in winter at garbage dumps on the North Slope and adjacent to other developed areas in the past (Burgess 2000). However, proper implementation of plans to prevent feeding wildlife in the Plan Area as outlined by the BLM and MMS (1998b) and state regulation can prevent foxes (and bears) from becoming habituated to human food.

Wolves, wolverines, and red foxes are uncommon in the Plan Area (Burgess et al. 2003b, Johnson et al. 1999) and the loss of habitat from construction activity would be limited (BLM and MMS 2003). Red foxes den annually in the ASDP Area, with approximately two or three dens per year on the Delta and probably a similar number in the National Petroleum Reserve-Alaska. Some small-mammal habitat would be lost beneath gravel fill and ice roads. For example, arctic ground squirrels occur in areas with well-drained, stable soils. However, the amount of habitat lost will be small compared to that available in the Plan Area.

Obstruction of Movements

Construction and use of ice roads, gravel roads, and other infrastructure will occur during the summer and winter for several years. The structures themselves, and human activity, may obstruct the movement of animals in the Plan Area. The mammals in the area may be particularly sensitive to human activity and novel infrastructure because they have not been exposed to it before as have the animals in the areas with existing oil fields to the east of the Plan Area. This may be particularly relevant for caribou of the TCH in the early years of the project because they have not been exposed to oilfields previously and they have been hunted regularly.

Obstruction of movements during the construction phase may be more pronounced than during the operation period because of the relatively high level of traffic and other activity (Table 2.3.10-1) (Pullman and Lawhead 2002). For example, in northeastern Alberta, roads obstructed caribou movements the most in late winter (Dyer et al. 2002). However, winter movements have not been significantly obstructed by the TAPS (TAPS Owners 2001a). In winter, caribou may seek areas with soft snow or windblown areas where snow tends to be shallow (Miller et al. 1982, Russell et al. 1993). Therefore, potential for obstruction of movements would be greatest if snow is deep during construction. Vehicle traffic on ice roads may be greater than 6,000 vehicles per month during the construction phase of Alternative A (Table 2.3.10-1), which could obstruct caribou movements to some extent. Use of the project roads for hunting access could obstruct caribou and other mammals' movements by deflecting animals away from roads from which hunting occurs.

Most of the CAH winters south and east of the Plan Area, and most of the TCH winters to the west and southwest of the Plan Area (PAI 2002a). However, considerable numbers of TCH caribou use winter ranges in the Plan Area (Figure 3.3.4.1-5) (Prichard et al. 2001; Burgess et al. 2002b, 2003b; BLM and MMS 2003), and some obstruction of movements could occur between CD-2 and CD-7 during construction of the road and pipeline. Ice roads, vehicle traffic, and construction activities may also affect the movements of muskoxen and moose during construction, although few of these species are likely to occur in the Plan Area in winter.

Construction during winter would not obstruct movements of grizzly bears that are in dens at that time. Arctic foxes are generally tolerant of human activities and may roam widely throughout the winter, depending on food supplies (Burgess 2000). Construction activities during this time are not expected to affect their movements. Foxes could be attracted to construction activities out of curiosity, even if food is not available.

Construction activities and noise may temporarily alter the distribution and movements of wolves, wolverine, and red foxes in the Plan Area. Wolves avoided highly-traveled roads in the Kenai National Wildlife Refuge but used closed or lightly traveled roads as travel corridors (Thurber et al. 1994). These species are not common in the Plan Area in the winter and impacts on them will be limited.

Disturbance and Displacement

In general, disturbance can be considered impacts that change behavior or cause stress in animals. Displacement refers to movement from one area to another in response to disturbance. It is important to note that disturbance and displacement can vary in intensity and over time. The construction activity for Alternative A will result in some disturbance to the terrestrial mammals in the Plan Area. If disturbance results in displacement from preferred habitats, or significant energy costs, it can have negative impacts on animals' condition, reproduction, or survival. If there is adequate alternative habitat and minor energy costs, disturbance and displacement may not negatively impact animals. Construction activity and new infrastructure may temporarily affect caribou distribution (Mahoney and Schaeffer 2002). Maternal caribou are more sensitive to disturbance than those without calves, especially during the calving period (de Vos 1960, Bergerud 1974, Roby 1978, Haskell 2003). For example, some caribou cows with calves avoided the trans-Alaska pipeline corridor and oilfield roads during construction (Cameron et al. 1979; Dau and Cameron 1986b; Johnson and Lawhead 1989; Lawhead et al. 2003). Construction activities of the Alternative A facilities in winter would avoid both the caribou calving period, and the summer when the largest number of caribou typically occur in the Colville Delta portion of the Plan Area (PAI 2002a). However, traffic levels will be much higher in the construction period than the subsequent operational period and some construction will occur year-round (Table 2.3.10-1). Densities of over-wintering TCH caribou in the vicinity of Judy and Fish creeks ranged from 0.3 to 0.75 caribou/km^2. Densities between May and October were 0.75 to 2.1 caribou/km^2 (Burgess et al. 2002b, 2003b). The areas south of the road to CD-7, near the Ublutuoch River, and in the vicinity of the Kalikpik and Kogru rivers have supported the highest densities of overwintering caribou in the Plan Area (BLM and MMS 2003, Figure 7). The Clover Potential Gravel Source, near the Ublutuoch River, might also support a high density of overwintering caribou. The potential disturbance associated with construction could cause the caribou in the vicinity to move more frequently and expend more energy (Smith et al. 2000). Caribou are relatively sedentary and less sensitive to disturbance during winter than during calving and summer periods, so these impacts would be limited (Skoog 1968, Dauphine 1976, Roby 1978). However, disturbance in the winter could still affect the animals negatively if it results in large energy loss or displacement to poor habitat.

There will be a considerable level of traffic during the summer construction periods also. This may result in disturbance and displacement of caribou and the other mammal species in the Plan Area. Disturbance would be localized around construction sites and the road and pipeline corridors associated with CD-3 and CD-4 in the Colville River Delta and CD-5, CD-6, and CD-7 in the vicinity of Fish and Judy creeks. If there is hunting in the area, caribou may be more sensitive to human activities than in unhunted areas and may avoid all human activity, including construction areas.

Moose and muskoxen are likely to occur in small numbers in the Plan Area during winter, and more frequently in the summer. Therefore, some disturbance may result from construction activities, especially in riparian areas. Few muskoxen occur west of the Colville River (Lenart 1999a), and the BLM and MMS (2003) identified the best potential habitat for muskoxen as south of the Plan Area. There is potential muskoxen habitat in the Plan Area. Studies on the North Slope show that undisturbed muskoxen tend to form larger groups and remain in a relatively small area in winter (27 to 70 km^2) than in summer (USGS 2002, Lenart 1999a). Female muskoxen drop calves in April and May before new vegetation emerges, and movement rates of satellite-collared animals were lowest at that time (Reynolds et al. 2002). The areas used in summer are significantly larger (223 km^2) than in winter or during the calving period (USGS 2002). Moose use riparian areas, especially those of the Colville River upstream of the Plan Area, and numbers in the Plan Area are generally small (Figure 3.3.4.1-10) (PAI 2002a). The relatively small numbers of muskoxen and moose and ample available habitat adjacent to the Alternative A infrastructure in the Plan Area suggest that disturbance and resulting displacement during construction would have limited impacts on these species.

Grizzly bears on the North Slope hibernate in dens beginning in late September and early November. They emerge between March and May. Bears in dens may be disturbed by the noise and activity during the winter construction associated with Alternative A (Reynolds et al. 1976, Shideler and Hechtel 2000). Grizzly bears hibernating in dens within a few miles of construction may be disturbed by noise from ice and gravel road construction, installation of pipelines, Rolligon traffic, and drilling operations (BLM and MMS 2003). Bears hibernating within 600 feet of construction activities may abandon their dens, which would result in negative impacts on those individuals, especially of newborn cubs (Reynolds et al. 1986, BLM and MMS 2003). Mortality could result if bears do not re-enter dens, and experience exposure and nutritional stress. Spatial and temporal restrictions on development activities could prevent abandonment of dens (Amstrup 1993). For example, stipulations to avoid known dens by 0.5 mile would mitigate this impact for some bears. Implementation of the 0.5mile avoidance stipulation and denning habitat away from the development area would minimize impacts on grizzly bears during construction. However, if bears enter dens and are undetected prior to construction activity, they will be susceptible to disturbance from construction noise. Small-mammal densities are unknown but are probably variable over years and by habitat type. The effects of disturbance on these species would be limited to the areas covered by ice roads and gravel deposition.

The winter distribution of arctic foxes is heavily influenced by food availability (Burgess 2000). Arctic foxes can habituate to human activity, so the effects of disturbance on foxes from winter construction would probably be small. However, if foxes are hunted or trapped, they might avoid human activity including construction areas. Similarly, noise and traffic from construction could displace wolves and wolverines from construction areas. However, few wolves and wolverines occur in the Plan Area, so impacts would be limited.

Mortality

Potential sources of mortality may include vehicle collisions, poisoning (e.g., ingestion of industrial materials), disease (such as rabies in foxes), nuisance or defense-of-life-and-property (DLP) kills, and enhanced predation or increased hunting. Accidental road kills of caribou, bears, and other mammals in the existing North Slope oilfields are uncommon (Murphy and Lawhead 2000; TAPS Owners 2001a; C. Rea, CPAI 2004, pers. comm.). During the winter construction period, grizzly bears would be in dens, and wolves, muskoxen, and moose are relatively uncommon in the Plan Area, so direct mortality of these species would likely be limited in winter. Caribou occur in the Plan Area in winter, and road kills are possible, especially with the high levels of traffic during construction (Table 2.3.10-1) and the dark driving conditions of winter. Foxes and other small mammals are also vulnerable to vehicle collisions, particularly in the winter because of the high traffic level and darkness. However, in the Kuparuk Oilfield between 1987 and 2003 there was only one fox-vehicle collision mortality reported (C. Rea, CPAI 2004, pers. comm.). Wildlife in the Plan Area has been exposed to hunting, so they may avoid human activity, which would reduce the chance of vehicle collisions, DLP mortality, or exposure to poisons. If any bears are displaced from denning locations they could either die from exposure, lack of nutrition, or they could be killed in DLP.

OPERATION PERIOD

The same general impacts described in other oilfield operations are relevant to this project (BLM and MMS 1998a, 2003; TAPS Owners 2001a; Truett and Johnson 2000; BLM 2002a). In this section on the Operation Period under CPAI Development Plan Alternative A, we briefly review the literature dealing with the impacts of oilfield operations on terrestrial mammals. This background material will apply to all Alternatives.

Direct Habitat Loss, Alteration, or Enhancement

The extent of habitat directly lost under Alternative A would be that covered by gravel fill and tundra excavated to obtain that gravel. This would include 240 acres of vegetation under gravel roads, pads, and the airstrip at CD-3, and approximately 65 acres of vegetation cover could be lost at Clover. The primary habitat value lost would be forage for caribou, muskoxen, moose, and grizzly bear. As described below, the loss of forage for caribou, muskoxen, moose, and grizzly bear under gravel fill would be a small proportion of that available in the Plan Area. The amount of forage lost would probably be inconsequential to the animals using the Plan Area because alternative habitat would be available. Some natural denning habitat for grizzly bears and foxes could be lost. Anthropogenic (resulting from human activity) denning habitats for foxes could be created which could enhance fox reproduction or conversely, increase the probability of vehicle collisions or food conditioning and subsequent mortality.

Caribou, muskoxen, moose, and grizzly bears use a variety of habitat types on the Coastal Plain. Potential loss of preferred caribou habitat types resulting from gravel placement under Alternative A are quantified below. During calving, caribou use moist tundra and feed on *Eriophorum vaginatum* (tussock cottongrass). Their diet broadens during the summer after calving and include *Eriophorum vaginatum* (tussock cottongrass), *E. angustifolium* (tall cottongrass), *Carex aquatilis* (aquatic sedge), and *Salix planifolia* ssp. *pulchra* (diamond-leaf willow) (Murphy and Lawhead 2000; PAI 2002a; Jorgenson et al. 2003c, and references therein). These species occur in the two most important habitat types used by caribou during summer: Moist Sedge-Shrub Meadow and Moist Tussock Tundra (Section 3.3.4.1) (Lawhead et al. 2003, Russell et al. 1993, Jorgenson et al. 2003c). The Barrens habitat type also provides insect-relief to caribou in summer (Jorgenson et al. 2003c), and a small amount of this habitat would be lost under gravel fill. However, insect relief habitats would also be created on gravel roads, pads, and in areas shaded by pipelines and structures. Some TCH and CAH caribou overwinter on the coastal plain (Davis and Valkenburg 1978, Prichard et al. 2001, PAI 2002a), and the TCH animals may use habitats in the Plan Area. The fall and winter diets of caribou are dominated by lichens, which comprise 65 % of the winter diet of PCH caribou (Thompson and McCourt 1981, Russell et al. 1993, Murphy and Lawhead 2000). Caribou of the WAH also use mostly lichen (69 %) in addition to graminoids (19 %) during winter (Jandt et al. 2003). Muskoxen use a variety of habitats, depending upon the season. Sedges found in Moist Tussock Tundra and Moist Sedge-Shrub Meadow habitats are important forage plants for muskoxen in spring (Jingfors 1980, Reynolds et al. 1986, PAI 2002a). Willow, forbs (including legumes), and sedges (Robus 1984, O'Brien 1988, PAI 2002a) are important forage plants for muskoxen in late spring and summer. These plants occur in river terraces, gravel bars and shrub stands along rivers and tundra streams (Jingfors 1980, Robus 1981, PAI 2002a). Muskoxen select upland habitats that allow access to food plants, such as places with shallow, soft snow cover in upland habitats near ridges and bluffs (Klein et al. 1993, PAI 2002a). The most important habitat types for muskoxen on the Colville River Delta include the Riverine, Upland Shrub, and Moist Sedge-Shrub Meadow habitat types (PAI 2002a; BLM and MMS, 2003, and references therein). Potential losses of preferred muskoxen habitat types resulting from gravel placement under Alternative A are quantified below.

Moose range from the northern foothills of the Brooks Range to the Arctic Coast in the summer and move to riparian corridors of large river systems in fall. They concentrate in those riparian areas in winter. The largest winter concentrations are in the inland reaches of the Colville River (Carroll 2000b). In spring, moose generally remain in riparian areas, but also move to other areas. The tall shrubs, including willow and alder shrub thickets, are important browsing species for moose, particularly in winter (Mould 1979, PAI 2002a, BLM and MMS 2003). These plants occur in Riverine and Upland Shrub habitat types on the coastal plain, so these habitat types are important to moose. Potential losses of these preferred moose habitat types resulting from gravel placement under Alternative A are quantified below.

Hedysarum alpinum (peavine roots) and various legumes (found in river terraces and bars) are important food sources for grizzly bears in the early spring. *Equisetum arvense* (field horsetail) and various grasses and sedges are important forage plants in summer, and *Arctostaphylos rubra* (bearberry) is important in late summer and early fall (Shideler and Hechtel 2000). These plant species occur in the Riverine, Upland Shrub, and Moist Sedge-Shrub Meadow habitat types and sometimes in the Barrens habitat type, all of which are important for grizzly bears (Shideler and Hechtel 2000; Jorgenson et al. 2003c; PAI 2002a, and references therein). The Riverine and Upland Shrub habitat types are used by grizzly bears for foraging and denning areas, travel corridors, and access to prey species (such as ground squirrels) (Johnson et al. 1996, Shideler and Hechtel 2000). Other sites used by grizzly bears during the summer include ground squirrel mounds, meadows below snowbanks, and the ecotone between wet sedge and drier habitats (Shideler and Hechtel 2000). In addition to streambanks and hillsides, grizzly bears commonly den in pingos (Shideler and Hechtel 2000). Sand dunes and other well-drained areas that are more common in the Plan Area than areas to the east with existing oil field development could provide more of these habitats for bears. Potential losses of these preferred grizzly bear habitat types resulting from gravel placement under Alternative A are quantified below.

A total of 2,927 acres of Moist Sedge-Shrub Meadow are available in the Colville River Delta (Table 4A.3.3-3). A habitat map is available for 175,152 acres in the National Petroleum Reserve-Alaska, but not for the entire area (Figure 3.3.1.3-1). The total area of Moist Sedge-Shrub Meadow in the habitat-typed area of the National Petroleum Reserve-Alaska is 42,071 acres (Table 4A.3.3-3). A total of 43.2 acres (9.0 acres in the Colville River Delta, 34.2 acres in the National Petroleum Reserve-Alaska) of Moist Sedge-Shrub Meadow would be lost as a result of gravel placement (roads, pads and airstrips) under Alternative A (Table 4A.3.1-2). The potential loss of Moist Sedge-Shrub Meadow from gravel fill is less than 0.2 % of that available on the Colville River Delta. The proportional loss of habitat in the National Petroleum Reserve-Alaska cannot be calculated because a habitat map is not available for the entire area. However, in the part of the area for which habitat typing is available, the potential loss of Moist Sedge-Shrub Meadow habitat type resulting from gravel fill in the area in the National Petroleum Reserve-Alaska is less than 0.1 % of that available. In addition to that habitat affected by gravel fill, 258.7 acres (60.8 acres in the Colville River Delta; 197.9 acres in the National Petroleum Reserve-Alaska) of Moist Sedge-Shrub Meadow would be altered by dust and alteration of thermal and moisture regimes (as calculated for vegetation impacts in Section 4A.3.1).

The combined area of riverine and upland shrub habitats in the Colville River Delta is 7,994 acres (Table 4A.3.3-3). The combined area of riverine and upland shrub habitats in the habitat-typed area in National Petroleum Reserve-Alaska is 4,778 acres. A total of 8.3 acres (8.0 acres in the Colville River Delta, 0.3 acre in the National Petroleum Reserve-Alaska) of riverine and upland shrub habitats would be lost as the result of gravel placement (roads, pads, and airstrips) under Alternative A. The potential loss under gravel fill in the Colville River Delta and the habitat-typed area in the National Petroleum Reserve-Alaska is less than 0.1 % of the riverine and upland shrub habitats available in that area. In addition to gravel fill, 27.7 acres (26.1 acres in the Colville River Delta; 1.6 acres in the National Petroleum Reserve-Alaska) of riverine and upland shrub habitats would be altered by gravel fill related impacts.

A total of 525 acres of Moist Tussock Tundra habitat type is available in the Colville River Delta. The total area of Moist Tussock Tundra in the habitat-typed area of the National Petroleum Reserve-Alaska is 49,647 acres (Jorgenson et al. 2003c). A total of 96.5 acres (1.1 acres in the Colville River Delta, 95.4 acres in the National Petroleum Reserve-Alaska) of Moist Tussock Tundra would be lost or altered under Alternative A. The potential loss from gravel fill in the habitat-typed area in the Colville River Delta and the National Petroleum Reserve-Alaska is less than 0.1 % of the Moist Tussock Tundra habitat type available in that area. In addition, no acreage would be altered in the Colville River Delta, and 486.0 acres of the Moist Tussock Tundra habitat type would be indirectly altered in the National Petroleum Reserve-Alaska.

The total area of Barrens habitat type in the Colville River Delta is 20,993 acres (Table 4A.3.3-3). The total area of Barrens in the habitat-typed area of the National Petroleum Reserve-Alaska is 1,552 acres. A total of 1.3 acres of Barrens would be lost as the result of gravel placement (roads, pads, and airstrips) in the Colville River Delta, and no Barrens would be lost or altered in the National Petroleum Reserve-Alaska under Alternative A. The potential loss of Barrens habitat is less than 0.1 % of that available in the Colville River Delta. In addition to Barrens habitat lost as the result of gravel fill in the Colville River Delta, 16.1 acres of Barrens habitat type would be indirectly altered under Alternative A, while no acreage would be altered in the National Petroleum Reserve-Alaska.

In the Prudhoe Bay Oilfield and adjacent oilfields, caribou sometimes occur on gravel pads and roads in the summer. The abundance of mosquitoes and oestrid flies on gravel pads is lower than adjacent tundra so gravel structures may provide insect-relief habitat (Pollard et al. 1996a). This is most common during periods of harassment by oestrid flies, but it is possible that caribou also use gravel structures during harassment by mosquitoes (Pollard et al. 1996b, Noel et al. 1998, Ballard et al. 2000, Murphy and Lawhead 2000). Such use of the roads and pads developed under Alternative A could increase potential insect relief habitat in the summer. However, the small amount of such habitat created and the potential for human disturbance to reduce the attractiveness of the gravel structures to caribou suggest this would not likely provide a measurable benefit at the population level. Other habitat alterations that could benefit caribou could also occur. Caribou could be attracted to areas of dust fallout where there is early snowmelt and plant emergence near roads in spring (Roby 1978, Lawhead and Cameron 1988, Smith et al. 1994). Other areas near infrastructure where impounded water or accumulated snow causes delayed plant phenology and senescence could also enhance habitat for caribou (Roby 1978). Also, caribou might use patches of persisting snow next to pipelines for relief from heat in June. However, there could be an increased risk of vehicle collisions if caribou use habitats close to roads and structures.

Oilfield operations in the Prudhoe Bay area appear to have increased the availability of food, shelter, and possibly numbers of grizzly bears and arctic foxes (Shideler and Hechtel 2000, Burgess 2000). However, many of the bears raised as food-conditioned bears have been killed in recent years by hunters or in DLP incidents (Shideler and Hechtel 2000). The density of arctic fox dens and offspring productivity was higher in the Prudhoe Bay Oilfield than in undeveloped areas to the east (Eberhardt et al. 1983, Burgess et al. 1993, Ballard et al. 2000). Foxes are attracted to garbage dumpsters as a source of food and may also den or seek shelter beneath buildings, in culverts, or in other structures (Burgess 2000).

Disturbance and Displacement

During the operation period of Alternative A, terrestrial mammals may be disturbed and displaced by vehicular traffic, low-flying aircraft, unfamiliar infrastructure, noise and activity on facilities, road and pipeline maintenance, and humans on foot (Shideler 1986). Vehicle and aircraft traffic will be considerably lower during the operation period than during the construction period (Table 2.3.10-1) so disturbance will decrease over time. Humans on foot tend to elicit the most regular flight responses of caribou (Roby 1978, Murphy and Lawhead 2000). Potential impacts from research and monitoring also warrant consideration. Disturbance or mortality to animals can result from surveys and capture activities (Bart 1977, Götmark 1992). Designing research to minimize disturbance and mortality can mitigate this potential impact.

Oilfield operations in the Plan Area could disturb and displace caribou from preferred habitats. This could include vehicle and air traffic, and general human activity. This would not be common for calving caribou because the Alternative A proposed facilities are not near the primary calving areas of the CAH or TCH caribou. Disturbance could displace caribou to areas of poor insect-relief value in summer or poor forage availability in any season. However, the amount of habitat directly lost to infrastructure under Alternative A is a small proportion of that available in the Plan Area, so it is probable that there is adequate habitat away from the proposed infrastructure. Disturbance and displacement of caribou of the CAH in the Prudhoe Bay, Kuparuk, and Milne Point oilfields have been studied extensively. Cow caribou with calves tend to be most sensitive to disturbance during the calving period in late May until approximately 20 June. In this period, displacement of 1 km away from roads with traffic (Dau and Cameron 1986; Cameron et al. 1992b; Lawhead et al. 2002, 2003) and a general shift away from development have been reported (NRC 2003, USGS 2002, Murphy and Lawhead 2000, Lawhead et al. 2003). Others have also reported that caribou cows with calves generally avoid areas of human activities by up to 1 km and are sensitive to human-caused disturbance (Johnson and Lawhead 1989, de Vos 1960, Lent 1966, Bergerud 1974). However, studies in the Milne Point Oilfield from 1991 to 2001 suggest displacement from roads may not occur during the calving period (Haskell 2003, Noel et al. 2004). With regard to regional calving shifts, factors other than the oilfields may be responsible (Murphy and Lawhead 2000). Factors such as timing of snowmelt, range conditions, presence of predators, and animal population density could also result in shifting of calving areas.

Avoidance of the oilfields by caribou during the post-calving summer period has also been reported (Cameron et al. 1995, 2002; NRC 2003). However, caribou use habitats in the Prudhoe Bay Oilfield frequently and are not displaced from infrastructure in the post-calving period (Pollard et al. 1996b; Noel et al. 1998; Cronin et al. 1998a, 1998b). During the post-calving period, CAH caribou of all sex and age classes frequently forage adjacent to, and rest on, gravel roads and pads or in the shade of oilfield buildings and pipelines (Lawhead et al. 1993; Pollard et al. 1996b; Cronin et al. 1998a, 1998b; Noel et al. 1998; Ballard et al. 2000; Haskell, 2003).

Recent impact assessments have led to the hypothesis that displacement from oilfield infrastructure during the calving period may affect the nutritional status of cow caribou and result in reduced calf production and reduced herd growth. In particular, comparison of caribou in contact with oilfields (west of the Sagavanirktok River) and not in contact with oilfields (east of the Sagavanirktok River) have suggested such effects (Cameron et al. 2002, Griffith et al. 2002, NRC 2003). However, the CAH has grown from approximately 5,000 to 32,000 animals since the beginning of oilfield development (Cronin et al. 1998b; Arther and Del Vecchio 2003; NRC 2003). The numbers of animals in the western part of the calving range with oilfields has increased along with the entire herd, and the calf/cow ratios in the oilfield areas have been as high or higher than in undeveloped areas (Maki 1992; Cronin et al. 1998b, 2000, 2001). Factors such as population density, range condition, and movements of animals, in addition to calf recruitment, are probably responsible for the changes in numbers of animals in the areas east and west of the Sagavanirktok River (Cronin et al. 1997, 2000). Other herds without oil fields in their ranges have shown varying trends in population growth over the same time period. The TCH and the WAH in northern Alaska have exhibited faster population growth than the CAH during the same time frame, but the PCH grew during the 1970s and 1980s and declined in numbers since 1990 (Cronin et al. 1998b, NRC 2003).

Other studies of disturbance of caribou in oilfields provide additional insights. Roby (1978) found that caribou changed behavior within 656 to 984 feet of the Dalton Highway depending on sex, age, and time of year. Lawhead and Murphy (1988) and Lawhead (1990) reported that under varying levels of insect harassment and road traffic about 83 % of acute disturbance events occurred within 328 feet of the Endicott Road in the North Slope oilfields. Haskell (2003) reported that 90 % of the behavioral reactions to humans occurred within 1,640 feet of the observer's vehicle. Murphy and Curatolo (1987) determined that moving stimuli such as vehicles were more disruptive to caribou behavior than stationary infrastructure such as pipelines and roads. It is important to note that disturbance reactions may vary and caribou might habituate to human activity, including oilfields (Bergerud et al. 1984, Cronin et al. 1994). Shideler (2000) noted that CAH caribou habituated to development over several years. Haskell (2003) reported that rehabituation of CAH caribou occurred annually and the timing and extent of habituation was positively correlated with the timing of spring snowmelt.

Considering the varying responses of caribou to oilfields, it is not possible to explicitly predict the impacts of the proposed action. However, it is reasonable to expect that the activities associated with Alternative A may cause some displacement and disturbance of caribou in the Plan Area. Such impacts have been the greatest during the calving period in the existing oilfields (USGS 2002, NRC 2003). Because little calving occurs in the areas to be developed in Alternative A (Figure 3.3.4.1-2), few impacts during the calving period are expected. Caribou could be disturbed and displaced during the post-calving period and winter when more caribou are present. Vehicle traffic on the roads between CD-1 and CD-4 and between CD-2 and CD-7, as well as activity on the facility pads and the airstrips, could disturb caribou. The pipeline without a road between CD-1 and CD-3 would not disturb caribou after construction, but aircraft operations between these sites could. Aircraft supporting operations of Alternative A can be expected to add disturbance, particularly near the airstrip at CD-3 when flights are at low altitude. It has been noted that in some cases disturbance from aircraft may be greater than that from road traffic (BLM 2004a). However, there would be less aircraft traffic, but greater road access, under Alternative A than Alternatives B and D.

Lack of previous exposure of the TCH caribou to oilfields may result in more disturbance and displacement than that of the CAH caribou in the existing oilfields. This sensitivity may lessen with time as the TCH caribou habituate to the oilfield activity and infrastructure (Cronin et al. 1994, Haskell 2003). Caribou from the CAH also use the Plan Area and may already be habituated to oilfield activity. Conversely, use of the Alternative A project roads by local residents in addition to industry may result in higher levels of traffic and increased disturbance. This may be particularly important if the local residents are hunting and cause caribou and the other terrestrial mammals in the Plan Area to avoid human activity. Caribou in the Plan Area may habituate to the oilfield structures, but not snowmobiles and trucks if they are associated with hunting.

Grizzly bears frequently avoid roads and human activity and flee in reaction to humans on foot (Harding and Nagy 1980). However, they may become habituated to noise and human activity over time, which would increase the likelihood of human-bear interactions (McLellan and Shackleton 1989, Shideler and Hechtel 2000). Grizzly bears often run or hide in response to aircraft (McLellan and Shackleton 1989, BLM and MMS 2003). Responses vary among individual bears depending on availability of cover, habituation, and aircraft flight characteristics (Harting 1987). Capturing associated with biological research may sensitize bears to disturbance from helicopters.

The existing North Slope oilfields have increased the number of human-bear interactions (NRC 2003). Bears have been conditioned to use human foods because of poor garbage management in Deadhorse and Prudhoe Bay. These bears may be attracted to human activity and killed by hunters or because of safety concerns (Shideler and Hechtel 2000). During the 1980s and early 1990s, six adult female and two adult male bears in the oil field region fed on garbage. These females that were conditioned to eating anthropogenic food had cubs with higher survival to weaning (77 %) than did females eating only natural foods (47 %). However, food-conditioned subadults had a high rate of mortality after weaning (84 %). These subadults were habituated to humans, and were killed by hunters in DLP situations away from the oilfields (R. Shideler, pers.comm. 2003). The high cub survival and high post-weaning mortality probably balanced each other and the number of bears in the region has not appreciably changed. However, recognition that anthropogenic food conditioning could have potential impacts on the bear population and endanger humans led managers to prevent access by fencing the garbage landfill and installing bear-proof garbage containers in the oilfields in the late 1990s. This was followed by the lethal removal of seven adult and subadult bears that threatened humans in 2001 and 2002.

Disturbance and displacement of grizzly bears during Alternative A operations would primarily be from road traffic between CD-2 and CD-7 and between CD-1 and CD-4, increased levels of human activity and noise at production sites, and aircraft at CD-1 and CD-3. This could include disturbing bears in winter dens. Increased traffic by local residents may increase the level of disturbance. Increased bear-human interactions with associated DLP kills could result from the Alternative A development, although controlling access of bears to garbage, as required by the BLM and the state, can minimize this impact (BLM and MMS 1998b).

Muskoxen show initial disturbance reactions to aircraft, traffic, snowmobiles, and human activity. When disturbed or threatened, muskoxen may gather together in a tight circle, charge, or run away (Miller and Gunn 1984, McLaren and Green 1985). In addition, helicopters and low-flying aircraft can cause muskoxen to stampede and abandon their calves (Winters and Shideler 1990). Muskoxen reacted when snowmobiles approached to within an average of 1,132 feet, and some animals reacted to snowmobiles when 0.6 mile away. Muskoxen reacted to larger vehicles as far as 0.8 miles away (McLaren and Green 1985). Muskoxen are most sensitive to disturbance during the winter months when they restrict their movements and activity and select a small home range with low snow cover (Reynolds et al. 2002).

Female muskoxen calve in April and May before the new vegetation emerges and must be in good body condition at calving to successfully rear offspring (Reynolds et al. 2002). Repeated disturbance to the same group of muskoxen during the late winter or early spring could have adverse effects on reproductive success and winter survival rates (BLM and MMS 2003).

Miller and Gunn (1984) observed some short- and long-term habituation to repeated helicopter overpasses at greater than 180 meters altitude. Small groups of muskoxen are frequently seen during the summer near the Dalton Highway (Nowlin 1999) and may reflect habituation to traffic. There is also evidence that muskoxen can habituate to human activity associated with oilfields. During June road surveys for caribou in 2001, a group of 25 muskoxen including 8 calves was frequently observed within 0.6 mile of roads or pads in the Milne Point Oilfield (S. Haskell, pers.comm. 2003).

Air and ground traffic associated with Alternative A may disturb muskoxen and displace them from some habitats. There are generally few muskoxen in the Plan Area, and there are alternative habitats away from the proposed roads and facility pads, thus limiting impacts. However, muskoxen use riparian zones, particularly in the winter, so the road/pipeline crossings of streams and rivers between CD-2 and CD-7 could affect the animals in the area. Also, the CD-3, and CD-4 facilities in the Colville River Delta could be a source of disturbance.

Arctic foxes have habituated to the Prudhoe Bay Oilfields and development activities (Burgess 2000). They might continue to use breeding dens even when roads or production pads are constructed nearby (Burgess 2000). Foxes have successfully raised litters within 25 meters of heavily traveled roads and within 50 meters of operating drill rigs (NRC 2003). The roads and facilities proposed in Alternative A may provide den habitat for foxes, but result in vehicle collision mortality. Access to garbage could cause increased population densities of foxes, but proper refuse management, as mandated by the BLM and the state, would mitigate this impact. If hunting and trapping occur from the Alternative A roads, fox numbers may be kept at a low level.

Potential effects on wolves and wolverines include disturbance and habitat abandonment caused by air and surface vehicle traffic and human presence (BLM and MMS 2003). If the Alternative A development changes caribou distribution, this could also alter the distribution of these predators. In addition, if the Alternative A development results in increased hunting or trapping pressure, this may also affect wolf and wolverine distribution. Because of small numbers in the Plan Area, Alternative A development within the Plan Area would likely affect few wolves or wolverines.

Obstruction to Movements

Roads with traffic and adjacent pipelines would be the primary obstructions to movements of terrestrial mammals during the operation period. Vehicle and aircraft traffic will be considerably lower during the operation period than during the construction period (Table 2.3.10-1), so this impact will be less in the operation period. Possible impacts of obstructed movements include delay of caribou moving between coastal insect-relief habitat and inland foraging areas, particularly during the mosquito season. It has been suggested that this could have negative consequences on energy balances of caribou (Smith 1996, Murphy et al. 2000) which could affect reproductive success of females and cause population declines (Nelleman and Cameron 1998, Cameron et al. 2002, NRC 2003). However, serious impacts at the population level are not apparent in the case study of the CAH in the existing North Slope oilfields. The CAH has had a large increase in numbers and high calf production during the period of oil field development (Cronin et al. 1998b, 2000, 2001).

Obstruction to movements of caribou caused by oilfield infrastructure has been described in other assessments, and these findings generally will apply here (Curatolo and Murphy 1986; Cronin et al. 1994; BLM and MMS 1998a, 2003; TAPS Owners 2001a; Murphy and Lawhead 2000; BLM 2002a). However, these studies have been primarily in the snow-free periods, and the Plan Area is used by caribou in the winter, so the potential impact of snow accumulation must be considered (Pullman and Lawhead 2002). To mitigate effects of road/pipeline corridors on caribou movements, pipelines will be elevated at least 5 feet above the ground and generally separated from roads by 350 to 1,000 feet, where feasible (see Section 2.3.2.1). These measures will provide considerable mitigation of the potential impact of obstructed movements. Separation of 350 feet may not be feasible where terrain features (e.g. lakes) constrict corridor space and where pipes and roads converge at facilities.

Factors that influence the success of caribou crossing roads and pipelines include levels of vehicle traffic, road and pipeline configuration, the size or composition of the group of caribou, insect activity, topography, snow accumulation, and learning by the caribou (Curatolo 1975, Fancy 1983, Cronin et al. 1994). The most important characteristics of pipelines with regard to animal crossing is their height above the ground and their position relative to adjacent roads. Low (less than 4 feet above ground) pipelines, such as some found in older areas of the Prudhoe Bay oilfield, can block caribou movements and may exclude caribou from some areas (Cameron et al. 1995, Murphy and Lawhead 2000). Also, pipelines in close proximity to roads tend to obstruct caribou movements. Caribou crossings were found to be significantly reduced when roads with moderate or heavy traffic was directly adjacent to an elevated pipeline (Curatolo and Murphy 1986, Cronin et al. 1994). Mitigation measures, such as elevating pipes to at least 5 feet above the ground and separating roads from pipelines by at least 300 to 500 feet generally alleviate such problems (Curatolo and Murphy 1986, Cronin et al. 1994, Murphy and Lawhead 2000). Curatolo and Murphy (1986) found that, regardless of traffic level, caribou crossing pipelines did not appear to select particular heights within the range of 5 to 14 feet above ground. Pipeline-crossing studies (Cronin et al. 1994, Curatolo and Murphy 1986, Lawhead et al. 1993) indicate that caribou movements are not obstructed by pipes elevated 5 feet above the ground, although they may more readily cross under higher pipes (Cronin et al. 1994, TAPS Owners 2001a). Gravel ramps over pipelines appear unnecessary where pipelines are elevated at least 5 feet (Cronin et al. 1994). Even though elevating pipelines allows crossings by caribou, these elevated pipes and traffic on adjacent roads may delay or deflect caribou movements to some extent before crossing. High levels of traffic (more than 15 vehicles per hour) can disrupt movements of caribou, especially when large groups aggregate during mosquito harassment (Johnson and Lawhead 1989, Smith et al. 1994, Murphy and Lawhead 2000). Burying pipelines can also enhance crossing by caribou. Crossing success can be higher at long buried sections of pipelines, particularly early in the life of a project when infrastructure is a novelty to caribou (Smith and Cameron 1985, Cronin et al. 1994). However, burying pipes within or adjacent to roadways can be expensive, may decrease safety, and can cause thermal instability of the fill and underlying substrate (Cronin et al. 1994; North Slope Buried Pipeline Study Team, 2003).

There are other factors that affect caribou movements relative to roads, pipelines, and other structures. Caribou under insect harassment are relatively insensitive to human disturbance, and will readily cross infrastructure to access relief (Ballard et al. 2000). Crossing success tends to be higher during the oestrid fly season when caribou groups are generally smaller than during the mosquito season when groups are large (Smith and Cameron 1985a, Curatolo and Murphy 1986). Also, caribou habituate to development over time and appear to have learned to navigate through oilfield infrastructure in the Prudhoe Bay region (Cronin et al. 1994, Shideler

2000, Ballard et al. 2000). When caribou are deflected by roads and pipelines, they appear more likely to cross at intersections with natural barriers such as lakes (Smith and Cameron 1985b).

Snow accumulations may effectively reduce the height of elevated pipelines. During periods of snow cover in interior Alaska, caribou crossings of the trans-Alaska pipeline were less than expected for pipe sections less than or equal to approximately 7 feet above ground (Eide et al. 1986, Carruthers and Jakimchuk 1987). Snow depths averaged 20.5 inches, and the trans-Alaska pipeline is a larger-diameter (4 feet) pipe than those proposed in the Plan Area (less than 2 feet). Differences in visual effects between pipe diameters and snow depths may alter caribou behavior and crossing success. Snow settles under and adjacent to pipelines depending on orientation of the pipeline and wind direction. On Alaska's North Slope, windward scouring and leeward deposition of snow occur around physical structures on the landscape (Li and Sturm 2002). In late spring 1982, snow under much of the 30-km east-west Kuparuk pipeline accumulated to create an impassible barrier to caribou (Smith and Cameron 1985a). Also, drifting snow around a pipeline could result in easier access to forage in wind-scoured areas beneath or windward of the pipeline. In March and April 2001, with slightly greater than annual average snow depths (about 10 inches), Pullman and Lawhead (2002) found that pipelines oriented east-west caused greater accumulation of snow than pipelines oriented north-south. Snow accumulated to significantly greater depths than controls at 25 % of sites surveyed under pipelines, and 18 % of sites had significantly less snow accumulated than control sites (Pullman and Lawhead 2002). Clearance under pipes was lowest in areas where snow accumulates naturally such as in low thaw-basins and in the lee of small-scale topographic relief. Pipelines oriented parallel to prevailing winds may cause decreased wind speeds and more settling of snow. Also, pipelines in the lee of roads may collect more snow. Higher pipes may reduce snow accumulation, and maintenance of ice roads directly adjacent to pipelines can affect snow accumulation under pipelines (Pullman and Lawhead 2002). Pullman and Lawhead (2002) found that snow depths in the Colville River Delta were less than those adjacent to the Alpine pipeline and Tarn pipeline corridors to the east. These factors suggest that snow drifting and scouring in the Plan area could result in snow accumulation under pipelines and obstruction of caribou movements. Snow drifting could make elevation of pipelines to 5 feet inadequate for animal crossings in some of the Plan Area.

Grizzly bears might avoid areas of human activity such as high-traffic roads or noisy drilling sites (McLellan 1990). Grizzly bears have been displaced from roads in Alaska, British Columbia, Montana, and Yellowstone National Park, with individual bears avoiding areas within 0.6 mile of roads in most cases (TAPS Owners 2001). There is no evidence to suggest that pipelines restrict grizzly bear movements, and some bears have been observed walking along the top of the elevated Badami pipeline (Noel et al. 2002a). It is possible that grizzly bears will experience some disturbance, but not obstruction of movements from the Alternative A development.

Muskoxen in the Colville River drainage spend the winter in the Itkillik Hills to the southeast of the Plan Area. In summer, some muskoxen (predominantly small male-dominated groups or lone bulls) travel up the Itkillik River into the vicinity of Colville River Delta and Fish and Judy creeks (Johnson et al. 1997, Burgess et al. 2002). Muskoxen generally move less than 3 miles per day, although they may move 6 miles per day between seasonal ranges (Reynolds 1992, 1998). Since reintroduction into the ANWR, muskoxen have moved west of the Colville River and are expected to continue expanding into the National Petroleum Reserve-Alaska (TAPS Owners 2001a, BLM and MMS 2003). This range expansion required crossing the Dalton Highway and trans-Alaska pipeline (it is unknown whether they crossed buried or elevated sections of pipeline) or the Prudhoe Bay and Kuparuk oilfields and suggests that muskoxen are capable of crossing roads, pipelines, and other infrastructure.

Caribou, moose, and muskoxen may occur in the Plan Area during all seasons of the year (Figures 3.3.4.1-1 through 3.3.4.1-10). Depending on the rate of vehicle traffic, movements may be obstructed by the road and pipelines from CD-1 to CD-4 and from CD-2 to CD-7. Movements may also be obstructed at the bridge over the Nigliq Channel. With both industry and local residents using the roads, traffic levels would be higher than in Alternative B in which there is no use by local residents and Sub-Alternative D in which there are no roads. Caribou generally cross roads with pipelines elevated greater than 5 feet if the roads and pipelines are generally separated by 350 to 1000 feet, as proposed in Alternative A. Previous studies suggest that the roads and pipelines in Alternative A will not obstruct caribou movements to a great extent (Cronin et al. 1994, Murphy and Lawhead 2000). However, some caribou, particularly in large groups (as may occur during summer when CAH animals move into the Plan Area) may be deflected by the road/pipelines. Caribou under insect harassment are relatively insensitive to human disturbance, and will readily cross oilfield infrastructure to access relief (Ballard et al. 2000; Cronin et al. 1999; Murphy and Lawhead 2000). Muskoxen can cross elevated pipelines, although the success of crossing with different road/pipeline configurations has not been specifically assessed (PAI 2002a). Moose are not generally obstructed by the trans-Alaska pipeline (TAPS Owners 2001a) and probably would cross roads and pipelines in the Plan Area without much difficulty. In addition, crossing of elevated pipelines without roads, such as the pipeline from CD-1 to CD-3, would probably not be impaired for caribou, muskoxen, or moose (Cronin et al. 1994). Under Alternative A, power lines would be on the pipeline VSMs (overhead on 60-foot high power poles from CD-6 to CD-7) and will not obstruct wildlife movements.

Compared with the CAH caribou which has had oilfields in its summer range for more than 20 years, TCH caribou are largely inexperienced with traversing oilfield infrastructure and associated human activities. Therefore, obstruction of movements of TCH caribou in the Plan Area could occur early in the project. Under Alternative A, the northern portion of the Colville River Delta would remain roadless, so caribou should have little problem moving there during the mosquito season. The road and pipeline from CD-2 to CD-7 could cause some short-term delay to TCH caribou over the life of the project, particularly during winter (Dyer et al. 2002). Large groups of TCH caribou (hundreds to thousands) during the mosquito season may be found northwest of the Plan Area and possibly near the coast within the Kalikpik-Kogru Rivers and Fish-Judy Creeks facility groups. Smaller groups of caribou may be present near the proposed gravel access road to CD-7 and associated production sites year-round. The largest groups of caribou in the Plan Area typically occur in the Colville River Delta when warm weather and westerly winds bring hundreds or thousands of CAH caribou westward (PAI 2002a). These caribou could be delayed in crossing the road/pipeline between CD-1 and CD-4 and between CD-2 and CD-7.

To mitigate effects of road/pipeline corridors on caribou movements, pipelines will be elevated at least 5 feet above the ground and generally separated from roads by 350 to 1000 feet, where feasible. Separation of 350 feet may not be feasible where terrain features (e.g. lakes) constrict corridor space and where pipes and roads converge at facilities.

Because caribou use the Plan Area during the winter, crossing of the road/pipeline combination at that time of year is of concern because snow accumulation may effectively reduce clearance or create a visual barrier. Because east-west-oriented pipelines could cause greater accumulation of snow than north-south-oriented pipelines, the pipeline segment from the Ublutuoch River west to CD-6 may collect more snow than the pipelines from CD-1 to CD-3 and CD-4. Thus, Alternative A (with pipelines elevated to 5 feet) may result in greater obstruction to movement in winter than Alternatives C, D, and F (with pipelines elevated to 7 feet).

Muskoxen moving into the Colville River Delta could be deflected by the pipeline to CD-3 and associated infrastructure. Muskoxen in the Ublutuoch River area could encounter the road and pipeline between CD-5 and CD-7. Reactions of muskoxen to roads with traffic and pipelines have not been studied, so these potential impacts are speculative . It is possible that roads with elevated pipelines would deflect or obstruct movements of muskoxen, as they can with caribou. However, the steady westward expansion of musk oxen suggests they can negotiate various obstacles, and it is unlikely that movements would be totally obstructed by the Alternative A Development Plan. Arctic foxes move relatively unimpeded through existing developed areas on the North Slope and would be expected to do the same in the Plan Area. The movements of red foxes and other small mammals are expected to be similarly unaffected. Movements of wolves and wolverines through the Plan Area are not well understood, but both species may avoid areas of human activity, especially where hunted (Thurber et al. 1994, BLM and MMS 2003).

Mortality

Mortality to terrestrial mammals from the Alternative A Development Plan could result from vehicle collisions, DLP kills, and increased hunting access. There are other potential causes of mortality, for example a caribou was killed after its feet were entangled in seismic cable (BLM 2004b). Vehicle collisions with all terrestrial mammals should be relatively rare with proper driver training and adherence to industry safety regulations. In addition, vehicle collisions will be less frequent in the operation period than the construction period because there will be less traffic. Vehicle collisions with wildlife have been infrequent in the Kuparuk and Milne Point oilfields over the last ten years (C. Rea, CPAI 2004, pers. comm.) However, because caribou and muskoxen may be in the Plan Area in winter, vehicle collisions can occur year-round. Increased access to the Plan Area with the new roads could result in increased levels of hunting and trapping mortality to mammals, particularly caribou, moose, musk oxen, and grizzly bears. However, local residents typically do not choose to hunt near developments (see Section 3.4.3.2).The extent of this impact depends on the intensity of hunting and trapping and regulatory harvest limits and seasons. Potential impacts from research and monitoring also warrant consideration. Disturbance or mortality to animals can also result from surveys and capture activities (Bart 1977, Götmark 1992, TAPS Owners 2001a). Research should be designed to minimize disturbance and mortality.

With proper garbage management, as required by the BLM and stipulations and state regulations, the Alternative A Development Plan should not artificially increase the numbers of grizzly bears or foxes. In this case, increased predation on caribou, muskoxen, or moose would probably not result from Alternative A. However, the experience in the Prudhoe Bay region shows the potential impacts if food conditioning occurs. During the 1980s and early 1990s, six adult female and two adult male bears in the oilfield region fed on garbage. These females that were conditioned to eating anthropogenic food had cubs with higher survival to weaning (77 %) than did females eating only natural foods (47 %). However, food-conditioned subadults had a high rate of mortality after weaning (84 %). These subadults were habituated to humans, and were killed by hunters in DLP situations away from the oilfields (R. Shideler,pers. comm. 2003). The high cub survival and high post-weaning mortality probably balanced each other and the number of bears in the region has not appreciably changed. However, recognition that anthropogenic food conditioning could have potential impacts on the bear population and endanger humans, led managers to prevent access by fencing the garbage landfill and installing bear-proof garbage containers in the oilfields in the late 1990s. This was followed by the lethal removal of seven adult and subadult bears that threatened humans in 2001 and 2002.

Controls on feeding wildlife in the Plan Area as outlined by the BLM and MMS (1998b) are designed to prevent bears and foxes in the Plan Area from becoming food-conditioned, to minimize human-wildlife interactions, and to prevent DLP killings. Strict adherence to these policies and rigorous monitoring should minimize the potential for food conditioning bears and foxes. Although these policies have been in place in the existing oilfields, violations may occur and complete effectiveness is difficult.

The increased presence of oilfield workers increases the probability of human-bear encounters and DLP kills, even if there is no food conditioning and the bear numbers do not increase (NRC 2003, BLM and MMS 2003). In addition, the biggest impact of new developments on grizzly bears can be increased access by hunters that results in increased legal and illegal harvest and DLP kills due to improper garbage control by hunters. On the North Slope, grizzly bears are especially susceptible in the spring, when snow makes them visible and allows hunters to use snowmobiles. The road system developed under Alternative A may provide some increased access for hunters.

There may also be increased human-fox contact. The presence of rabies in foxes may result in control actions that kill foxes. Wolves are scarce but would likely avoid human activities in this area and would not directly experience increased mortality as a result of Alternative A. However, under Alternative A, roads would be open to local residents, potentially increasing hunting and trapping mortality to wolves, wolverines, and other species.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation activities will disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance would be less than during construction, however, because caribou, muskox, and other terrestrial mammals are likely to have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals may be killed by collisions with road traffic. If roads are left in place and maintained in useable condition upon abandonment, they may continue to provide improved access to hunting areas with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and the CD-3 airstrip left in place will facilitate restoration of habitat. Because plant communities on these raised gravel structures may be different from those that prevail in adjacent areas, the habitat will differ from that which currently prevails. However, pads, roads, and the CD-3 airstrip, if left in place may furnish some insect relief for caribou. If gravel fill is removed and the pad revegetated with vegetation similar to that which surrounds it, caribou and possibly other terrestrial mammals will use it (Kidd et al. 2004). Foam insulating materials that could be used in pad construction may be broken up in the course of removal and used by fox as denning material. Depending on the material's toxicity and the amount ingested by kits, this could cause mortality, though the numbers are likely to be very small. Overall impacts of abandonment and rehabilitation activities would be measured as impacts to individuals; no adverse impacts to populations are expected.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT IMPACTS ON TERRESTRIAL MAMMALS

Alternative A – FFD is shown in Figure 2.4.1.2-1. The amount of gravel fill under Alternative A would be approximately 1,262 acres. Because neither detailed site locations nor habitat mapping are available, we cannot quantify specific terrestrial mammal habitat lost under Alternative A. However, more acreage is covered with gravel in Alternative A than in Alternatives B and D. In Alternative A, a large portion (66 %) of gravel fill would be roads.

COLVILLE RIVER DELTA FACILITY GROUP

Direct Habitat Loss, Alteration, or Enhancement

In the Alternative A FFD Plan scenario, direct habitat loss to gravel fill in the Colville River Delta Facility Group other than described in the ASDP would include roads to access HP-4 and HP-5 as well as gravel for seven production pads. Four of the sites on the northern half of the Delta (in addition to CD-3) would be without roads but would also require gravel fill for airstrips and connecting pipelines. This gravel fill would result in the loss of potential forage for caribou, muskoxen, and moose. Winter ice roads would also cover potential forage during that time of year. The amounts of forage lost would be small relative to that available throughout the area. The increased number of gravel pads, roads, elevated pipelines, and structures would provide some insect-relief habitat, including shaded areas.

The impacts to habitats of other terrestrial mammals would be similar to those described previously in the section on the CPAI Development Plan but would be over the larger FFD area. This includes loss of tundra habitats under gravel fill and increases in potential den sites for foxes. It is unlikely that the amount of habitat for any terrestrial mammal would be significantly increased or decreased to the extent that it would affect the numbers of animals occurring in the Plan Area.

Disturbance and Displacement

The construction phase of FFD would take place primarily during winter months but over a longer time period than the ASDP, so there is the potential for longer-term disturbance to terrestrial mammals. Caribou do not occur frequently in the winter in the Colville River Delta, so disturbance during construction and winter operation should be limited. Denning grizzly bears are subject to disturbance in winter, and this may happen during FFD. Similarly, industry-related disturbances during operation on calving caribou would be minimal because few caribou are in the Colville River Delta during this time. During the post-calving season, some caribou could be disturbed by operations when large numbers of animals move into the area. However, the lack of roads would remove potential effects of vehicle traffic. Air traffic would result in some disturbance of caribou in the area during the summer. Moose, muskoxen, and grizzly bears could be disturbed somewhat during the summer months. This disturbance may be exacerbated by increased traffic from local residents, who could use the roads associated with the new development, such as those to hypothetical pads HP-4, HP-5, and HP-8.

Obstruction to Movements

During the winter construction phase of FFD, traffic on ice roads could obstruct movements of caribou. However, winter densities of caribou are low in the Colville River Delta (Figure 3.3.4.1-5) (BLM and MMS

2003), so this impact would be limited. Construction during FFD also has the potential to affect the movements of moose and muskoxen in the Colville River Delta Facility Group, but both of these species usually winter to the south of the Plan Area (Burgess et al. 2002, BLM and MMS 2003). Few caribou occur in the Colville River Delta Facility Group during calving, so obstruction of movements from operations would be minimal at that time. However, large numbers of caribou may move into the Delta during the post-calving season. Moose and muskoxen also use the Colville River Delta during summer. Most FFD in the Delta, especially in the northern portion, would include only pipelines without roads to the CD-3, HP-7, HP-12, HP-13, and HP-14 facilities. These pipelines would be elevated to 5 feet and, without associated roads, should allow free passage of caribou. Roads/pipelines to HP-4, HP-5, and HP-8 may obstruct local movements to some extent, but as discussed previously, elevated pipes usually allow passage of caribou. Overall, the limited number of roads in the Alternative A FFD Plan would limit the extent of obstruction of movements of terrestrial mammals in the Colville River Delta.

Mortality

Road kills should be few in the Colville River Delta Facility Group because there are few caribou, muskoxen, or moose present in winter when much of the construction would occur, and there are no roads to the production sites during operations in the northern part of the area. Some vehicle-caribou collisions could occur during summer along the roads to HP-4, HP-5, and HP-8. There is potential for increased human-bear encounters and exposure to foxes at FFD production sites. This may result in mortalities of these species.

FISH-JUDY CREEKS FACILITY GROUP

Direct Habitat Loss, Alteration, or Enhancement

The Alternative A FFD Plan would have additional roads and pads in the vicinity of Fish and Judy creeks. This would cover more habitat than the ASDP alone. Habitats directly lost for foraging activities are as described previously in the CPAI Development Plan Impacts section. However, the proportion of habitat to be covered is small relative to that in the entire area. Terrestrial mammals in the Plan Area would likely not experience a major loss of habitat as a result of gravel placement. Caribou might selectively use elevated gravel sites as insect-relief habitat, and areas near infrastructure for foraging where plant phenology might be altered and forage could remain available later in the year. Effects of habitat alteration on terrestrial mammals would be the same as described in the ASDP section but over a larger area and over a longer period of time.

Disturbance and Displacement

There is the potential for disturbance and displacement of caribou and other terrestrial mammals in the Fish-Judy Creeks Facility Group, as in the CPAI Development Plan areas. The production facilities and road/pipelines connecting them throughout the area may impose new disturbance on caribou during the summer and winter. The level of impact would probably be greatest during the construction periods and would depend on levels of vehicle traffic in summer and winter. This is not a major caribou calving area, but traffic on roads could displace some of the calving caribou that are present.

The experience in existing oilfields as described previously in the ASDP sections suggests that caribou would not abandon or avoid FFD in the Fish-Judy Creeks Facility Group as summer habitats. As FFD progresses and TCH caribou are exposed to oilfield disturbance, habituation might proceed as with the CAH caribout. However, if hunting were to take place near FFD oilfields, habituation might not occur and avoidance of human activities could increase.

Disturbance and displacement of grizzly bears, muskoxen, moose, wolverines, and wolves can be expected to be similar to that described for the CPAI Development Plan Alternative A, but under FFD disturbance and displacement would be spread across a broader area. Development in riparian habitats such as those near Judy Creek and Fish Creek can be expected to have a proportionally greater impact on these species, because they are often associated with those habitats. Road access for hunters and trappers has the potential to increase negative effects of road development in the Fish-Judy Creeks Facility Group.

Obstruction to Movements

The Fish-Judy Creeks Facility Group is in the eastern part of the TCH caribou range, and many animals of the TCH use this area. Densities of overwintering caribou have been highest in the past near the Ublutuoch River by the prospective HP-10 and HP-11 sites in the Fish and Judy creeks area (Figure 3.3.4.1-5) (BLM and MMS 2003). Considerable numbers of caribou have also used the northern portion of the Fish and Judy creeks area during the summer (Figure 3.3.4.1-3 and Figure 3.3.4.1-4). The HP-15, HP-1, and HP-3 production pads and road/pipelines connecting them could obstruct caribou movements, although pipelines will be elevated to 5 feet and separated from the road generally by 350 to 1000 feet, where feasible. Some TCH caribou might selectively use riparian areas such as Fish Creek and Judy Creek during the oestrid fly season (Burgess et al. 2003). The proposed gravel access roads to the hypothetical HPF-1 and HP-19 sites would cross Fish and Judy creeks and parallel Judy Creek. Temporary obstructions to movements of some caribou could be expected, and caribou also could use infrastructure for insect-relief habitat. Increased traffic on the roads from local residents and industry use may cause some obstruction if at high enough levels. Small numbers of calving caribou have occurred in the Fish-Judy Creeks Facility Group area (Figure 3.3.4.1-6), so impacts during the calving period would be limited.

The greatest density of caribou reported in the Plan Area in recent years was in July 2001 when about 6,000 CAH caribou moved west through the area of Fish and Judy creeks in response to warm temperatures and westerly winds. CAH caribou would probably be more experienced at crossing oilfield infrastructure than TCH caribou, especially early in the life of the project. Roads and pipelines near riparian areas may disproportionately affect movements of large mammals other than caribou such as bears, moose, and muskoxen compared to similar infrastructure situated away from riparian areas. However, densities of these mammals are low and alterations of movements should be temporary.

Local and temporary obstruction of movements caused by roads and pipelines can be expected to be similar to that described for the ASDP, but construction of a more fully developed oilfield can create additional issues associated with larger-scale obstructions. Smith et al. (1994) reported that early in their study, large groups of insect-harassed caribou approached the central portion of the Kuparuk Oilfield, but by the end of their study, large groups of caribou primarily approached only the edges of their study area, indicating that caribou avoided the center of activity.

Mortality

Accidental deaths from vehicle collisions should remain uncommon but would probably be proportionally greater by road length than in the CPAI Development Plan. Existing traffic restrictions and personnel training in existing oilfields mitigate occurrences of vehicle strikes in oilfields. Garbage control in the FFD should prevent increases in predator numbers that could potentially affect caribou and muskoxen. In Alternative A, local residents would have access to roads. If hunting were to be allowed from the road system, mortalities of terrestrial mammals in the FFD could increase. This could be managed by federal or state hunting regulations. During difficult winters, disturbance and displacement of muskoxen from riparian areas, overwintering caribou, or bears from dens could cause winter mortality or reduce calf survival in the spring.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Direct Habitat Loss, Alteration, or Enhancement

The Kalikpik-Kogru Rivers Facility Group would have four production pads and one processing facility connected by pipelines and roads under Alternative A – FFD Scenario (Figure 2.4.1.2-1). Some habitat would be lost under gravel, as described in the section about the CPAI Development Plan. However, the proportion of habitat that would be covered is small compared to that in the entire area. Terrestrial mammals would likely not experience serious range limitation as a result of gravel placement. In addition, habitat enhancement could occur, because caribou might use elevated gravel sites as insect-relief habitat. Effects of altered habitats would be the same for terrestrial mammals as described in the ASDP section but would occur over a larger area and over a longer period of time.

Disturbance and Displacement

Densities of calving caribou are expected to be greatest near the Special Caribou Stipulations Area in the northwest portion of the Kalikpik-Kogru Rivers Facility Group. This is particularly the case near prospective HP-21 and the processing facility HPF-2, which are in the calving area of the TCH caribou (Figure 3.3.4.1-2) (BLM and MMS 1998a, 2003; Jensen and Noel 2002). Because of this, the BLM and MMS (1998b) outlined specific mitigation stipulations for development and operations in this area.

The access road and pipeline from HPF-2 to HP-21, the pipeline from HP-21 to HP-22, and the air traffic at HP-22 may disturb calving caribou, but stipulations limiting vehicle and air traffic would minimize disturbance. The TCH caribou are not experienced with oilfields, and disturbance may be greatest during the first year of operations. Disturbance of caribou during summer and winter could also occur locally as described previously in the CPAI Development Plan section, but potential impacts could be mitigated by controlling traffic and human activity. However, during difficult winters, disturbance could have adverse effects on survival of overwintering caribou and muskoxen and on calf viability in the spring.

Obstructions to Movement

Densities of caribou in all seasons have been high in the area of the Kalikpik and Kogru rivers compared to the other parts of the Plan Area (BLM and MMS 2003, Prichard et al. 2001). The roads/pipelines and facilities may impede movements during any time of the year, although as described previously for the CPAI Development Plan, caribou usually cross pipelines and roads like those designed for Alternative A. Moose and muskoxen are uncommon in this facility group area, so impacts to these species would be limited.

Mortality

Accidental deaths of terrestrial mammals from vehicle collisions in the Kalikpik-Kogru Rivers Facility Group would likely be uncommon if caution is taken. Existing traffic restrictions, including BLM stipulations and personnel training, mitigate vehicle collisions in oilfields. Like the CPAI Development Plan, development should have little or no impact on predator densities if garbage is managed properly and intentional feeding is prohibited, as required by BLM stipulations. In Alternative A, local residents would have access to roads. If hunting were allowed from the road system, mortalities could increase.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON TERRESTRIAL MAMMALS

The CPAI Development Plan Alternative A would involve the changing of habitats used by terrestrial mammals in several ways. An estimated 241 acres of undeveloped land would be covered with gravel fill and approximately 65 acres would be excavated to obtain the gravel. This is a small %age of the land in the Plan Area. The amount of habitat types preferred by caribou, muskoxen, and moose that would be affected by this fill is a small proportion (less than 0.1 %) of that available in the Plan Area. Alternative A would result in a small direct loss of terrestrial mammal habitat.

Construction and operations would cause some disturbance of terrestrial mammals. Disturbance could in turn displace mammals from preferred habitats. Noise and human activity associated with construction, industry vehicle traffic, aircraft traffic, and activity on facilities and pipeline routes during operations could disturb caribou, moose, muskoxen, and grizzly bears in the vicinity of infrastructure. This could cause animals to be displaced from infrastructure. Displacement is most likely early in the life of the project because some habituation is likely over time. Disturbance of caribou (and probably also moose and muskoxen) is most likely for 2 to 3 weeks around the calving period in late May to early June. Because the CPAI Development Plan does not extend westward enough to include the primary calving areas of the TCH caribou, as long as the calving range remains west of the development area, Alternative A would have little or no disturbance impact on calving caribou. During the summer post-calving period and winter, caribou are less sensitive to disturbance and would probably habituate to industry infrastructure and activity. However, access to the developed area by local residents may considerably increase the amount of disturbance to caribou, moose, muskoxen, and grizzly bears during summer and winter if hunting is allowed.

There would be 26 miles of road/pipeline and an additional 10 miles of pipeline without a road under CPAI Development Plan Alternative A. Pipelines would be elevated 5 feet and generally separated from roads by 350 to 1,000 feet, where feasible. This should allow passage of caribou and other terrestrial mammals. The road/pipeline combination may delay or deflect caribou crossing, especially if traffic levels are more than 15 vehicles per hour. If local hunting occurs on the roads, crossing may be impeded because of increased avoidance of human activity.

Mortality of terrestrial mammals directly caused by the Alternative A development would probably be limited to occasional road kills and DLP killing of bears. Hunting by local residents on the oilfield roads would increase the mortality of caribou and possibly of moose, muskoxen, and grizzly bears.

All of the impacts described above are relevant to individual animals. It is unlikely these impacts would have a negative impact at the population level. The experience in existing North Slope oilfields shows that populations of terrestrial mammals (most notably caribou) have grown or remained stable since initiation of development. The inclusion of local access to, and possibly hunting in, the Alternative A development could cause disturbance and mortality that affects the population. However, the past harvest levels of caribou, muskoxen, and moose by the local community are a small enough proportion of the populations that negative impacts are unlikely if proper mitigation and regulations are enforced. In fact, harvest is a primary tool of wildlife managers, for example, to keep a population at a level compatible with available habitat. A positive aspect of increased hunter access is that it could allow more control over hunting harvest if managers would have more ability to increase harvest when necessary. However, the local residents typically choose not to hunt around developed areas.

Impacts from the Alternative A FFD would have the same effects described for the CPAI Development Plan, but over a larger area. An exception is the potential for increased disturbance of calving caribou of the TCH in the northwestern part of the Plan Area.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR TERRESTRIAL MAMMALS

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the FFD Plan Alternative A.

PREDATORS

- Communications among CPAI, local residents, the NSB, the State of Alaska, and federal agencies can minimize conflicts and accidents related to activities in the Plan Area, including hunting by local residents.
- A management plan for bears and other predators (e.g., foxes, ravens, gulls) should be developed that addresses the proper methods of food and garbage storage at drill sites, processing facilities, construction sites, water withdrawal sites, and other operational sites. Bear-proof and fox-proof garbage and food containers and regulations to prohibit careless treatment of garbage and food should be implemented. Site design can incorporate features that reduce the risk of attracting or confining polar bears or grizzly bears and allows effective detection and hazing of bears. A bear safety awareness program for employees and contractors should be developed.
- Fox denning in culverts and other structures can be discouraged by inspection and removal or structure design.

HERBIVORES

- Pipelines should be elevated more than 5 feet to allow unimpeded crossings by caribou. Greater elevation (e.g., 7 feet) could enhance crossing success in some cases (Eide et al. 1986, PAI 2002a, Cronin et al. 1994).
- Pipelines and roads with traffic should be separated by more than 300 feet where possible. This enhances caribou crossing success (PAI 2002a, Murphy and Lawhead 2000, Curatolo and Reges 1986, Cronin et al. 1994). The success of animals trying to cross pipelines adjacent to roads with more than 5 vehicles per hour was reduced if the pipelines and roads were separated by less than 328 feet (100 meters) (Curatolo and Reges 1996). These results led to recommendations of separation of roads and pipelines by 400 to 500 feet for efficient crossing success (PAI 2002a, Cronin et al. 1994).
- Sections of pipeline can be buried to enhance crossing success of caribou, muskoxen, and moose. Caribou have shown selection of long, buried pipeline sections (average length 1.1 km) when crossing the trans-Alaska pipeline (Eide et al. 1986, Carruthers and Jakimchuk 1987, Cronin et al. 1994, TAPS Owners 2001). Moose did not show a preference for long buried sections. Neither caribou nor moose showed a preference for short (less than 18.3 meters) "sagbend" buried sections. Long buried sections of pipeline could be included in all six alternatives, but it may be most useful in Alternatives A and C, where there are long sections of pipeline/road combinations. Because the Plan Area is used by caribou in the winter, buried sections of pipeline may mitigate the potential barrier effect from snow drifting near pipelines in all of the alternatives. The observations of large numbers of caribou moving across the area of Fish and Judy creeks and across the Colville River Delta in the summer suggest placement of buried sections between CD-2 and CD-7 for Alternatives A and C might be appropriate. For Sub-Alternative C-1, buried sections between CD-1 and CD-3 could mitigate crossing the pipeline/road combination in that area. CPAI and management agencies should consult to determine if buried sections of pipeline are necessary and what specific locations and lengths of buried pipeline sections should be used. It should be noted that buried pipelines have serious limitations due to high cost, identification of and repair of corrosion and leaks, and melting of surrounding permafrost (North Slope Buried Pipeline Study Team 2003).
- Vehicle traffic can be restricted to groups of vehicles traveling in convoys, instead of unrestricted traffic. This may be appropriate during and immediately after calving periods in some areas, although it appeared that convoys were not particularly effective in reducing calving disturbance and displacement at the Meltwater Project, east of the Colville River (Lawhead et al. 2003). Closing roads to all vehicle traffic during the calving period when animals are present could also be an effective mitigation measure. Restrictions of aircraft size and flight frequency and flight paths and altitudes may also mitigate potential impacts on calving caribou, muskoxen, and moose. Currently, caribou calving is restricted to the western part of the Plan Area. If this range extends east or if the FFD proceeds to that area, such restrictions may be appropriate.
- Potential impacts from research and monitoring also warrant consideration. Disturbance or mortality can result from surveys and capture activities (Bart 1977, Götmark 1992, TAPS Owners 2001a). Research should be designed to minimize disturbance and mortality.

ALTERNATIVE A –EFFECTIVENESS OF PROTECTIVE MEASURES FOR TERRESTRIAL MAMMALS

The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations 5 a, b, c, and d, 14, 15, and 16 regarding solid- and liquid-waste disposal, fuel handling, and spill cleanup are expected to reduce the potential effects of spills and human refuse on grizzly bears and other terrestrial mammals. Stipulation 34 assists in movement of wildlife by calling for the 500-foot separation of roads and pipelines. Stipulation 55 that requires aircraft to maintain 1,000 feet above ground level (AGL) (except for takeoffs and landings) over caribou winter ranges from October through May 15 is expected to minimize disturbance of caribou. Additional potential mitigation identified in this EIS regarding pipeline height, road and pipeline separation, burial of portions of above ground structures, and traffic management is expected to reduce impacts to caribou movements.

4A.3.4.2 Marine Mammals

Development activities within the Plan Area that could affect marine mammals include construction of roads, pads, airstrips, and pipelines; facility operation; and vehicle and aircraft traffic. Impacts from construction activities and during operations would be primarily from noise from vehicle and aircraft traffic. Noise propagation and measurement and the reactions of marine mammals to noise have been described previously (Richardson et al. 1995, USACE 1999, Richardson et al. 2002). Attractants for polar bears, such as garbage, may be generated by human activities during all phases of development. However, this would be mitigated with proper waste management. Ringed seals, bearded seals, and polar bears remain in the vicinity of the Plan Area during the winter months and might be present during construction of the project. During summer, beluga whales, spotted seals, and other marine mammals might also be present.

Oil spills also could directly or indirectly affect marine mammals in the Plan Area. Potential oil and chemical spills in the Plan Area are described in Section 4.3.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON MARINE MAMMALS

RINGED SEAL AND BEARDED SEAL

Construction Period

Habitat Loss, Alteration, or Enhancement

All roads, pads, airstrips, and pipelines would be constructed during the winter. None of the development infrastructure proposed under Alternative A is in or near ringed or bearded seal habitat, so there would be no impacts to those species.

Disturbance and Displacement

Neither aircraft nor vehicular traffic to any sites would likely have serious impacts to ringed seals or bearded seals. Noise from vehicular traffic using an overland ice road to CD-3 or construction activity is not expected to propagate into seal habitat and would not affect seals.

Several round-trips per day by fixed-wing aircraft from Deadhorse-Prudhoe Bay and/or the existing airstrip at CD-1 to the proposed airstrip at CD-3 would be a potential source of disturbance to seals hauled out on the ice in spring. Aircraft would be expected to maintain an altitude greater than 1,000 feet over water under the MMPA, except upon takeoff and landing. At such elevations, the potential for disturbance to seals would be greatly reduced. Flight elevations of less than 1,000 ft are anticipated to be over land areas within 3.6 miles northeast and southwest of the airstrip at CD-3. Moulton et al. (2003) reported that there were no negative reactions to surveys flown at 300 feet, and only 1.5 % of the observed seals dove into their holes in response to the aircraft. Other flights by fixed-wing aircraft or helicopters supporting construction could disturb or displace seals from their haulouts. The number of seals affected would depend on the frequency of flights over the Beaufort Sea seal habitat. Aircraft routes are not expected to pass over seal pupping habitat, so no impacts to seal pups are expected.

Obstructions to Movement

Construction of Alternative A facilities would not result in any obstruction to movements of ringed seals and bearded seals.

Mortality

Construction of Alternative A facilities would not result in any mortality to ringed seals and bearded seals except as the result of possible oil spills.

Operation Period

Habitat Loss, Alteration, or Enhancement

No ringed seal or bearded seal habitat alteration is expected, except as a result of possible oil spills.

Disturbance and Displacement

Some disturbance and displacement of ringed seals and bearded seals during the operation period could occur from aircraft noise. Ringed seals follow the edge of the retreating pack ice north during summer, so few ringed seals are expected to be in the Plan Area during summer. Those ringed seals that remain may be displaced for a short time by aircraft noise, but any effects are expected to be uncommon and of less than 1 hour duration. Flights that go over the ice edge could affect seals there. Breathing holes, lairs, and haulouts of ringed seals are often found away from lead edge habitat. The anticipated flight path for the airstrip at CD-3 would be over land areas in the Colville River Delta. Maintaining a 1,000-foot minimum altitude would minimize effects on ringed seals at these sites.

Operation of production facilities is not expected to affect bearded seals, because noise from operations would not propagate into bearded seal habitat. Fixed-wing aircraft and helicopters could disturb a small number of bearded seals hauled out along shore and pack ice edges during the spring and summer. However, bearded seals generally prefer areas of less stable or broken sea ice (Cleator and Stirling 1990). Noise from airplanes or helicopters could displace bearded seals into the water for a short time. However, aircraft are expected to maintain an altitude greater than 1,000 feet over water under the MMPA and flight paths are not anticipated over water or ice. Therefore, only a few bearded seals might be affected for short durations annually. Maintaining flight paths away from lead edge habitat would mitigate impacts to bearded seals.

Obstructions to Movement

Alternative A operations would not result in any obstruction to ringed seal and bearded seal movements.

Mortality

Alternative A operations would not result in any direct mortality to ringed and bearded seals, except as the result of potential oil spills.

SPOTTED SEALS

Spotted seals regularly use the main channel of the Colville River and Nigliq Channel in summer. Therefore, production activities on the Colville River Delta have greater potential to affect spotted seals than ringed seals or bearded seals. Johnson et al. (1998, 1999) found spotted seals only in the East Channel of the Colville River, at the mouth of the Kachemach River, and on the southwest end of Anachlik Island. Local residents of Nuiqsut report that spotted seals regularly use Nigliq Channel and the Fish and Judy creek deltas (Morris 2003, pers. comm.). Spotted seals have been observed as far upstream as Ocean Point and occur regularly as far as the mouth of the Itkillik River (Reed 1956; Seaman et al. 1981).

Construction Period

Habitat Loss, Alteration, or Enhancement

Alternative A includes construction of a 1,200-foot-long bridge across the Nigliq Channel to connect National Petroleum Reserve-Alaska sites CD-5, CD-6, and CD-7 to CD-2. The bridge across Nigliq Channel has the potential to alter spotted seal haulout habitat on gravel or sand bars in the river through changes in the flow of the river that could change the deposition of sand within the channel. The number of spotted seals affected would depend on the amount of habitat alteration that occurs and the number of seals using the area. The severity of the disturbance depends on the proximity of other suitable haulouts. However, effects to individual seals are likely to be short duration (less than 1 year) and are not expected to result in injury to any spotted seals.

Disturbance and Displacement

Because spotted seals are present in the Plan Area only during the summer, winter construction activities would not disturb or displace spotted seals. However, spring or summer construction in the vicinity of the rivers could disturb spotted seals. The extent of displacement would vary depending on the type of construction activity, the behavior and activity state of the seals, the proximity of the seals to the construction activity, and other known and unknown factors.

Obstructions to Movement

Because spotted seals are present in the Plan Area only during the summer, winter construction activities would not obstruct spotted seal movements. However, spring or summer construction could block movements of seals up and down the rivers. The extent of obstruction would vary depending on the type of construction activity, the behavior and activity state of the seals, the proximity of the seals to the construction activity, and other known and unknown factors.

Mortality

Because spotted seals are present in the Plan Area only during the summer, winter construction activities would not cause any spotted seal mortality. With the exception of the results of possible oil spills, spring or summer construction would not cause mortality.

Operation Period

Habitat Loss, Alteration, or Enhancement

The construction of bridges could alter habitats as described above. No additional habitat alterations are expected during operations, with the exception of the results of possible oil spills.

Disturbance and Displacement

Vehicle traffic across the bridge over Nigliq Channel could disturb spotted seals hauled out on sand or gravel banks nearby. Noise from vehicle traffic could displace a small number of seals from haulouts on sand or gravel bars near bridges. However, a large volume of traffic on the roads during operations is not anticipated. The number of seals affected would depend on the proximity of the bridge to any haulouts, and the number of seals on the haulouts. Impacts to individual seals are expected to be short-term and are not expected to result in injury to any spotted seals.

Aircraft traffic in the Plan Area is also a potential source of disturbance to spotted seals hauled out on sand or gravel bars during the summer. The approach trajectories for aircraft include a path over the Nigliq Channel, and planes may approach across the main channel coming to or from Deadhorse. Overflights by fixed-wing aircraft could cause the temporary displacement of seals from the haulouts. Under the MMPA, aircraft are expected to maintain an elevation greater than 1,000 feet over water, except during takeoff and landing. At 1,000 feet, the potential for disturbance to seals is greatly reduced. Johnson et al. (1998) reported no reaction of seals to surveys flown at altitudes of 255 to 705 feet but reported reactions (seals entering water) when the plane circled the haulouts at those altitudes. However, when aircraft are at low altitude during takeoff and for landing, the potential for disturbance increases. The number of seals affected would depend on the number of takeoffs and landings and the number of seals on the haulouts. Displacement of hauled out seals is not likely to result in injury to any seals, and they could habituate to the noise.

Obstructions to Movement

Facility operations in Alternative A are not expected to obstruct movements of spotted seals, although it is possible that seals will hesitate before crossing under bridges.

Mortality

Alternative A operations are not expected to cause any mortality of spotted seals, except as the result of possible oil spills. If access for hunters increases, mortality could increase.

POLAR BEARS

Polar bears are present in the Plan Area throughout the year. Males and non-pregnant females may be active on the ice and onshore throughout the year, while pregnant females could den in the Plan Area.

Construction Period

Habitat Loss and Alteration

Parts of the Plan Area are polar bear habitat; some polar bear denning habitat may be lost as a result of construction activities. Stipulations require that construction activities under Alternative A not occur within 1 mile of known or suspected polar bear dens. Adhering to this stipulation could reduce loss of habitat.

Disturbance and Displacement

Construction of roads, pads, and pipelines is a potential source of disturbance for polar bears in the Plan Area. Female polar bears denning within approximately 1 mile of the construction activity could be disturbed by vehicular traffic or construction noise. Disturbance of females in maternity dens could result in either abandonment of the cubs or premature exposure of cubs to the elements, resulting in mortality (Amstrup 1993). Few dens have been located in the Plan Area in the last 10 years, although bears are known to occasionally den in the area (Figure 3.3.4.2-1). Regulations require that road and other construction activities maintain a 1-mile buffer around known or suspected polar bear dens. MacGillivray et al. (2003) measured noise from industrial activities in artificial dens at varying distances from the activity. Noise in the dens from vehicular traffic was generally at background levels when vehicles were approximately 500 meters away. However, one vehicle was detectable above background levels at a distance of 2,000 meters. Thus, current regulations should prevent disturbance to polar bears in natal dens that have been identified. Bears in unidentified dens could be disturbed by the construction of roads, pads, or pipelines. The number of bears affected would depend on the number of dens that are undetected but within a 1-mile buffer around construction activity. The severity of the effect would depend on the reaction of individual bears, whether the den is abandoned, and the age of the cubs when the disturbance occurs.

Aircraft traffic to and from the Plan Area could also disturb polar bears in dens. MacGillivray et al. (2003) reported that helicopters were the loudest vehicles recorded during their study, and that sound was only minimally attenuated by distance and through the snowpack. Fixed-wing aircraft also can disturb denning bears. The number of bears affected would depend on the number of polar bear dens in flight paths. As with other noise impacts, the severity of effects would depend on the reaction of individual bears, whether the den is abandoned, and the age of the cubs.

Aircraft traffic may also disturb non-denning polar bears in the Plan Area. Non-denning polar bears often react to low-flying aircraft by running away. Helicopters are sometimes used to scare bears away from human habitation (Richardson et al. 1995). The number of bears affected would depend on the number of bears that are near aircraft flightpaths. Effects would be limited to displacement for a short time.

Non-denning polar bears may avoid the immediate vicinity of construction activities or they may be attracted to it, depending on the circumstances and temperament of individual bears. Avoidance of the area would reduce the potential number of human-bear interactions, thereby reducing the potential for injury to people or the need to kill bears.

Obstructions to Movement

No obstructions to polar bear movement are expected as a result of CPAI Development Plan Alternative A construction.

Mortality

No polar bear mortality is expected as a result of Alternative A construction. However, human-bear conflict, oil spills, or increased hunting access could result in mortality. Attraction to the area would increase the potential for human-bear interactions, and may result in the death of the bear in DHP. However, such actions have been rare (Federal Register 68(143)44028); only two polar bear deaths related to oil and gas have occurred in the past, and such deaths are not expected to be common in the Plan Area. Training of oilfield workers and regulations such as those already in place for other arctic developments would be helpful in minimizing bear-human conflicts. Thus, interactions between humans and bears are expected to be few and of short duration.

Operation Period

Habitat Loss, Alteration, and Enhancement

The facilities for Alternative A could cover potential denning habitat. However, alternative denning habitats are likely available in the Plan Area and adjacent areas. Bears have denned on inactive gravel pads, so new den sites could be available in the future.

Disturbance and Displacement

In general, potential impacts to polar bears during the operation period are similar to those described for construction. These impacts would be primarily from noise from vehicles, facilities, and aircraft that could affect non-denning or denning bears. Polar bears in the Beaufort Sea seldom venture onto land (Amstrup 2000) and are unlikely to be found in the Plan Area during summer. They are therefore unlikely to be affected by operations activities that occur during the summer.

Obstructions to Movement

No obstructions to polar bear movement are expected as a result of operations under Alternative A.

Mortality

No polar bear mortality is expected as a result of operations under Alternative A. However, human-bear conflict, oil spills, or increased hunting access could result in mortality, as described for the construction period.

BELUGA WHALES

Beluga whales could be present offshore of the Plan Area in low numbers during the summer. Belugas pass near the Plan Area during their fall migration from the eastern Beaufort Sea to their wintering grounds in the Bering Sea, but few probably pass through Harrison Bay. Treacy (1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 2000, 2002a, 2002b) detected small numbers of belugas in Harrison Bay during aerial surveys conducted during the fall bowhead whale migration. Most belugas pass north of a line from Cape Halkett to Oliktok Point during migration. During the spring migration, nearshore waters are ice-covered and belugas stay far offshore of Harrison Bay in the lead system.

Construction Period

Habitat Loss, Alteration, or Enhancement

Construction of the bridge over the Nigliq Channel would modify habitat at that site. Construction activities at that site would not likely have large impacts on beluga whales because much of the construction activity will take place during the winter when belugas are not present in the Plan Area.

Disturbance and Displacement

Beluga habitat is primarily in the Beaufort Sea, and no impacts from construction are expected there with the exception of possible oil spills. Construction of the bridge over the Nigliq Channel could change stream conditions and affect the few belugas that go there.

Obstructions to Movement

Construction of facilities under Alternative A would not obstruct movements of beluga whales.

Mortality

Construction of facilities under Alternative A would not cause beluga whale mortality except as the result of possible oil spills.

Operation Period

Habitat Loss, Alteration, or Enhancement

The 1,200-foot bridge over the Nigliq Channel of the Colville River has the potential to affect beluga whales in the Nigliq Channel. Nuiqsut residents report that belugas occur in the Nigliq channel and main channel of the Colville River and in the Fish Creek Delta (Morris 2003, pers. comm.). Bridge supports in the Nigliq Channel could affect beluga navigation of the channel if water flow and deposition of sand or gravel is altered. The number of belugas affected would depend on how many enter the Nigliq Channel.

Disturbance and Displacement

Operations during the summer would not affect belugas in the Beaufort Sea, because noise from facilities is not expected to propagate there. Vehicle traffic over the Nigliq Channel bridge may create noise that could affect belugas near the bridge. Such impacts are expected to be short term, short distance displacement and are not expected to result in injury to any whales. Aircraft traffic over the Nigliq Channel could affect beluga whales in the Plan Area. Beluga whales respond to aircraft differently depending on the context of their social group, environmental conditions, and aircraft altitude (Richardson et al. 1995). Feeding groups of belugas appeared to be less prone to disturbance by an aircraft at 1,640 feet altitude than are lone animals (Bel'kovich 1960 in Richardson et al. 1995). Inupiat hunters suspected that low-flying aircraft were responsible for preventing belugas from entering a bay along the Alaskan Beaufort Sea coast (Burns and Seaman 1985). The number of whales that might be affected would depend on the number of whales using the Nigliq Channel. There are no estimates of the number of whales using Nigliq Channel. Reports indicate belugas commonly occurred near the shorefast ice in the Colville Delta region until ice moved offshore (Helmericks, pers. comm., cited in Hazard 1988). The severity of the effect would depend on the conditions described above, but impacts are expected to be short-term and are not expected to result in injury to any whales.

Obstructions to Movement

No obstructions to beluga whale movements are expected as a result of facility operations under Alternative A. It is possible that activity on the Nigliq Channel bridge would delay belugas, but few probably go up the channel.

Mortality

No beluga whale mortality is expected as a result of operations under Alternative A, with the exception of that caused by possible oil spills and increased hunter access.

ABANDONMENT AND REHABILITATION

Impacts of abandonment and rehabilitation activities are expected to be similar to those for construction. Aircraft flights could disturb ringed or bearded seals and non-denning polar bears, and spotted seals could be disturbed by spring or summer activities near the Nigliq Channel bridge. Denning polar bears could be disturbed—and mortality caused to cubs abandoned or introduced to the elements prematurely—by activities within about a mile of their dens if these dens are not detected and the disturbance avoided as required by regulation.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON MARINE MAMMALS

The Alternative A – FFD Scenario sites with the most potential to affect marine mammals are hypothetical pads HP-4, HP-5, HP-7, HP-8, HP-11, HP-12, HP-13, and HP-14 in the Colville River Delta; HP-1, HP-3, and HP-15 in the Fish-Judy Creeks Facility Group; and HP-21 and HP-22 in the Kalikpik-Kogru Rivers Facility Group.

COLVILLE RIVER DELTA FACILITY GROUP

Facilities in the river deltas have the potential to affect ringed seals, spotted seals, and beluga whales. Noise from construction of roads and facilities and aircraft traffic along the coast during the winter has the potential to disturb ringed seals. Construction and operations, and aircraft traffic during the summer, have the potential to displace spotted seals and beluga whales from river habitats. HP-5 is directly adjacent to the Nigliq Channel, andHP-4, HP-7, HP-8, HP-12, and HP-14 are adjacent to the main channel of the Colville River. Roads are planned to HP-4 and HP-5. Aircraft would serve the other pads.

Construction, operation, and aircraft and ground vehicle traffic have the potential to disturb denning and non-denning polar bears. Denning polar bears within approximately 1 mile of roads could be disturbed. Denning and non-denning polar bears could also be disturbed by aircraft traffic. Bears could also be displaced from, or drawn to, construction activities, depending on individual bears' reactions. Impacts to denning bears could result in abandonment or early emergence of cubs. Impacts to non-denning bears could range from displacement to death if a bear threatens human life or property, is struck by a vehicle, or encounters a toxic substance. Mitigation measures already in place for other arctic developments would minimize these impacts. Increased hunter access may result in more mortality of polar bears and seals.

FISH-JUDY CREEKS FACILITY GROUP

HP-3 and HP-15 lie within the delta of Fish and Judy creeks, and roads would access them. Local hunters from Nuiqsut identified Fish and Judy creeks as spotted seal and beluga habitat. Construction and operations activities and aircraft traffic to and from these sites may displace some spotted seals and beluga whales. The number of seals and whales affected would depend on the numbers that are present in the area. Disturbance would generally be short-term. Impacts to polar bears in this area would be similar to those described above for the Colville River Delta Facility Group. Disturbance of polar bears (including dens) is less likely the farther inland the sites would be.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

HP-21 and HP-22 are adjacent to the Kogru River, which is also potential spotted seal and beluga whale habitat. Construction and operation activities and aircraft traffic to and from the sites may disturb some spotted seals and beluga whales. Disturbance would generally be short-term. Impacts to polar bears would be similar to those described above for the Colville River Delta Facility Group. Disturbance of polar bears is less likely the farther inland the sites are.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON MARINE MAMMALS

There would be limited impacts on marine mammals from the CPAI Development Plan because the project is onshore. Construction of, and traffic on, a bridge over the Nigliq Channel and other rivers could cause some disturbance of spotted seals and beluga whales. Aircraft traffic to and from the Plan Area could also disturb some marine mammals. Construction and operational noise in winter could disturb some denning polar bears.

Access by local residents could increase harvest of marine mammals, including seals in the rivers and nearshore Beaufort Sea. Hunting by local residents on the oilfield roads could increase the mortality of polar bears that are onshore. Mortality of polar bears directly caused by the Alternative A development could include occasional road kills and killing of bears in DLP.

All of the impacts described above are relevant to individual animals. It is unlikely these impacts would have a negative effect at the population level. The experience in existing North Slope oilfields shows that populations of marine mammals have not been affected by onshore development. The inclusion of local access to, and possibly hunting in, the Alternative A development may cause disturbance and mortality that affect marine mammal populations. However, the past harvest levels of seals and polar bears by the local community are a small enough proportion of the populations that negative impacts are unlikely if proper mitigation and regulations are enforced. In fact, harvest is a primary tool of wildlife managers, for example, to keep a population at a level compatible with available habitat. A positive aspect of increased hunter access is that it could allow more control over hunting harvest if managers would have more ability to increase harvest when necessary. However, the local residents typically choose not to hunt around developed areas.

Impacts from Alternative A FFD would have the same effects described for the CPAI Development Plan but over a larger area.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR MARINE MAMMALS

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the FFD Plan Alternative A.

1. Aircraft minimum altitude restrictions over the nearshore Beaufort Sea to reduce disturbance.

2. Surveys for polar bear dens prior to construction of ice roads or permanent roads and facilities would allow avoidance of the dens by 1 mile.

3. For Alternatives A and C, communications among stakeholders with activities in the Plan Area (including hunting by local residents) could help minimize conflicts.

ALTERNATIVE A – EFFECTIVENESS OF PROTECTIVE MEASURES FOR MARINE MAMMALS

The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulation 55 requiring aircraft to maintain a 1,000-foot AGL (except for takeoffs and landings) may reduce any disturbance of spotted seals hauled out along the Colville River Delta or ringed or bearded seals hauled out on the fast-ice along the coast. Stipulations 76 and 77 will reduce impacts to polar bears by minimizing bear/human interaction. Additional mitigation identified in this EIS would call for polar bear surveys that would allow for greater avoidance of den sites.

4A.3.5 Threatened and Endangered Species

4A.3.5.1 Bowhead Whale

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON BOWHEAD WHALES

Bowhead whales are not found in the Plan Area. During spring migration, bowheads are far offshore in the lead system of the Beaufort Sea. During fall migration, most bowheads pass north of a line from Cape Halkett to Oliktok Point. For a discussion of the impacts of oil spills and the likelihood of a large spill during fall migration, see Section 4.3. Alternative A construction and operations will not affect the bowhead whale population, habitat, migration, foraging, breeding, survival and mortality, or critical habitat.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON BOWHEAD WHALES

The only impacts to bowheads under FFD could be from aircraft noise and ships used to transport equipment through the Beaufort Sea to the Plan Area. In this case, bowheads could be affected by noise, fuel spills, and vessel strikes. However, the use of docks was determined not to be a practical means of developing the facilities proposed by CPAI or during future development, so the probability of vessel traffic would be low. If shipments in support of the ASDP are made to the existing West Dock, they can be timed for periods when bowheads are absent.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON BOWHEAD WHALES

Bowhead whales generally do not occur in the nearshore Beaufort Sea north of the Plan Area. During spring and fall migrations, bowheads are far offshore in the lead system of the Beaufort Sea. Activities that would occur in the Plan Area under all CPAI alternatives would not affect the bowhead whale population, habitat, migration, foraging, breeding, survival and mortality, or critical habitat.

In general, impacts from the Alternative A – FFD Scenario would be the same as those described for the CPAI Development Plan over a larger area. Under the FFD, sealifts may be used to transport drilling or processing facilities. In this case, there is the potential for additional impacts to bowhead whales from vessels. Impacts to bowheads could result from noise, pollution, and vessel strikes. However, the use of docks was determined not to be a practical means of developing the facilities proposed by CPAI or during future development, so this impact may not be realized. If some whales do come into the nearshore environment, there could be some disturbance of bowheads from air traffic over the Beaufort Sea. However, altitude restrictions would minimize these impacts.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR BOWHEAD WHALES

In the event of sealifts to transport material to the FFD sites, measures to minimize disturbance of, or strikes to, migrating whales by vessels are appropriate and would require coordination with NOAA Fisheries for compliance with the MMPA. Flight altitude restrictions in the nearshore environment would minimize disturbance from air traffic.

4A.3.5.2 Spectacled Eider

Impacts to spectalced eiders associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. The construction period includes gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The operation period includes continued drilling and day-to-day operations and maintenance once production has begun. Site specific nest densities for spectacled eiders presented in Table 3.3.5-1 were used to estimate the number of nest exposed to each alternative. Gravel footprint acreage and habitat alteration acreage (Tables 4A.3.1-1, 4A.3.1-2, 4A.3.1-3, 4A.3.1-4, 4B.3.1-1, 4B.3.1-2, 4B.3.1-3, 4B.3.1-4, 4C-1.3.1-1, 4C-1.3.1-2, 4C-1.3.1-3, 4C-1.3.1-4, 4C-2.3.1-1, 4C-2.3.1-2, 4D.3.1-1, 4D.3.1-2, 4D.3.1-3, 4D.3.1-4, 4F.3.1-1, 4F.3.1-2) were multiplied by average nest densities (Table 3.3.5-1) to estimate the total number of spectacled eider nests potentially affected by habitat loss and alteration. In addition, spectacled eider nests disturbed by air traffic were estimated using a maximum of a 67 % reduction in nests within a 500-meter buffer around each airstrip or helipad. This %age was derived from review of Figures 15-17 for greater white-fronted geese in Johnson et al. (2003a). No additional loss due to disturbance from vehicle traffic was calculated because losses within 50 meters of roads were considered sufficient to account for disturbance as well as habitat alteration impacts. Habitat loss due to ice roads was estimated using the average number of acres per year covered by ice roads during construction and operations (Tables 2.4.1-2; 2.4.1-9; 2.4.2-2; 2.4.2-8; 2.4.3-4; 2.4.3-10; 2.4.4-2; 2.4.4-6; and 2.4.4-10). Results of these analyses are presented in Tables 4A.3.5-1 and 4A.3.5-4. Preferred nesting and brood-rearing habitats (see Section 3.3.5.2 and Table 3.3.5-1) were also considered in evaluating impacts for spectacled eiders. Oil spills also may directly or indirectly affect spectacled eiders in the Plan Area. Impacts of oil and chemical spills and the potential for spills in the Plan Area are described in Section 4.3.

ALTERNATIVE A – CPAI DEVELOPMENT PLAN IMPACTS ON SPECTACLED EIDER

This section describes the potential impacts of the ASDP on threatened spectacled eiders. Impacts to other bird groups associated with the proposed development are described in Section 4A.3.3 and can be referred to for more detailed description of specific impacts. In Alternative A, the access road to CD-6 and CD-6 are within the sensitive 3-mile Fish Creek buffer and power lines are placed on poles between CD-6 and CD-7. These aspects of Alternative A do not conform with protective stipulations specified for development within the Northeast National Petroleum Reserve-Alaska Planning Area.

Spectacled eiders in the Colville River Delta are associated with coastal areas averaging about 4.0 km from the coast and within 14.3 km of the coast. Of the proposed pad sites, CD-3 has the highest concentration of spectacled eiders and is the area where impacts to spectacled eiders are likely to be greatest (see Table 3.3.5-1). The outer Colville River Delta has an average density of 0.21 spectacled eiders/km^2 during pre-nesting (n = 9 years) (Johnson et al. 2003b). Spectacled eiders are less common in the CD-4 area (less than 0.01 birds/km^2 during pre-nesting) than in the CD-3 area (Burgess et al. 2003a, Johnson et al. 2003b). The potential impacts of development at CD-4 would likely affect fewer spectacled eiders than would be affected at the CD-3 site. Spectacled eiders are also less common in the general area of the sites proposed for development in the eastern National Petroleum Reserve-Alaska compared to the northern portion of the Colville River Delta (Burgess et al. 2003b). The density of spectacled eiders during pre-nesting in the National Petroleum Reserve-Alaska portion of the Plan Area has ranged from 0.02 to 0.09 birds/km^2 (Anderson and Johnson 1999, Murphy and Stickney 2000, Burgess et al. 2003b).

CONSTRUCTION PERIOD

Habitat Loss, Alteration, or Enhancement

Winter placement of gravel and mining during construction would account for most of the direct habitat lost or altered by the proposed development. Tundra covered by gravel would be unavailable for spectacled eider nesting, brood-rearing, and foraging habitat. A summary of habitats lost due to gravel fill and altered by dust outfall, gravel spray, snow drifting, thermal and moisture regime changes by CPAI Development Plan Alternatives in the Colville River Delta and the National Petroleum Reserve-Alaska with habitat use by spectacled eiders is presented in Table 4A.3.5-2 and Table 4A.3.5-3. An estimated 0.7 spectacled eider nests would potentially be affected by habitat loss and alteration due to gravel fill based on nesting densities in the CD-3 area and in the National Petroleum Reserve-Alaska (Table 4A.3.5-1). In all cases, less than 1 % of habitats preferred or used by pre-nesting, nesting or brood-rearing spectacled eiders in the Colville River Delta and the National Petroleum Reserve-Alaska portion of the Plan Area would be directly and indirectly affected by gravel fill (Table 4A.3.5-2 and Table 4A.3.5-3).

Dust deposition can affect eider habitat by causing early green-up on tundra adjacent to roads and pads that could attract spectacled eiders and other waterfowl early in the season when other areas are not yet snow-free. Dust deposition can also increase thermokarst and soil pH and reduce the photosynthetic capabilities of plants in areas adjacent to roads (Walker and Everett 1987, Auerbach et al. 1997). Traffic levels, air traffic (including helicopters), and wind can all influence the amount of dust that is deposited adjacent to roads and pads.

Nesting habitat loss associated with gravel placement would occur on tundra adjacent to gravel structures where accumulated snow from snow plowing activities or snowdrifts becomes compacted and causes delayed snowmelt. Delayed snowmelt that persists into the nesting season would preclude eiders from nesting in these areas. Delayed melt resulting from the construction and use of ice roads during winter activities would also cause habitat loss. The maximum area covered by ice roads in a single year would be 393 acres, with an average of 210 acres per year. An estimated 0.1 spectacled eider nest would potentially be affected by ice road construction based on the average of 210 acres per year (Table 4A.3.5-1). Ice roads would be expected to cover habitats similar to gravel placement in the project area and would not be expected to affect a significant proportion of the available preferred or used pre-nesting, nesting, or brood-rearing habitats within the Colville River Delta or within the National Petroleum Reserve-Alaska portion of the Plan Area (Table 4A.3.5-2 and Table 4A.3.5-3).

Ponding created by gravel structures, ice roads, or snowdrifts could become permanent water bodies that persist from year to year or they might be ephemeral and dry up early during the summer (Walker et al. 1987, Walker 1996). Ponding could create new feeding and brood-rearing habitat that might be used by some bird species (Kertell 1993, 1994). Impoundments that drain during incubation can lead to decreased productivity for nests that end up far from the water's edges (Kertell 1993, 1994). Placement and maintenance of culverts in roadways eliminates or mitigates the formation of ponding. The Clover Potential Gravel Source would add aquatic habitat after reclamation that might be suitable for use by waterfowl (Appendix O).

TABLE 4A.3.5-1 CPAI ALTERNATIVES A-F – ESTIMATED NUMBERS OF SPECTACLED EIDER NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Spectacled Eider	Colville River Delta					NPR-A Area					Grand Total[a]
	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	Habitat Loss	Habitat Alteration	Ice Road Habitat Loss	Air Traffic Disturbance	Total	
CPAI Alternative A	0.1	0.2	0.0	0.9	1.2	0.1	0.3	0.1	0.0	0.5	1.7
CPAI Alternative B	0.1	0.2	0.0	0.9	1.2	0.1	0.2	0.1	0.3	0.7	1.9
CPAI Sub-Alternative C-1	0.1	0.1	0.0	0.0	0.2	0.1	0.5	0.1	0.0	0.7	0.9
CPAI Sub-Alternative C-2	0.1	0.1	0.0	0.0	0.2	0.1	0.5	0.1	0.0	0.7	0.9
CPAI Sub-Alternative D-1	0.1	0.2	0.0	1.1	1.4	0.1	0.1	0.1	0.3	0.6	2.0
CPAI Sub-Alternative D-2	0.0	0.1	0.0	0.5	0.6	0.0	0.0	0.0	0.1	0.1	0.7
CPAI Alternative F	0.1	0.2	0.0	0.9	1.2	0.1	0.3	0.1	0.0	0.5	1.7

Notes:
[a] See Section 4A.3.5.2 for assumptions and calculation methods

TABLE 4A.3.5-2 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE COLVILLE RIVER DELTA BY SPECTACLED EIDERS

Habitat Type	Colville River Delta[a]											Spectacled Eider[b]		
	Acres in Colville River Delta[b]	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Alternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting	Brood-Rearing
Open Nearshore Water	1,162													
Brackish Water	1,807											P		
Tapped Lake with Low-water Connection	5,397					3.0	<0.1%	<0.1	<0.1%					
Tapped Lake with High-water Connection	5,146	1.0	<0.1%	1.0	<0.1%	1.2	<0.1%	0.6	<0.1%	1.0	<0.1%			
Salt Marsh*	4,473	0.5	<0.1%	0.5	<0.1%	15.6	0.3%	0.8	<0.1%	0.5	<0.1%	P		
Tidal Fla*t	18,187											A		
Salt-killed Tundra*	6,362											P		U
Deep Open Water without Islands*	5,650	1.3	<0.1%	1.3	<0.1%	3.2	<0.1%	1.2	<0.1%	0.1	<0.1%			U
Deep Open Water with Islands or Polygonized Margin*	2,160	8.1	0.4%	8.0	0.4%	13.8	0.6%	0.1	<0.1%	0.2	<0.1%	P		U
Shallow Open Water without Islands	547	1.7	0.3%			0.3	<0.1%	0.1	<0.1%	1.7	0.3%			
Shallow Open Water with Island or Polygonized Margins	155			<0.1	<0.1%							P		
River or Stream	20,306	7.7	<0.1%	2.5	<0.1%	17.6	<0.1%	3.9	<0.1%	7.7	<0.1%	A		
Aquatic Sedge Marsh	32													
Aquatic Sedge with Deep Polygons	3,275	15.3	0.5%	15.3	0.5%	8.0	0.2%	15.3	0.5%	15.3	0.5%	P	U	U
Aquatic Grass Marsh*	369	1.6	0.4%	1.6	0.4%	1.6	0.4%			2.5	0.7%			
Young Basin Wetland Comple*x	0													
Old Basin Wetland Complex*	2													
Riverine Complex*	0													
Dune Complex	0													
Nonpatterned Wet Meadow	11,162	60.5	0.5%	36.0	0.3%	47.3	0.4%	49.3	0.4%	68.6	0.6%		U	
Patterned Wet Meadow	27,969	150.3	0.5%	125.5	0.4%	381.3	1.4%	214.8	0.8%	161.1	0.6%	A	U	U
Moist Sedge-Shrub Meadow	2,927	69.8	2.4%	69.8	2.4%	94.7	3.2%	5.7	0.2%	70.4	2.4%	A		
Moist Tussock Tundra	525	1.1	0.2%			0.1	<0.1%			1.1	0.2%			
Riverine Low and Tall Shrub*	1,270	1.2	<0.1%			5.5	0.4%			1.2	<0.1%			

TABLE 4A.3.5-2 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE COLVILLE RIVER DELTA BY SPECTACLED EIDERS (CONT'D)

Habitat Type	Colville River Delta[a]											Spectacled Eider[b]		
	Acres in Colville River Delta[b]	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Alternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting	Brood-Rearing
Upland Low and Tall Shrub	419					0.1	<0.1%							
Upland and Riverine Dwarf Shrub*	0													
Riverine or Upland Shrub	6,305	32.9	0.5%	24.4	0.4	66.6	1.1%	18.3	0.3%	32.9	0.5%	A		
Barrens (riverine, eolian, or lacustrine)	20,993	17.3	<0.1%	9.9	<0.1%	17.5	<0.1%	3.6	<0.1%	17.3	<0.1%	A		
Artificial (water, fill, peat road)	38													
Total Area	146,638	370.4	0.3%	295.8	0.2%	677.6	0.5%	313.6	0.2%	381.5	0.3%			

Notes:
[a] Totals from Tables 4A.3.1-2, 4B.3.1-2, 4C1.3.1-2, 4D.3.1-2, 4F.3.1-2.
[b] Selection (A, P) or use (U, ≥10% of observations) of habitats by life history stage (Johnson et al. 2003b, 2004).
[c] Total includes gravel for pads, roads, and airstrips indirectly affected by gravel fill.
* key Wetlands

TABLE 4A.3.5-3 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE NATIONAL PETROLEUM RESERVE-ALASKA BY SPECTACLED EIDERS

Habitat Type	National Petroleum Reserve-Alaska Areaa											Spectacled Eider[b]	
	Acres in NPR-A	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Aternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting
Open Nearshore Water	0												
Brackish Water	2												
Tapped Lake with Low-water Connection	412												
Tapped Lake with High-water Connection	7												
Salt Marsh*	36											P	
Tidal Flat*	0												
Salt-killed Tundra*	0												
Deep Open Water without Islands*	12,386	0.9	0.1%	<0.1	0.1%	0.4	<0.1%			0.5	<0.1%		
Deep Open Water with Islands or Polygonized Margins*	9,988	0.3	<0.1%	<0.1	<0.1%					0.1	<0.1%		U
Shallow Open Water without Islands	1,744	0.2	<0.1%	1.8	<0.1%	0.3	<0.1%			0.4	<0.1%		
Shallow Open Water with Island or Polygonized Margins	2,877	2.3	0.1%	1.6	<0.1%	2.6	<0.1%			3.0	<0.1%	P	U

TABLE 4A.3.5-3 CPAI ALTERNATIVES A-F – SUMMARY OF AFFECTED HABITAT TYPES IN THE NATIONAL PETROLEUM RESERVE-ALASKA BY SPECTACLED EIDERS (CONT'D)

Habitat Type	National Petroleum Reserve-Alaska Area[a]											Spectacled Eider[b]	
	Acres in NPR-A	Alternative A Loss or Alteration[c] (Acres and %)		Alternative B Loss or Alteration[c] (Acres and %)		Sub-Alternative C-1 Loss or Alteration[c] (Acres and %)		Sub-Alternative D-1 Loss or Alteration[c] (Acres and %)		Aternative F Loss or Alteration[c] (Acres and %)		Pre-Nesting	Nesting
River or Stream	1,456	0.7	<0.1%			0.4	<0.1%			0.7	<0.1%		
Aquatic Sedge Marsh	3,037	7.6	0.3%	3.2	0.1%	6.6	0.2%	1.4	<0.1%	6.3	0.2%		
Aquatic Sedge with Deep Polygons	66												
Aquatic Grass Marsh*	501												
Young Basin Wetland Complex*	624	19.1	3.1%	19.1	3.1%	19.1	3.1%	23.5	3.7%	20.3	3.6%		
Old Basin Wetland Complex*	15,673	42.9	0.3%	30.2	0.2%	64.4	0.4%	7.6	<0.1%	43.9	0.3%	P	U
Riverine Complex*	698	4.1	0.6%			2.7	0.4%			4.0	0.6%		
Dune Complex	1,889												
Nonpatterned Wet Meadow	5,697	24.5	0.4%	29.0	0.5%	24.1	0.4%	22.4	0.4%	29.1	0.5%		
Patterned Wet Meadow	19,861	105.1	0.5%	23.6	0.1%	81.1	0.4%	26.4	0.1%	105.8	0.5%		U
Moist Sedge-Shrub Meadow	42,071	232.1	0.6%	168.9	0.4%	389.5	0.9%	50.8	0.1%	303.1	0.7%		
Moist Tussock Tundra	49,647	581.3	1.2%	267.7	0.5%	795.5	1.6%	233.1	0.5%	565.7	1.1%	A	
Riverine Low and Tall Shrub*	1,803	1.9	0.1%	<0.1	<0.1%	1.2	<0.1%			1.9	0.1%		
Upland Low and Tall Shrub	735					0.6	<0.1%						
Upland and Riverine Dwarf Shrub*	2,240			<0.1	<0.1%	3.3	0.1%	0.8	<0.1%				
Riverine or Upland Shrub	0												
Barrens (riverine, eolian, or lacustrine)	1,552												
Artificial (water, fill, peat road)	150					0.4	0.3%						
Total Area	**175,152**	**1023.3**	**0.6%**	**545.3**	**0.3%**	**1392.2**	**0.8%**	**366.0**	**0.2%**	**1084.6**	**0.6%**		

Notes:
[a] Totals from Tables 4A.3.1-2, 4B.3.1-2, 4C1.3.1-2, 4D.3.1-2, 4F.3.1-2.
[b] Selection (A, P) or use (U, ≥10% of observations) of habitats by life history stage (Burgess et al. 2003b, Johnson et al. 2004).
[c] Total includes gravel for pads, roads, and airstrips indirectly affected by gravel fill.
* Key Wetlands

Spectacled eider nests average less than 4 meters from lake shorelines in the CD-3 area (Johnson et al. 2003a), and water withdrawal from lakes during ice road construction could lower the level of lakes and influence spectacled eider nesting habitat. Changes in the surface levels of lakes from water withdrawals depend on the amount of water withdrawn, the size of the lake, and the recharge rate. Water withdraw for construction of ice roads is not expected to alter spectacled eider pre-nesting, nesting, brood-rearing, or staging habitat because snowmelt recharge in early spring will increase and/or maintain water levels with adherence to State of Alaska volume withdraw permitting restrictions (Rovansek et al. 1996, Burgess et al. 2003b, Baker 2002).

Disturbance and Displacement

Because gravel placement would be conducted during the winter when spectacled eiders do not occur on the Arctic Coastal Plain, no spectacled eider nests would be disturbed or displaced by this activity. Some spectacled eiders would be disturbed during the summer breeding season by vehicle, aircraft, and boat traffic; noise from equipment on roads; noise from facilities; and pedestrian traffic. Disturbance by vehicles, equipment activities such as road grading and compaction, or aircraft during summer would decrease the numbers of spectacled eiders nesting, brood-rearing, or foraging adjacent to roadways (Ward and Stehn 1989, Murphy and Anderson 1993, Johnson et al. 2003b).

Noise and visual stimuli associated with helicopter and fixed-wing air traffic would disturb spectacled eiders near the proposed airstrip at the CD-3 site. Responses of birds to aircraft include alert postures, interruption of foraging behavior, and flight. Such disturbances may displace birds from nesting, brood-rearing and feeding habitats and negatively impact energy budgets. The potential for noise associated with aircraft to have negative impacts on birds is probably greatest during the nesting period when movements of incubating birds are restricted. The highest aircraft noise levels occur during takeoff as engines reach maximum power levels. During landings, aircraft noise levels are reduced as engine power decreases. Studies at Alpine Field indicate that disturbance during heavy construction would result in displacement of 0 to 67 % of nesting greater white-fronted geese within 500 meters of the airstrip (Johnson et al. 2003b). On the basis of spectacled eider nesting density in the CD-3 area, a similar response to disturbance would result in an estimated displacement of 0.9 spectacled eider nest.

Anderson et al. (1992) reported that during the nesting period, spectacled eiders near the GHX-1 facility in the Prudhoe Bay area appeared to adjust their use of the area to locations farther from the facility in response to noise. Spectacled eiders nesting near the proposed airstrip at the CD-3 site might be similarly affected and might relocate nest sites to areas farther from the airstrip in response to noise and movements from vehicular traffic and machinery and from air traffic.

Obstructions to Movement

In general, the infrastructure associated with Alternative A, including roads and production pads, the airstrip, buildings, elevated pipelines, and bridges, would not be major obstructions to movements of spectacled eiders. These birds can fly and can easily move over or around these structures. These structures may present some obstructions during brood-rearing and molting periods when birds are flightless, particularly if traffic levels are high (Murphy and Anderson 1993). However, Troy Ecological Research Associates (TERA) (1996) reported that spectacled eider broods did not avoid facilities, crossed roads, and were found in or moved to high noise areas such as gathering centers and the Deadhorse airport.

Mortality

Other than potential oil spill-related mortality (see Section 4.3), there likely would be little spectacled eider mortality related to the development under Alternative A. Some spectacled eider mortality would result from collisions with vehicular traffic, although roads in Alternative A are located in areas with very low spectacled eider density. Reduced speed limits along roads, particularly during periods of poor visibility, may help to reduce the potential for bird collisions with vehicles. Some mortality of a few individuals would be associated with birds that collide with structures such as power lines, pipelines, buildings, or bridges, although collisions would be infrequent (Murphy and Anderson 1993). Mortality of a few individuals would be associated with collisions with aircraft during takeoff or landing. Collisions with aircraft are the most likely source of mortality with the location of the airstrip at CD-3, in an area with the highest nesting density of spectacled eiders in the Project Area. Effects of mortality from aircraft collisions could be mitigated by hazing of birds away from active airstrips.

Some predators, such as ravens, glaucous gulls, arctic foxes, and bears, may be attracted to areas of human activity where they find human-created (anthropogenic) sources of food and denning or nesting sites (Larson 1960, Eberhardt et al. 1982, Day 1998, Burgess 2000, USFWS 2003b). The availability of anthropogenic food sources, particularly during the winter, may increase winter survival of arctic foxes and contribute to increases in the arctic fox population. Anthropogenic sources of food at dumpsters and refuse sites may also help to increase populations of gulls and ravens above natural levels. Increased levels of depredation resulting from elevated numbers of predators could adversely affect nesting and brood-rearing success for waterfowl and loons. Arctic foxes, glaucous gulls, bears, and common ravens prey on eggs and young of waterfowl and loons (Murphy and Anderson 1993, Noel et al. 2002b, Rodrigues 2002, Johnson et al. 2003a, USFWS 2003b). The NRC in their review of the cumulative effects of oilfield development on the North Slope (NRC 2003) concluded that ". . . high predation rates have reduced the reproductive success of some bird species in industrial areas to the extent that, at least in some years, reproduction is insufficient to balance mortality." The NRC (2003) review focused on the Prudhoe Bay Oilfield with most studies conducted through the mid-1990s when the landfill and dumpsters were accessible by gulls, ravens, bears and foxes. Since the late 1990s the landfill has been fenced to exclude bears and animal proof dumpsters have been installed throughout North Slope oilfields. At a more recent workshop on human influences on predators of ground-nesting birds on the North Slope, sponsored by the USFWS, participants concluded that common ravens have increased in response to developments, but that increases in arctic fox, bear and glaucous gull populations were uncertain (USFWS 2003b). There was further uncertainty in the link between increased predator populations and resulting population level impacts to ground-nesting birds.

The numbers of foxes and most avian predators in the Alpine Development Project area did not appear to increase during construction of the project, with the exception of common ravens, which nested on buildings at the Alpine Development Project site (Johnson et al. 2003a). There was no indication that the presence of this pair of ravens caused an increased in nest depredation within 2 miles of APF-1 (Johnson et al. 2003a). There is evidence, however, that common ravens nesting at Alpine, Nuiqsut, and Meltwater, based on their flight paths, reduced nesting success as much as 14 to 26 miles away at the Anachlik Colony (Helmericks 2004, J. Helmericks 2004, pers. comm.). Productivity for red-throated loons was reduced by over 70 % from averages of 85 to 90 % from 1987 to 2002, and to 12 % in 2003 primarily attributable to the increase in ravens observed foraging at the colony (Helmericks 2004, J. Helmericks 2004, pers. comm.). Common ravens also learned to raid nest boxes designed for long-tailed ducks and northern pintail ducks, destroying 13 of 24 nests in shelters in 2003; and 8 of 10 nests outside of shelters (J. Helmericks 2004, pers. comm., Helmericks 2004). Predator observations throughout the Plan Area documented jaegers and glaucous gulls as the most common nest predators followed by common ravens (Johnson et al. 2004).

Installation of predator-proof dumpsters at camps and improved refuse handling techniques minimize the attraction of predators to landfills. Oilfield workers undergo training to make them aware of the problems associated with feeding wildlife. These practices minimize the potential impacts related to increased levels of depredation and would be continued in the ongoing development of the Alpine Development Project. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on spectacled eider eggs and ducklings.

Researchers conducting studies on avian nest density and success may inadvertently affect nesting success by attracting predators to nests and broods (Bart 1977, Götmark 1992, Strang 1980). Birds that are flushed from their nests during surveys are more susceptible to nest depredation than are undisturbed birds. Ongoing activities by researchers could cause some mortality to spectacled eider eggs and chicks. Care should be taken by researchers to minimize research-related impacts that may occur, particularly from activities that flush incubating eiders from nests.

OPERATION PERIOD

Habitat Loss, Alteration, or Enhancement

Spectacled eider habitat loss and alteration from snowdrifts, gravel spray, dust fallout, and alteration of thermal and moisture regimes would continue during project operation. Additional post-construction habitat alterations would include ice roads and compaction by low-ground-pressure vehicles during summer or winter. These changes would affect an unknown number of additional spectacled eider nests.

Disturbance and Displacement

Disturbance and displacement from aircraft and vehicle traffic and facility noise would be similar to the construction phase. Disturbance would be reduced from the construction phase because of reduced levels of both air and ground traffic. Disturbance types along with the general reactions of spectacled eiders are discussed under the construction period.

Boat traffic during oil spill drills, equipment checks, and boom deployment, especially airboat traffic, could be disruptive to pre-nesting, nesting, foraging, and brood-rearing spectacled eiders. Spectacled eiders did not appear to use riverine habitats during pre-nesting, nesting or brood-rearing in either the Colville River Delta or the National Petroleum Reserve-Alaska sites proposed for development. Based on observations from the 1980s to 2003 (Helmericks 2004), eiders may have already been displaced from some riverine habitats in the Colville River Delta by boat activity associated with eider harvests and spring waterfowl hunting.

Obstructions to Movement

Obstructions to movements from roadways would continue during project operations and would be similar to project construction. Obstructions would be reduced from construction because of reduced traffic levels.

Mortality

Some spectacled eider mortality would result from collisions with aircraft, vehicles, elevated pipelines, buildings, power lines, or bridges, particularly under poor visibility conditions. Collisions would be limited to a few individuals and frequency of vehicle collisions would be reduced during operations compared to during construction because of reduced traffic levels. Road access from Nuiqsut would allow for increased local traffic and access to the lower delta and marine waters of Harrison Bay which could result in increased subsistence hunting pressure and increased spectacled eider mortality.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Power lines placed on poles from CD-6 to CD-7 would benefit avian predators by providing perches. Nest and duckling depredation due to predators attracted to developments could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on spectacled eider eggs and ducklings.

ALTERNATIVE A – FULL-FIELD DEVELOPMENT SCENARIO IMPACTS ON SPECTACLED EIDER

Under the Alternative A scenario for FFD, the mechanisms associated with impacts related to habitat loss and alteration, disturbance and displacement, obstruction to movements, and mortality for birds in the Colville River Delta, Fish-Judy Creeks, and Kalikpik-Kogru Rivers facility groups would be the same as those described under Alternative A for the ASDP. Under Alternative A FFD, roads would link all production pads, except for four pads in the lower Colville River Delta and one pad in the Kalikpik-Kogru Rivers area (HP-22), to processing facilities and to the existing Alpine Development Project facilities. Airstrips would be constructed at production pads in the lower Colville River Delta and the Kalikpik-Kogru Rivers areas for maintenance and operational support. Development in the three areas would be in addition to the development proposed under Alternative A of the ASDP, and the potential impacts described below would be in addition to those described under Alternative A for the ASDP. The effects of FFD on spectacled eiders would depend on the location and extent of development within each area. Table 4A.3.5-4 presents a summary of the estimated numbers of spectacled eider nests potentially affected by the hypothetical FFD in Alternative A based on ground-based nest densities in the Colville River Delta and in the National Petroleum Reserve-Alaska portion of the Plan Area (Table 4A.3.5-1) proposed for development in CPAI Alternatives.

TABLE 4A.3.5-4 ALTERNATIVES A-D FFD SCENARIOS – ESTIMATED NUMBERS OF SPECTACLED EIDER NESTS POTENTIALLY DISPLACED BY HABITAT LOSS, HABITAT ALTERATION AND DISTURBANCE

Spectacled Eider	Habitat Loss	Habitat Alteration	Ice road Habitat Loss	Air Traffic Disturbance	Total[a]
Alternative A - FFD Scenario					
Colville River Delta Group	0.6	1.7	0.3	4.0	6.6
Fish-Judy Creek Group	0.4	1.4	0.0	0.2	2.0
Kalikpik-Kogru Group	0.1	0.6	0.1	0.3	1.1
Alternative A - FFD Scenario Totals	**1.1**	**3.7**	**0.4**	**4.5**	**9.7**
Alternative B - FFD Scenario					
Colville River Delta Group	0.6	1.7	0.3	4.0	6.6
Fish-Judy Creek Group	0.3	1.0	0.1	0.5	1.9
Kalikpik-Kogru Group	0.1	0.5	0.1	0.2	0.9
Alternative B - FFD Scenario Totals	**1.0**	**3.2**	**0.5**	**4.7**	**9.4**
Alternative C - FFD Scenario					
Colville River Delta Group	0.6	2.9	0.3	0.0	3.8
Fish-Judy Creek Group	0.4	1.4	0.1	0.2	2.1
Kalikpik-Kogru Group	0.1	0.7	0.1	0.2	1.1
Alternative C - FFD Totals	**1.1**	**5.0**	**0.5**	**0.4**	**7.0**
Sub-Alternative D-1 - FFD Scenario					
Colville River Delta Group	0.7	1.3	1.0	6.0	9.0
Fish-Judy Creek Group	0.3	0.4	0.3	2.0	3.0
Kalikpik-Kogru Group	0.1	0.1	0.3	0.8	1.3
Sub-Alternative D-1 - FFD Scenario Totals	**1.1**	**1.8**	**1.6**	**8.8**	**13.3**
Sub-Alternative D-2 - FFD Scenario					
Colville River Delta Group	0.5	0.3	0.4	2.8	4.0
Fish-Judy Creek Group	0.1	0.1	0.1	0.7	1.0
Kalikpik-Kogru Group	0.1	0.0	0.1	0.3	0.5
Sub-Alternative D-2 - FFD Scenario Totals	**0.7**	**0.4**	**0.6**	**3.8**	**5.5**

Notes:
[a] See Section 4A.3.5.2 for assumptions and methods

COLVILLE RIVER DELTA FACILITY GROUP

Habitat Loss and Alteration

In addition to habitat loss described under Alternative A for the ASDP, there would be additional habitat loss at the Colville River Delta for airstrips associated with the hypothetical HP-7, HP-12, HP-13, and HP-14 sites. Short gravel roads would connect the CD-2 and CD-4 sites of the ASDP with HP-5 and HP-4, respectively. HP-8 would be connected by a road system to Nuiqsut and the existing Alpine Development Project.

Pre-nesting spectacled eiders are concentrated in the northwestern portion of the Delta north of the hypothetical HP-5 and HP-7 sites and west of the hypothetical HP-11 and HP-13 sites (Johnson et al. 1999). For the sites proposed under Alternative A FFD, the highest pre-nesting concentrations of spectacled eiders were reported in the vicinity of the HP-5 site (Johnson et al. 1999). An estimated 2.3 spectacled eider nests would be affected by habitat loss and alteration (Table 4A.3.5-4).

Disturbance and Displacement

Under Alternative A for FFD in the Colville River Delta Facility Group, aircraft traffic and noise likely would be the greatest source of disturbance to spectacled eiders. The types of disturbances would be the same as those described under Alternative A for the ASDP, but the potential impacts to spectacled eiders would be increased because of the increase in the number of airstrips.

Most displacement in Alternative A FFD would be from disturbance created by air traffic in the outer Colville River Delta. Based on a 67 % reduction in birds and nests within 500 meters of the airstrips, an estimated 4.0 spectacled eider nests would be displaced by air traffic disturbance (Table 4A.3.5-4).

Disturbance related to vehicular traffic and machinery would also affect eiders along the access roads to HP-4 and HP-5 as well as along the short access roads from production pads to airstrips at the other sites. The road from Nuiqsut may increase the potential for local traffic to affect spectacled eiders along the access roads to the CD-2, CD-3, CD-4, HP-4, and HP-5 sites. The types of disturbances would be the same as those described above under Alternative A for the ASDP sites. Disturbance to spectacled eiders from vehicular traffic and other associated road disturbances would be most likely to occur at the HP-5 site and the proposed access road to HP-5, where spectacled eider concentrations are higher. Disturbance in conjunction with habitat alteration within 50 meters of roads and pads would displace an estimated 1.7 spectacled eider nests (Table 4A.3.5-4).

Obstructions to Movements

Under Alternative A for FFD in the Colville River Delta Facility Group, there would be little increase in the potential for the proposed development to obstruct spectacled eider movements compared to Alternative A of the ASDP. Most of the proposed sites are roadless, and there is little evidence that pipelines present more than occasional, temporary obstruction to bird movements. Short access roads would be constructed for the HP-4 and HP-5 sites, although brood-rearing eiders may be delayed in crossing. High traffic levels or high speeds on roads could pose some obstruction to spectacled eider movements if birds were displaced because of disturbance. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, could help to minimize the potential for roads to obstruct bird movements.

Mortality

Bird mortality could result from collisions with vehicular traffic, buildings, pipelines, and bridges. Potential additional mortality from air strikes could result from the additional airstrips in the outer Colville River Delta. In Alternative A FFD, traffic levels in the Colville River Delta area would be minimal because of the roadless condition of most of the project.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Nest and duckling depredation could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Road access from Nuiqsut would allow for increased local traffic which could result in increased subsistence hunting pressure and increased spectacled eider mortality near the CD-2, CD-3, CD-4, HP-4, and HP-5 sites.

FISH-JUDY CREEKS FACILITY GROUP

Habitat Loss and Alteration

Habitat loss and alteration could occur in the Fish-Judy Creeks Facility Group from gravel placement for access roads and production pads. In the area of Fish and Judy creeks, the highest concentration of spectacled eiders was reported near the hypothetical HP-1 site and in portions of the area surrounding the hypothetical HP-15 site. Spectacled eider densities are generally lower in the Fish-Judy creek area than in the Colville River Delta area. Based on projected gravel fill for these hypothetical facilities, an estimated 1.8 spectacled eider nests would be displaced by habitat loss and alteration (Table 4A.3.5-4).

Disturbance and Displacement

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, vehicular traffic and other activities associated with the road system would be the greatest source of disturbance. In addition, noise associated with the hypothetical processing facility HPF-1 could also affect birds. The mechanisms of impacts would be the same as those described above under Alternative A for the ASDP sites. The greatest potential for vehicular traffic to affect spectacled eiders would occur along the proposed access road to HP-1 and possibly in the vicinity of HP-15. Displacement due to air traffic at HPF-1 would affect an additional estimated 0.2 spectacled eider nests (Table 4A.3.5-4).

Obstructions to Movements

Under Alternative A for FFD in the Fish-Judy Creeks Facility Group, potential obstruction to spectacled eider movements could occur along the road system particularly if traffic levels are high. Traffic levels are primarily the result of industry use and could increase if the roads are open to local traffic. In general, roads do not present obstructions to bird movements. High traffic levels or high speeds on roads could pose some obstruction to spectacled eider movements if birds were displaced due to disturbance. Speed limits for vehicular traffic and machinery, especially during brood-rearing periods, may help to minimize potential for roads to obstruct eider movements.

Mortality

Mortality could result from collisions of spectacled eiders with vehicular traffic. The potential for eider mortality associated with vehicular collisions under Alternative A for the FFD would be increased compared to Alternative A for the ASDP because of the increased road system. Reduced speed limits along roads, particularly during periods of poor visibility, may help to reduce the potential for eider collisions with vehicles. Spectacled eider mortality could result from collisions with buildings, pipelines, and bridges. Potential additional mortality from air strikes could result from the airstrip at the HPF-1 within the three-mile Fish Creek buffer.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Nest and duckling depredation could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Road access from Nuiqsut would allow for increased local traffic which could result in increased subsistence hunting pressure and increased spectacled eider mortality near HP-1 and HP-3.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

Habitat Loss and Alteration

Habitat loss and alteration would occur in the Kalikpik-Kogru Rivers Facility Group from gravel placement for access roads and production pads, although the concentrations of spectacled eiders reported for this area were generally lower than those reported for the Fish-Judy Creeks and Colville River Delta facility groups. The highest spectacled eider concentrations in the Kalikpik-Kogru Rivers Facility Group were reported in portions of the areas surrounding HP-20 and HPF-2. Based on projected gravel fill for these hypothetical facilities, an estimated 0.7 spectacled eider nests would be displaced by habitat loss and alteration.

Disturbance and Displacement

Under Alternative A for FFD in the Kalikpik-Kogru Rivers Facility Group area, vehicular traffic and other activities associated with the road system would be a source of disturbance to spectacled eiders. Road access from Nuiqsut could increase the potential for local traffic to disturb eiders along the entire road system of the Kalikpik-Kogru Rivers Facility Group area, particularly near HP-20 and HPF-2. In addition, noise associated HPF-2 would potentially affect eiders.

Placement of the airstrip for HP-22 and HPF-2 would increase disturbance to spectacled eiders due to noise from air traffic. Based on a 67 % reduction in birds or nests within 500 meters of the airstrip, an estimated 0.3 spectacled eider nest would be displaced by disturbance from air traffic.

Obstructions to Movements

Under Alternative A for FFD in the Kalikpik-Kogru Rivers Facility Group area, potential obstruction to spectacled eider movements would occur along the road system, particularly if traffic levels are high. Traffic levels are primarily the result of industry use and could increase if roads are open to local traffic.

Mortality

The potential for impacts of the FFD under Alternative A to affect spectacled eider mortality in the Kalikpik-Kogru Rivers Facility Group would be similar to that discussed above for the Fish-Judy Creeks Facility Group. The airstrip at HP-22 would increase the potential for mortality from collisions with aircraft. The potential impacts may be reduced compared to those for the Fish-Judy Creeks Facility Group area because of the reduced amount of infrastructure and lower densities of spectacled eiders in the Kalikpik-Kogru Rivers Facility Group area. Road access from Nuiqsut could increase the potential for subsistence hunting to affect spectacled eiders along the entire route of the road system in the Kalikpik-Kogru Rivers Facility Group area.

Spectacled eider nesting success in the Plan Area was generally low (33 %) (Johnson et al. 2004). Any increase in predator populations would result in decreased reproductive success for spectacled eiders. This is particularly true for increased glaucous gull, common raven, bear and arctic fox populations. The magnitude and extent of decreased productivity have not been quantified, but would be most detrimental to species with populations which may be declining, which are known to nest in aggregations at specific locations year after year, and to species with low total population size. Nest and duckling depredation could be minimized with proper handling of garbage and educating oilfield workers about the problems associated with feeding wildlife. Road access from Nuiqsut would allow for increased local traffic which could result in increased subsistence hunting pressure and increased spectacled eider mortality.

ALTERNATIVE A – SUMMARY OF IMPACTS (CPAI AND FFD) ON SPECTACLED EIDER

Impacts to spectacled eiders associated with construction and operation of the proposed development include habitat loss, alteration, or enhancement; disturbance and displacement; obstructions to movement; and mortality. Spectacled eiders occur in greater numbers near proposed developments in the Colville River Delta than in the National Petroleum Reserve-Alaska portion of the Plan Area. Additional impacts due to lost productivity are not quantified by this analysis, including impacts due to increased nest depredation caused by increased predator populations. We estimated the number of nests affected by habitat loss, alteration and disturbance for each alternative, based on site specific nesting densities for spectacled eiders to compare alternative development scenarios. Effects would be localized, and no measureable effects to North Slope populations would be expected. CPAI Alternative A would reduce nesting by 4 % for Plan Area spectacled eiders. Alternative A – FFD Scenario would reduce nesting by 22 % for Plan Area spectacled eiders and less than 1 % for the North Slope population. Habitat loss does not involve the direct loss of active nests because winter gravel placement, ice road construction, snow dumping, and snow drifting occurs when nests are not active. Most impacts would be initiated during the construction period, including gravel placement, grading of the gravel surface, placement of all facilities, and initial drilling. The effects of these activities on estimated spectacled eider production due to loss, alteration or disturbance of nesting habitat for Alternative A, CPAI Development Plan is presented in Tables 4A.3.5-1 and 4A.3.5-4 for the FFD Scenario. Impacts from CPAI Alternatives A through F on habitats used by spectacled eiders are summarized in Table 4A.3.5-2 and Table 4A.3.5-3. Summaries of vegetation classes affected directly and indirectly by gravel fill for Alternative A – FFD Scenario are presented in Table 4A.3.5-4.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR SPECTACLED EIDER

Potential mitigation measures would be similar for the CPAI Development Plan Alternative A and the Alternative A – FFD Scenario. Mitigation measures protective of bird habitats are presented in Section 4A.3.4.

OBSTRUCTIONS TO MOVEMENTS

- Traffic speeds on roads would be reduced during brood-rearing.

MORTALITY

- Spectacled eiders would be hazed away from active airstrips to prevent collisions with aircraft.
- Ravens could be discouraged from nesting on oilfield structures. If problem birds persist, control may be necessary to reduce depredation on spectacled eider eggs and ducklings.

4A.3.5.3 Steller's Eider

This section describes the potential impacts of the ASDP on threatened Steller's eiders. Impacts to other bird groups associated with the proposed development are described in Section 4A.3.3 and can be referred to for a more detailed description of the mechanisms of specific impacts. In general, impacts to Steller's eider potentially are the same as those described for the spectacled eider under all of the alternatives. However, the likelihood of impacts occurring to Steller's eider is very small, even under FFD scenarios, because they occur very rarely in the Plan Area. There would be a loss of potential Steller's eider habitat from the ASDP. Given the current distribution of Steller's eider in the Plan Area, it is unlikely that any of the project alternatives would affect this species.

4A.3.5.4 Abandonment and Rehabilitation Affecting Threatened and Endangered Species

Activities related to abandonment and rehabilitation in the Plan Area are not expected to affect bowhead whales. The impacts of abandonment and rehabilitation on spectacled and Steller's eiders would be similar in many respects to that incurred by construction activity.

Most impacts to spectacled eiders would be associated with activities near CD-3. Activities that occur in the winter would cause little disturbance or displacement, because eiders are absent from the area during the winter. However, ice roads could cause impoundments of water that could reduce habitat for nesting birds; such impacts would only affect nesting in the summer following ice road use. Summer road and air traffic generated by abandonment and rehabilitation activities could cause disturbance, displacement, and mortality to eiders similar to, and at the same levels as, those described for traffic during construction and operations. If pads, roads, and airstrips are not revegetated, they would remain lost habitat for eiders. If they are revegetated without removing the gravel, the habitat would not return to its current utility. If gravel is removed, habitat similar to that currently existing in the area could be created and used by eiders, though the precise mix of rehabilitated habitat types would likely not be the same as what currently prevails (Kidd et al. 2004). Foam insulating materials that could be used in pad construction may be broken up in the course of removal. Fine particles of foam that may not be removed from the environment could be ingested by some birds incidentally; depending on the material's toxicity and the amount ingested, this could cause mortality, though the numbers are likely to be very small.

TABLE 4A.3.5-5 ALTERNATIVE A – SUMMARY OF AFFECTED VEGETATION CLASSES FOR FFD USED BY SPECTACLED EIDERS

Vegetation Classes	Colville River Delta Facilities Group[a]		Fish-Judy Creeks Facility Group[a]		Kalikpik-Kogru Facility Group[a]		Grand Total (acres)	Plan Area Totals[b]		Spectacled Eider Habitats
	Loss (acres)	Alteration (acres)	Loss (acres)	Alteration (acres)	Loss (acres)	Alteration (acres)		Acres	% Affected	
Riverine Complex	0.3	1.6	1.1	6.1	0.0	0.0	9.1	698.3	1%	
Fresh Grass Marsh	0.7	2.5	22.9	134.7	33.2	200.1	394.1	2583.7	15%	√
Fresh Sedge Marsh	<0.1	<0.1	17.8	52.9	11.7	18.1	100.7	40953.6	<1%	√
Deep Polygon Complex	4.4	9.9	18.8	33.7	11.8	18.3	96.9	55208.0	<1%	√
Young Basin Wetland Complex	0.9	5.4	55.5	303.5	19.4	92.1	476.8	22910.8	2%	
Old Basin Wetland Complex	1.5	9.3	25.9	136.0	0.0	0.0	172.7	15674.5	1%	√
Wet Sedge Meadow Tundra	91.9	266.6	135.3	657.3	76.6	232.4	1460.1	185820.8	1%	√
Salt-Killed Wet Meadow	12.4	25.3	0.0	0.0	0.0	0.0	37.7	6368.7	1%	√
Halophytic Sedge Wet Meadow	9.3	19.2	0.0	0.0	0.0	0.0	28.5	4453.2	1%	√
Halophytic Grass Wet Meadow	0.2	0.5	0.0	0.0	0.0	0.0	0.7	398.3	<1%	√
Moist Sedge-Shrub Tundra	13.2	56.5	81.8	424.7	0.0	0.0	576.2	44405.7	1%	
Tussock Tundra	7.9	43.2	186.8	886.0	151.6	726.1	2001.6	208178.9	1%	
Dryas Dwarf Shrub Tundra	0.2	0.5	2.3	10.0	0.0	0.0	13.0	1358.6	1%	
Cassiope Dwarf Shrub Tundra	4.9	29.5	128.6	774.2	15.4	83.5	1036.1	7734.0	13%	
Halophytic Willow Dwarf Shrub Tundra	0.1	0.1	0.0	0.0	0.0	0.0	0.2	143.1	<1%	√
Open and Closed Low Willow Shrub	20.5	65.3	14.5	79.7	4.2	25.3	209.5	13557.3	2%	
Open and Closed Tall Willow Shrub	<0.1	<0.1	1.8	8.1	0.0	0.0	10.1	687.2	1%	
Dune Complex	0.0	0.0	6.9	26.5	1.5	2.3	37.2	5913.9	1%	
Partially Vegetated	10.4	26.7	3.5	14.5	1.2	1.9	58.2	10149.3	1%	
Barrens	37.3	88.8	7.7	29.6	8.0	34.2	205.6	44009.2	<1%	
Totals	**215.9**	**650.9**	**711.1**	**3577.3**	**334.4**	**1434.1**	**6923.7**	**671207.1**	**1%**	

Notes:
[a] Totals from Tables 4A.3.1-3 and 4A.3.1-4
[b] Totals from Table 3.3.1-1 (no data, shadows and water categories not included)

Overall impacts of abandonment and rehabilitation on threatened and endangered species would be localized and no adverse impacts to North Slope populations are expected.

4A.3.5.5 Alternative A – Effectiveness of Protective Measures for Threatened and Endangered Species

Current management practices and stipulations developed through the permitting process and attached to land uses authorizations for temporary facilities, overland moves, seismic operations, and recreational operations, are adequate to protect endangered and threatened species. The Northeast National Petroleum Reserve-Alaska IAP/EIS stipulation 55 requiring aircraft to maintain a 1,000-foot AGL (except for takeoffs and landings) may reduce disturbance of bowhead whales. Stipulations included under several categories, such as solid- and liquid-waste handling, hazardous-material disposal and cleanup, overland moves and seismic work, ground transportation, orientation program, aircraft traffic, and other activities should provide adequate protection to eiders from some activities. Additional mitigation measure identified in this EIS would include altitude restrictions to reduce aircraft impacts to bowhead whales, reducing speeds on roads, and hazing away from airports for eiders.

4A.4 SOCIAL SYSTEMS

4A.4.1 Socio-Cultural Characteristics

The socio-cultural characteristics of the North Slope communities of Nuiqsut, Barrow, Anaktuvuk Pass, and Atqasuk have been described in Section 3.4.1. These communities are small (Barrow is the largest with a population of 4,581) and primarily populated with Alaska Natives. These communities strive to maintain their traditional subsistence way of life but have adapted to and use a number of modern technologies. The communities are separated by relatively long distances and only one, Nuiqsut, is in close proximity to the Plan Area. Members of the other communities are known to interact with Nuiqsut and use portions of the Plan Area for subsistence activities.

4A.4.1.1 Alternative A – CPAI Development Plan Impacts on Socio-Cultural Characteristics

SOCIAL ORGANIZATION

As described in Section 3.4.1, the social organization of North Slope communities is based on kinship, marriage, and alliance groups formed by such characteristics as age, sex, ethnicity, community, and trade. Social organization is also based on the cultural values of the community, including sharing, mutual support, and cooperation.

Factors that are likely to cause stress or change to the social organization of the four communities include the following:

- Influx of non-Native residents not associated with an existing kinship group
- Influx of non-resident temporary workers
- Increased interaction between residents and oil industry workers
- Change in subsistence uses
- Reduction or disruption of harvest production
- Availability of new technologies (transportation, energy production, educational, etc.)
- Increased or variable personal and family annual income

Construction and operation of Alternative A – CPAI Development Plan is not expected to result in the significant influx of new, non-Native population. Oil industry construction and operations personnel will be housed in work camps or at centralized industry facilities co-located at industry production facilities. Because industry will provide worker housing, demand for housing in Nuiqsut is not expected to increase as a result of the proposed oil development.

The construction of winter ice roads near Nuiqsut and increased demand for accomodations at Nuiqsut could increase interaction between residents and oil industry workers. However, non-resident industry workers are not expected to seek leisure time activities or other services in Nuiqsut or the other communities to any significant degree. Industry practice is to have workers work 12-hour shifts for several weeks then be transported off the North Slope during their off days. Industry housing includes eating, exercise, and entertainment facilities so there would be no demand from industry workers for these services in Nuiqsut. In addition, the limited availability of ground transportation to industry workers is expected to minimize visits to Nuiqsut. No increase in visits by industry workers to Barrow, Atqasuk, or Anaktuvuk Pass is expected.

Disruption of subsistence harvest patterns and uses could affect community social organization. The sharing of subsistence foods is essential to the maintenance of family ties, kinship networks, and community well being. Disruption of subsistence-harvest patterns could alter these cultural values and affect community social structure. For the system of sharing to operate properly, some households must consistently produce a surplus of subsistence goods. For this reason, the supply of subsistence foods in the sharing network is more sensitive to harvest disruptions than the actual harvest and consumption of these foods by primary producers. Thus, when disturbance to the subsistence harvest occurs, it could disrupt the community culture. Subsistence is a cyclical activity, and harvests vary from year to year, sometimes substantially. Numerous different species are hunted to compensate for a reduced harvest of a particular resource in any one year. However, multiyear disruptions to some important resources such as caribou or bowhead whale could have substantial effects on sharing networks and subsistence-task groups.

Subsistence harvest and use impacts under Alternative A – CPAI Development Plan are described in detail in Section 4A.4.3. This analysis found that threats to subsistence harvest success are likely as a result of the following factors:

- Displacement or deflection of subsistence resources from customary harvest locations
- Reduced access to customary harvest areas where oil industry facilities are located due to perceived restrictions on hunting techniques, especially the use of firearms, and hindrance to passage during winter along raised road berms and pipelines
- Preference for animals not habituated to industry facilities

As a result of these effects on traditional subsistence-use areas, especially those near Nuiqsut, subsistence hunters will likely travel farther and spend more time away from the community pursuing subsistence harvest activities. They also will have increased direct economic costs for subsistence resulting from increased fuel consumption, and maintenance and repair of equipment. This could increase a problem some North Slope residents perceive that cash employment takes hunters away from the community, which can lead to their missing short-term subsistence opportunities.

Effects on subsistence harvest and use, and any associated stress to community social organization, are most likely to occur in the community of Nuiqsut because of its proximity to the Plan Area. While community members of Barrow, Atqasuk, and Anaktuvuk Pass all pursue subsistence activities in the Plan Area, they take a larger proportion of their subsistence harvest from other areas not directly affected and thus are less likely to experience subsistence related disruption to their social organization.

Potential changes to the cultural organization of Nuiqsut could occur as a result of implementation of Alternative A – CPAI Development Plan. These changes, to the extent that they would occur, would most likely be related to increased stress in the community as a result of changes in the pattern and success of subsistence hunting. Changes to community social organization are not likely to occur as a result of the presence of additional industry workers in the region.

Community comment on Social Organization Impacts - North Slope Inupiat continue to express concern about the differences in how they and the dominant culture relate to the land and waters. Rex Okakok from Barrow expressed the problem when he stated:

> "Our land and sea are still considered and thought by outsiders to be the source of wealth, a military arena, a scientific laboratory, or a source of wilderness to be preserved, rather than as a homeland of our Inupiat." (USDOI, MMS 1987c)

ECONOMIC ORGANIZATION

As described in Section 3.4.1, the economic organization of Nuiqsut, Barrow, Anaktuvuk Pass, and Atqasuk is composed of a mixed cash and subsistence economy. Impacts to the subsistence economy (e.g., subsistence harvest and use) are described in Section 4A.4.3.

The cash economy of the potentially affected communities includes the wage income of community members, income derived by businesses owned by community members, and royalty and tax revenues and other distribution that flow to each community. Little increase in wage income is expected to occur under Alternative A – CPAI Development Plan. Increases in personal or family income resulting from increased Native corporation dividend distributions could occur.

As noted in the previous discussion of Social Organization, little increase in contact between non-resident industry workers and the local population, and, by inference, local businesses providing local services, is expected. Therefore, only a minimum increase in local business income would be expected. However, many of the contractors hired by the oil industry to support exploration, drilling, and production on the North Slope are Native corporations (ASRC et al.), subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures and other relationships. As previously noted, more than $250 million dollars in contract fees were received by the Kuukpik (Nuiqsut Village Corporation) during development of CD-1 and CD-2. To the extent that these companies are successful bidders for contracts during construction and operation, significant local economic benefits are expected to result from implementation of Alternative A – CPAI Development Plan.

INSTITUTIONAL / COMMUNITY SERVICES

Because oil industry workers (with the exception of current local residents) are not expected to seek housing in Nuiqsut or the other North Slope communities or seek to utilize education, health or other community services, no impact on the existing community institutions or services would be likely to occur. Current residents who do use these services are not expected to create an incremental increase in service demand as a result of industry employment should it occur.

COMMUNITY HEALTH AND WELFARE

Residents of North Slope communities, including the communities likely to be impacted by the proposed Alternative A – CPAI Development Plan, have documented increased rates of crime, drug abuse, domestic violence and child abuse, and other community welfare pathologies. While these health and welfare problems have increased over the time of oil industry development on the North Slope, they have not been directly linked to oil industry activity. Their occurrence is symptomatic of changes in community social organization, economy, and increased access to technology and sources of cash income. No direct impacts in rates of crime, drug abuse, domestic violence, child abuse, or other community welfare pathologies are expected to occur as a result of implementation of Alternative A. To the extent that changes in the subsistence harvest place stress on other elements of community structure, indirect impacts on community health and welfare could occur.

POPULATION AND EMPLOYMENT

Figure 3.4.1.7-1 shows trends in population growth for Nuiqsut, Barrow, and Atqasuk. Each community is expected to grow independent of the applicant's proposed action, although at modest rates. Indirect economic impacts under Alternative A – CPAI Development Plan could provide the impetus for some additional population growth in addition to the trend; however, the amount of this growth will likely be small.

Employment opportunities for local residents, especially Alaska Natives, as a result of Alternative A – CPAI Development Plan, could occur either as direct jobs for industry or as new jobs are created as a result of increased local economic activity (so-called "induced employment").

Employment of Alaska Natives in oil-related jobs on the North Slope has been low. In spite of this limited participation, community and NSB leaders continue to seek implementation of programs that would result in increased hiring of local residents, especially Alaska Natives. The NSB has attempted to facilitate Native employment in the oil industry at Prudhoe Bay and has expressed concern that industry has not done enough to accommodate training of unskilled laborers or to accommodate their cultural need to participate in subsistence hunting. The NSB also is concerned that even though recruitment efforts are made and training programs are available, industry recruits workers using methods more common to Western industry practices. Suggestions have been made that industry-hiring practices be modified to become more Inupiat-appropriate. One North Slope operator, BPXA, has instituted its Itqanaiyagvik hiring and training program, designed to put more Inupiat into the oilfield workforce. It is a joint venture with the ASRC and its oilfield subsidiaries and is coordinated with the NSB and the North Slope Borough School District. Other initiatives are an adult "job-shadowing" program and an effort called Alliances of Learning and Vision for Under Represented Americans, developed with the University of Alaska (BPXA 1998d).

As a result of continued industry and NSB efforts, some increase in employment of local residents in industry jobs is expected to occur, but the number employed is expected to be small.

The industry practice of providing work site housing and importing a significant segment of the workforce to the project site means that development induced local employment is likely to be small especially as they translate into employment of Alaska Natives.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation activities will likely generate jobs for local residents for several years above the level that may exist during operations. However, after the satellite pads have been shut down and termination activities have been completed, jobs associated with them will cease. If local residents have become substantially integrated into satellite operations and the community substantially dependent on revenues associated with their operation, and if other oilfields are not active in the area to provide jobs and contribute economically to the local economy and government revenues, the community will face a time of adjustment. Subsistence resources will be subject to fewer impacts, potentially improving subsistence opportunities. However, if local residents have come to utilize the oilfield roads to access subsistence resources and depend on oil reliant incomes to help support subsistence harvesting and the roads are dismantled and the income lost, local residents may find it difficult to realize any improvement in subsistence harvests.

4A.4.1.2 Alternative A – Full-Field Development Scenario Impacts on Socio-Cultural Characteristics

Complete development of the Alternative A – Full-Field Development Scenario would result in additional well pads, roads, and other facilities. To the extent that socio-cultural impacts are related to the number and extent of facilities developed, impacts from FFD would generally be greater than under the Alternative A - CPAI Development Plan.

SOCIAL ORGANIZATION

Impacts of the Alternative A – Full-Field Development Scenario would be the same as, or in some instances greater than, the impacts of the Alternative A - CPAI Development Plan. FFD would affect a much greater area of traditional subsistence use near Nuiqsut causing greater disruption of subsistence harvest activities. In particular, FFD could reduce the use and harvest of subsistence resources in the Colville River area, a key subsistence-use area for Nuiqsut. As community members avoid or are displaced from traditional use areas, they will travel farther and into the subsistence-use areas of other communities. This displacement could result in competition for resources between communities, extended absences of community members from their home village, and increased costs to pursue subsistence resources. To the extent that such disruption of subsistence harvest patterns and use occurs, it could stress the community social organization and lead to changes in underlying cultural values.

ECONOMIC ORGANIZATION

Depending on the extent of FFD, impacts to the cash economy could be significantly greater under this alternative. As described in the impact analysis found in Section 4A.4.2 on Regional Economy, the flow of revenues to the NSB and village corporations is correlated to oil production and price. Under FFD, oil production could be 4.5 to 10 times greater than under the Alternative A – CPAI Development Plan. To the extent that production generates revenues that flow to the community or community-based organizations, greater benefits would occur under FFD.

Enhancement of the cash economy from wage employment or income to local businesses providing local services is expected to be the same as under Alternative A – CPAI Development Plan.

INSTITUTIONAL / COMMUNITY SERVICES

Alternative A – FFD is not expected to increase demand for community services beyond what could occur under Alternative A – CPAI Development Plan. Without changes in demand for community services, changes to community institutions, other than those that would otherwise occur, are not expected.

COMMUNITY HEALTH AND WELFARE

No direct impacts in rates of crime, drug abuse, domestic violence, child abuse, or other community pathologies are expected as a result of FFD. To the extent that changes in subsistence harvest place stress on other elements of community structure, indirect impacts on these community health and welfare problems could occur. Section 4A.4.3 describes impacts of FFD on subsistence harvest. Since subsistence impacts are more likely under FFD, impacts to these community health and welfare problems, to the extent that they would occur, are also more likely under FFD.

POPULATION AND EMPLOYMENT

No changes to population growth rates or increased population as a result of migration of industry workers are expected as result of FFD. Any increases in direct or induced employment that would occur would likely be the same as under the Alternative A – CPAI Development Plan.

4A.4.1.3 Alternative A – Summary of Impacts (CPAI and FFD) on Socio-Cultural Characteristics

NUIQSUT

- Potential impacts to subsistence harvest and use could cause stress and change in community social organization. To the extent that they occur, these impacts would likely increase under Alternative A –FFD.

- Economic benefits are expected to occur as a result of Kuukpik and other corporate participation in construction and operations contracting. These economic impacts would likely be increased under FFD.

- No direct incremental impacts to community health and welfare concerns (crime, drug abuse, etc.) are expected as a result of the proposed project or FFD. To the extent that changes in community social organization occur, changes in community health and welfare could also occur. These impacts, to the extent that they occur, are more likely to occur under FFD.

- Very modest levels of direct employment in the construction and operation phases of the project is expected for Nuiqsut residents. Employment levels are not expected to increase under FFD. No change in the population growth rate is expected.

BARROW, ATQASUK, AND ANAKTUVUK PASS

- To the extent that subsistence hunters of these communities rely on subsistence-use areas in the Plan Area, there could be some effect on subsistence harvest in Barrow, Atqasuk, and Anaktuvuk Pass. However, the extent of these impacts is likely to be small and not sufficient to impact community social organization. Under FFD, impacts to subsistence harvest and use are expected to be greater, increasing the potential that changes to community social organization could occur.

- Economic benefits are expected to occur as a result of village corporate participation in construction and operations contracting. The impacts are expected to be greater under FFD.

- No direct incremental impacts to community health and welfare concerns are expected as a result of the applicant's proposed action or FFD. To the extent that changes in community social organization occur, changes in community health and welfare could also occur. These impacts, to the extent that they occur, are more likely to occur under FFD.

- Very modest levels of direct employment in the construction and operations phases of the project is expected for Barrow residents under Alternative A – CPAI Development Plan or FFD. No change in the population growth rate is expected.

4A.4.1.4 Potential Mitigation Measures (CPAI and FFD) for Socio-Cultural Characteristics

Direct impacts to the socio-cultural characteristics of Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass are generally related to changes in subsistence harvest and uses, and economic benefits from revenue streams produced by oil production. Additional revenue is expected to accrue from contracting by North Slope-based Native corporations. Without intervention, employment opportunities for local residents are expected to be minimal. Indirect impacts include potential effects on community health and welfare.

Potential mitigation measures for both the Alternative A – CPAI Development Plan and the Alternative A – Full-Field Development Scenario are as follows:

- Mitigation measures to lessen the impacts to subsistence harvest and uses as discussed in Section 4A.4.3.

- No direct and immediate impacts are expected to community social organization, community services, or community health and welfare as a result of direct project impacts. If impacts in these sectors of community life occur as an indirect result of project development, such impacts are likely to occur incrementally and over a long period of time. A number of indicators of overall community welfare have been identified in previous studies prepared for the Kuukpikmuit Subsistence Oversight Panel (CRA 2002). CPAI would assist in continued monitoring of the indicator on a periodic basis to provide additional information to community leaders and appropriate social, health, and law enforcement organizations on overall community welfare. Such information could then be used to prioritize budgeting of community and NSB resources to address selected community welfare issues.

- To the extent practicable, appropriate job training and recruiting programs should be implemented to encourage industry employment of local residents to increase wages earned in the local community.

4A.4.1.5 Alternative A – Effectiveness of Protective Measures for Socio-Cultural Characteristics

Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations for general disturbance, general damage, and the chasing of wildlife as well as the wildlife stipulations for polar bears, caribou, and birds afford effective subsistence-resource protection, which in turn helps reduce impacts to the areas socio-cultural systems.

4A.4.2 Regional Economy

This section addresses the economic impacts associated with the ASDP. The analysis focuses on the income and employment that would result from construction and operation of facilities under the Alternative A – CPAI Development Plan and Alternative A – Full-Field Development Scenario.

The applicant's proposed action consists of five satellite oil production pads connected to the existing Alpine Central Processing Facility, located at CD-1. It is close to the North Slope Native village of Nuiqsut. Impacts have already been occurring for several years as a result of the initial Alpine Development Project at CD-1 and CD-2. The direct economic impacts from the Alternative A – CPAI Development Plan would both create new economic activity and extend the economic life of the existing Alpine Field into the future.

All of the economic "impacts" that have been identified are in fact increased revenues and income that are expected to accrue to the state, the NSB, and Nuiqsut (including through Nuiqsut's Native corporation). In Section 4A.4.3, Subsistence Harvest and Uses, impacts to subsistence hunting and gathering are discussed. These impacts also could have an economic consequence; however, the economic consequences have not been given a value because the loss of subsistence harvest or increased cost of subsistence harvest has not been determined.

4A.4.2.1 Production

The existing Alpine Field has been producing oil and related economic activity since 2000. Without the applicant's proposed action, production from CD-1 and CD-2 would continue to provide jobs and revenues. However, without the ASDP, the level of production and related economic activity from the Alpine Development Project would increase slightly between 2003 and 2008 and then decline after that point.

The economic impacts of Alternative A would be derived from royalties, taxes, and other payments related to production and employment income from construction and operation. For North Slope communities and the State of Alaska, the larger components are royalties, taxes, and other payments related to production. Implementation of Alternative A would be expected to extend the life of the ASDP to approximately 2015 before production falls below current levels. CPAI's plans to extend production capacity for the Alpine Central Processing Facility from the current capacity of 105,000 bbl of oil per day would increase to 145,000 bbl per day in 2004 to 2005 (see Table 2.3.12-1, Potential Schedule for Processing Facility Expansion).

Figure 4A.4.2-1 shows the projected oil production from the existing Alpine Field (CD-1 and CD-2) and the proposed ASDP (CD-3 through CD-7). The data used to portray oil production in Figure 4A.4.2-1 were developed by the State of Alaska (Alaska Department of Revenue [ADR] 2003a). Analysts with the ADR forecast oil production throughout Alaska as an integral part of their annual state revenue estimate that is used by the Alaska legislature in developing the budget. The areas on this graph that exceed the projected processing capacity are due to the production model used in the projections. Under actual operating conditions, the production would be reduced to remain within the processing capacity limit.

Production estimates for the wells and additional production facilities assumed to accrue as part of FFD are presented in Table 4A.4.2-1 for a 20-year period. The last line in Table 4A.4.2-1 shows the total production for each of the production units, including production for years not included in the table.

TABLE 4A.4.2-1 PROJECTED OIL PRODUCTION FOR EXISTING, CPAI DEVELOPMENT PLAN, AND FFD SCENARIO: 2003 THROUGH 2023 (IN BARRELS PER DAY)

YEAR	CD-1 and CD-2	CD-3	CD-4	CD-5	CD-6	CD-7	NPR-A FFD[a]
2001	40,000						
2002	96,000						
2003	98,000						
2004	100,000						
2005	103,000						
2006	103,000						
2007	103,000	20,000	14,000				
2008	103,000	20,000	14,000				10,000
2009	90,000	20,000	14,000		2,500		12,000
2010	73,800	17,600	11,900		20,000		20,000
2011	61,254	15,488	10,115		20,000		9,600
2012	51,453	13,629	8,598	16,000	20,000	20,000	22,680
2013	43,735	11,994	7,394	16,000	17,000	20,000	33,644
2014	37,612	10,555	6,433	15,000	14,450	20,000	62,915
2015	32,723	9,288	5,661	13,350	12,283	17,600	71,932
2016	28,796	8,174	5,038	11,748	10,563	14,960	83,942
2017	25,628	7,193	4,534	10,338	9,190	12,716	92,121
2018	23,066	6,401	4,081	9,096	8,087	10,936	227,647
2019	20,759	5,761	3,673	8,006	7,197	9,514	231,877
2020	18,891	5,185	3,306	7,045	6,478	8,372	235,341
2021	17,191	4,667	2,975	6,200	5,830	7,451	238,016
2022	15,643	4,200	2,707	5,456	5,247	6,706	240,237
2023	14,392	3,780	2,464	4,856	4,722	6,036	242,080
Cummulative Total Production[b]	**475,400**	**76,000**	**50,300**	**60,000**	**71,800**	**73,600**	**1,657.800**

Source: ADR, Tax Division. Unpublished files from Spring 2003 Revenue Sources Book.
Notes:
[a]FFD in this table is based upon assumptions provided by the BLM.
[b]This figure shows the total estimated production in thousands of barrels over the life of the production area, including years past 2023.

Figure 4A.4.2-2 also shows the effect of adding the projected FFD under the BLM's production assumptions. A map showing the projected locations for FFD was shown in Figure 2.4.1.2-1. This figure shows 22 hypothetical production areas (HP-1 through C HP-22) and two hypothetical processing facility/production areas (HPF-1 and HPF-2).

The BLM estimates an average of 50 MMbbl (with a range of 25 MMbbl to 150 MMbbl) for HP-1 through HP-22 and an average of 250 MMbbl (with a range of 150 million to 300 million) for the two processing/production pads. Further the BLM estimates the timing for development of one of the processing/production units in 15 years with the second to follow in another 10 years (BLM 2003).

To estimate production for FFD, the BLM assumed that each of the 22 hypothetical production pads (HP-1 through HP-22) would have an average production of 50 MMbbl. To this was added 2 times the projected production from HPF-1and HPF-2 (250 MMbbl), resulting in a total production from FFD of 1.6 Bbbl.

Production streams for FFD under the BLM assumptions were developed using the method described above. To determine the timing of production, production pads in the FFD had to be linked to specific processing facilities; the production pads were assumed to be brought online in different years. These groupings were made based on the proximity or each production pad to the most likely processing area. Thus, it was projected that production from HP-1, HP-3, HP-4, HP-5, HP-6, HP-7, HP-8, HP-9, HP-11, HP-12, HP-13, HP-14, and HP-15 would go to the existing Alpine Central Processing Facility at CD-1. It appears that most of this production also would be outside the boundary of the National Petroleum Reserve-Alaska. The production from HP-2, HP-10, HP-16, HP-17, and HP-19 would go to HPF-1, and the production from HP-18, HP-20, HP-21, and HP-22 would go to HPF-2.

Figure 4A.4.2-2 shows the estimated FFD production resulting from the BLM assumptions. The additional production from FFD is presented by increment grouped by processing facility: APF-1, HPF-1, and HPF-2. The gap between peak production for HPF-1 and HPF-2 is due to the hypothetical timing of the production assumptions. It is most likely that under actual production conditions the operating companies would work to schedule production so that this gap would not exist. The production assumptions shown in Figure 4A.4.2-2 provide the basis for determining the economic effects of FFD.

As illustrated in Figure 4A.4.2-2, the addition of FFD results in much higher average production per year and significant extension of production into the future. Figure 4A.4.2-1 shows that by 2023, production under the Alternative A – CPAI Development Plan would fall to less than 40,000 bbl per day, or less than 30 % of the peak production of 145,000 bbl per day. Figure 4A.4.2-2 shows that FFD production would not decline to this level until 2042.

4A.4.2.2 Alternative A – CPAI Development Plan Impacts on Regional Economy

REVENUES

ROYALTY AND TAX IMPACTS

As demonstrated in Section 3.4.2, the State of Alaska depends heavily upon oil royalties and taxes to fund its annual operating budget. The state funds approximately 80 % of its general fund unrestricted revenues from petroleum revenue, and 35 % or more of all state revenues are derived from the oil industry (ADR 2003).

Figure 4A.4.2-1 showed that oil production and revenues from the Alpine Field would begin to decline in 2008 without the ASDP. The increased production from Alternative A shown in Figure 4A.4.2-1 would contribute both state and federal tax revenues on an annual basis. Table 4A.4.2-2 shows the projected state and federal revenues for the period from 2003 through 2020 for the Alternative A – CPAI Development Plan. These estimates are based on the revenue model used by the ADR to forecast state revenues. The model is dependent upon a number of assumptions, the most important of which are level of production and forecasted wellhead value for oil. The production estimates used for both the Alternative A – CPAI Development Plan and the Alternative A – Full-Field Development Scenario are illustrated in Figures 4A.4.2-1 and 4A.4.2-2. The ADR publishes estimated projections of future oil prices as an integral component of their annual spring and fall revenue forecast for the state. The current oil price forecast by the ADR is shown in Table 4A.4.2-3. To the extent that future oil prices differ from these projections, revenue projections based on this projection are subject to underestimation or overestimation.

Royalty tax payments from within the National Petroleum Reserve-Alaska are treated differently from those from other state or federal lands, and Alternative A includes a portion of the ASDP within the boundaries of the National Petroleum Reserve-Alaska (CD-5 at least partially and CD-6 and CD-7 entirely). Federal law establishes a requirement that 50 % of lease sale revenues, royalties, and other revenues would be paid to the State of Alaska. However, that payment is conditional upon the use of the state's share for (a) planning, (b) construction, maintenance, and operation of essential public facilities, and (c) other necessary provisions of public service. The law stipulated further that the state should give priority to use by subdivisions of the state most severely impacted by development of oil and gas leased under the section (ADCED 2003).

In the period between 1987 through 1996, when the program became inactive because of lack of revenue from the National Petroleum Reserve-Alaska, $9.7 million was allocated to community projects in the region. With new lease sales in the National Petroleum Reserve-Alaska in 1999, the program became active again, providing $31.4 million in grants to communalities for 1999, 2001, and 2002. There are current applications for a total of $53.2 million for projects by the communities of Anaktuvuk Pass, Atqasuk, Barrow, the NSB, Nuiqsut, and Wainwright. During the program, Nuiqsut has received just under $9 million for community projects. The National Petroleum Reserve-Alaska Impact Mitigation Program provides direct economic support from oil development within the National Petroleum Reserve-Alaska to communities within the region.

PROPERTY TAX

The property tax for the ASDP would be based on the assessed valuation of the facilities developed onsite. The annual levy is based on the full and true value of property taxable under AS 43.56. For production property, the full and true value is based on the replacement cost of a new facility, less depreciation. The depreciation rate is based on the economic life of the proven reserves. Pipeline property is treated differently from production facilities. It is valued on the economic value of the property over the life of the proven reserves. Typically, the economic value is based on the present value of all future income streams from the pipeline.

TABLE 4A.4.2-2 SUMMARY OF STATE AND FEDERAL REVENUES FOR CD-3 THROUGH CD-7

Year	State Royalty[a]	State Oil Production Tax[a]	Federal Royalty[a]
2003	$0.0	$0.0	$0.0
2004	$0.0	$0.0	$0.0
2005	$0.0	$0.0	$0.0
2006	$0.0	$0.0	$0.0
2007	$25.0	$0.0	$0.0
2008	$24.9	$0.0	$0.0
2009	$26.1	$0.5	$1.1
2010	$30.7	$4.2	$9.1
2011	$29.7	$4.4	$11.2
2012	$43.0	$9.9	$26.9
2013	$38.6	$7.1	$24.7
2014	$34.9	$5.4	$22.9
2015	$30.0	$2.8	$19.5
2016	$25.6	$1.5	$16.5
2017	$21.9	$0.7	$13.9
2018	$18.9	$0.3	$11.9
2019	$16.3	$0.1	$10.1
2020	$14.2	$0.0	$8.8

Source: calculated by ResourcEcon from Dept. of Revenue data
Notes:
[a]Revenues are shown in millions of dollars.

TABLE 4A.4.2-3 PROJECTED OIL PRICES

Fiscal Year	Market Price – U.S. West Coast $/barrel	Wellhead Value $/barrel
2004	$25.28	$18.72
2005	$21.67	$14.99
2006	$22.00	$15.15
2007	$22.00	$15.05
2008	$22.00	$15.01
2009	$22.00	$15.05
2010	$22.00	$14.96
2011	$22.00	$14.77
2012	$22.00	$14.83
2013	$22.00	$14.69
2014	$22.00	$14.53
2015	$22.00	$14.34
2016	$22.00	$14.11
2017	$22.00	$13.87
2018	$22.00	$13.63
2019	$22.00	$13.21
2020	$22.00	$12.97

Source: Alaska Department of Labor. Oil price forecasts used in the State Revenue Forecast, Spring 2003.

The state property tax rate is 20 mills. A local tax is levied on the state's assessed value for oil and gas property within a city or borough and is subject to local property tax limitations. The 2002 property tax rate for the NSB was 18.5 mills (ADCED 2003) leaving the state portion of the property tax at 1.5 mills.

The NSB is also heavily dependent upon oil revenue from property taxes. In 2001, 95.44 % of property taxes received by the NSB came from BPXA, Phillips Alaska, Alaska Pipeline Services Company, Nabors Alaska Drilling, and Halliburton Company (NSB 2001).

The NSB faces a declining property tax base because of depreciation of petroleum-production related facilities that comprise most of the assessed valuation. The real property assessed valuation for the NSB has declined from $11.5 billion in 1992 to $9.4 billion in 2001 (NSB 2001). The ASDP Alternative A would help expand assessed property valuation and resulting taxes to the NSB.

An estimate for the potential property tax revenues from Alternative A can be calculated using a unit factor estimate of $0.50 per barrel (ADR 2003b). Using the point estimate of $0.50 per barrel, we can calculate the property tax value from the production figures in Table 4A.4.2-1. The estimated property tax, using the per barrel unit factor, is shown in Table 4A.4.2-4.

TABLE 4A.4.2-4 PROJECTED PROPERTY TAX REVENUES: ALTERNATIVE A – CPAI DEVELOPMENT PLAN

Year	CD-3 through CD-7 Daily Production[a]	Estimated Property Tax	
		NSB	State of Alaska
2007	34,000	$5,739,625	$465,375
2008	34,000	$5,739,625	$465,375
2009	34,000	$5,739,625	$465,375
2010	49,500	$8,356,219	$677,531
2011	45,603	$7,698,356	$624,191
2012	78,227	$13,205,695	$1,070,732
2013	72,388	$12,219,999	$990,811
2014	66,438	$11,215,565	$909,370
2015	58,182	$9,821,849	$796,366
2016	50,483	$8,522,161	$690,986
2017	43,971	$7,422,854	$601,853
2018	38,601	$6,516,331	$528,351
2019	34,151	$5,765,116	$467,442
2020	30,386	$5,129,537	$415,908
2021	27,123	$4,578,701	$371,246
2022	24,316	$4,104,845	$332,825
2023	21,858	$3,689,904	$299,181

Notes:
[a] Daily production in barrels

This analysis shows NSB revenues derived from the proposed development of CD-3 through CD-7. They would be expected to increase from approximately $5.7 million annually in 2007 when this revenue stream begins, to $13.0 million in 2012, when it would peak. It would decline to $3.7 million in 2023, the last year estimated. Incremental revenue to the State of Alaska would be $0.465 million in 2007, rise to approximately $1.1 million in 2012, and then decline to $0.3 million in 2023. These revenues represent an incremental increase approximately 2 percent to 4 percent of total NSB revenues (based on 2001 revenues – See discussion in Section 3.4.2). Increased property tax revenue would represent an incremental increase in tax revenue to the state of less than 1 percent.

CAPITAL EXPENDITURES

Indirect economic impacts would result from project capital expenditures. Detailed information on the capital expenditure for the Alternative A – CPAI Development Plan is presented in Appendix J. The capital expenditures for Alternative A are estimated to be $1.061 billion. These expenditures would occur over an 20-year period.

Most materials and capital equipment would likely be purchased outside of Alaska and would be shipped to the job site. However, some portion of the total capital expenditures would be made within Alaska, mostly in Anchorage and Fairbanks. Expenditures in Anchorage or Fairbanks might include construction of a module or project supplies. Limited expenditures might be made within Barrow or Nuiqsut. Such expenditures would likely be provision of goods and services to support construction activities**.**

EMPLOYMENT

Project-related employment from the Alternative A – CPAI Development Plan would consist of construction employment and operations employment. Construction income and earnings would be one of the most easily visible effects of the project. These impacts also are sequentially the first economic impact to be realized. For large remote projects such as the ASDP, as much as half of the total project expense is typically directed to labor costs.

Many of the construction workers hired would need skills and experience in drilling and pipeline construction. Most of the workers would be hired through union halls in Alaska for the respective tasks. However, most of the workers might come from out of state, because Alaska does not have a resident workforce with the range of skills necessary. As discussed later in this section, CPAI has had some success in providing employment opportunities for residents of Nuiqsut; however, in total these opportunities reflect a relatively small number of jobs. (See discussion in Section 3.4.1.6 – Population and Employment)

Table 4A.4.2-5 summarizes drilling manpower for the Alternative A – CPAI Development Plan. Construction crews would be housed at production pads, the Kuparuk Operations Center, or temporary camps. Small temporary camps could also be used during drilling operations.

Manpower requirements reflect a maximum of 60 personnel residing at the temporary drilling camp at each of the four road-connected pads in the Alternative A – CPAI Development Plan. Winter drilling at CD-3 would require an additional 15 people, for a total of 75 personnel.

TABLE 4A.4.2-5 DRILLING MANPOWER REQUIREMENTS

Time Period	Alternative A – CPAI Development Plan Manpower Required
Summer 2004	0
Winter 2004–2005	75
Summer 2005	0
Winter 2005–2006	75
Summer 2006	60
Winter 2006–2007	75
Summer 2007	60
Winter 2007–2008	135
Summer 2008	60
Winter 2008–2009	135
Summer 2009	60
Winter 2009–2010	195
Summer 2010	120
Winter 2010–2011	195

Source: Table 2-3, CPAI 2003n

CPAI estimated that a total of 3,000,000 man-hours would be expended between 2004 and 2010 for construction and operation of CD-3 through CD-7. The total work force is projected to peak at over 500 workers in 2006. Engineering and design work for the alternative are anticipated to require 500,000 man-hours. Offsite fabrication, which could occur in Fairbanks, Anchorage, or Nikiski, is estimated to require 250,000 man-hours (CPAI, RFI #85 response).

The Alaska Department of Labor (ADL) shows statewide average wages for all oil-related manufacturing of $31.24 for June 2003 (ADOL 2003a). The product of this wage rate and the estimate of 3,000,000 man-hours cited above results in a total project labor expenditure of $93.7 million.

Similarly, based on the average civil engineer wage rate of $32.50 within Alaska for oil-related jobs and the man-hour estimate of 500,000, the projected total labor expenditure for engineering and design is estimated to be $16.2 million. Based on the average Alaska wage rate for plumbers, pipefitters, and steamfitters of $26.51, and the estimate of 250,000 hours for fabrication, the estimated labor expenditure for this category totals $6.6 million (ADOL 2003b).

The specific profile of employment and skill area for Alternative A is not yet available. Typical job skill categories for similar projects include the following: laborers, teamsters, operators, general foremen, welders, welder's helpers, heavy duty mechanics, auto weld technicians, office engineers, office clerks and technicians, truck mechanics, project managers, field engineers, project engineers, office managers, safety managers, fitters, electricians, security guards, medics, and welder repair.

Most construction jobs are likely to be filled by workers from outside the region or from outside Alaska. The current level of participation by residents of the NSB in petroleum-related employment is relatively limited. In the 2000 census, there were 2,990 males and 1,348 females in the workforce for the communities comprising the NSB. The job category of mining, which includes petroleum-related employment, included 33 jobs in 2000, 30 of which were filled by Alaska Native residents of the NSB. There were 207 workers residing in the NSB communities working in construction, 139 of whom were Alaska Natives. Among female workers, there appeared to be very little participation in petroleum-related jobs in 2000 (ADOL 2003c).

Operations personnel for Alternative A would be based at production pads. Anticipated staffing levels are shown in Table 2.3.3-2 (Section 2). There would be 22 jobs associated with operations for CD-3 through CD-7. Total annual operations labor expenditures for these workers are not available.

Section 3.4 described a number of jobs and economic activity in Nuiqsut as a result of the existing Alpine Field. These job opportunities include participation in joint venture companies to provide oilfield services, direct employment, funding of subsistence panel and research jobs, and others. These employment opportunities are important to the residents of the community, particularly given the residents' relatively low opportunity for employment.

LOCAL ECONOMIC ACTIVITY

A number of economic impacts to Nuiqsut and other local communities were described in Section 3.4. The impacts discussed include direct employment and earnings to residents; funding for the Kuukpikmuit Subsistence Oversight Panel, increased economic activity at Nuiqsut businesses such as the Kuukpik Hotel, and revenues to Nuiqsut Village Corporation resulting from joint-venture business activities in the region.

Without a continuing and increased oil industry, these effects would begin to decline slowly, beginning in 2008. New economy activity represented by the Alternative A – CPAI Development Plan is expected to increase the level of local economic activity over the current level, and those impacts would be extended many years into the future.

In addition, because some of the facilities of the Alternative A – CPAI Development Plan would be within the National Petroleum Reserve-Alaska, the local communities would receive direct funding assistance through the

National Petroleum Reserve-Alaska Impact Mitigation Program. The expenditures under this program were described in Section 3 and would be substantially expanded under this alternative.

4A.4.2.3 Alternative A – Full-Field Development Scenario Impacts on Regional Economy

Estimates of the amount and timing of production related to FFD were discussed in Section 4A.4.2.2.

REVENUES

ROYALTY AND TAX IMPACTS

The economic effects from royalty and tax payments can be determined only if the specific location relative to BLM-managed lands is known (that is, whether oil is derived from federal or non-federal land). Because the description of FFD is hypothetical, it was assumed that impacts of FFD would be generally proportional to production in each year. In 2012, for example, the full-field production under BLM assumptions is 4.5 times that of the assumptions of the ADR for development of the applicant's proposed action. The ratio changes from year to year, but full-field production under BLM assumptions increases over time. In 2023, the full-field production under BLM assumptions is 10 times that of the CPAI's proposal assumptions of the ADR.

CAPITAL EXPENDITURES

There currently are no estimates for capital expenditures for FFD.

EMPLOYMENT

Table 4A.4.2-5 summarizes the drilling manpower requirements for the applicant's proposed action. FFD assumes a one-rig drilling program, so the duration of drilling activities would increase. The FFD one-rig program would continue an additional 1 to 2 years per additional production pad, depending on whether drilling is in winter only or year-round.

There is currently no estimate available for total project employment for FFD.

LOCAL ECONOMIC ACTIVITY

Increases in employment and income to village corporations from contracts provided during construction and operations are expected to be similar or greater than the levels achieved under the Alternative A – CPAI Development Plan. However, the portion of tax and royalty revenues and the availability of grants that are proportional to production would be substantially higher under FFD.

ABANDONMENT AND REHABILITATION

Removing facilities and rehabilitating the land will generate substantial employment for several years. The number of jobs created may be comparable to that for construction if gravel fill is removed. Once oil ceases to flow from the satellites and termination activities are complete, economic stimulus from the satellites—with the exception of relatively insignificant employment from monitoring and long-term rehabilitation—would cease.

4A.4.2.4 Alternative A – Summary of Impacts (CPAI and FFD) on Regional Economy

- The Alternative A – CPAI Development Plan would provide an incremental increase in federal, state, and local tax revenues. This increase would be 2 to 4 % (of 2001 revenues) for the NSB. It would be less than 1 % of state tax revenues. Increased revenues under FFD could be 4.5 to 10 times the annual revenue estimated for the Alternative A – CPAI Development Plan, depending on production in any given year.

- The NSB would benefit from the expanded property tax base that would help fund government services to residents.

- The NSB and village corporations also would experience increased economic activity in the region, increased opportunity for direct employment of local residents, and increased opportunity for grants under the National Petroleum Reserve-Alaska Impact Mitigation Program. As a result of this program, oil lease sale fees and royalties from the National Petroleum Reserve-Alaska have a disproportionately large beneficial effect on communities in the region.

- There could be economic impacts to subsistence harvesting activities from Alternative A resulting from increased travel costs and increased travel times. The more densely developed FFD scenario for Alternative A would likely exacerbate these impacts (see discussion in Section 4A.4.3, Subsistence.).

4A.4.2.5 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Regional Economy

Currently, very few residents of the region obtain employment in the oil industry. Job training, educational funding, and future employment programs could help to mitigate loss of opportunity for participants in the traditional subsistence lifestyle.

4A.4.2.6 Alternative A – Effectiveness of Protective Measures for Regional Economy

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that change potential economic effects. This EIS does identify training and employment programs as a potential mitigation measure.

4A.4.3 Subsistence

4A.4.3.1 Alternative A – CPAI Development Plan Impacts on Subsistence

CONSTRUCTION PERIOD

Under the Alternative A – CPAI Development Plan, CPAI proposes to use two gravel mines: the existing ASRC Mine Site and Clover. Excavation would take place in the winter and involve the use of pneumatic drills, earthmovers, and blasting. The ASRC Mine Site would require an ice bridge across the Colville River. The ASRC Mine Site is located within the current Nuiqsut use area for wolf and wolverine, winter and summer caribou, fish, and moose. Clover is located within the current Nuiqsut use area for wolf and wolverine, winter caribou, fish, and moose. Barrow residents occasionally use the mine areas for the harvest of winter caribou, wolf, and wolverine, and Anaktuvuk Pass residents occasionally use these areas for the harvest of fish and caribou. Noise, lights, traffic, and blasting during construction at the proposed mines would divert, displace, or both divert and displace caribou and furbearers (Section 4A.3.4), resulting in decreased availability of these resources to hunters near these locations. Fish availability in the areas near the proposed mines could decrease if noise and vibration from traffic and gravel extraction divert fish from their habitats and because changes in water levels in adjacent connected lakes and streams caused by gravel extraction result in a decline in overwintering fish habitat (Section 4A.3.2.1). A North Slope Inupiat hunter who has observed wildlife displacement associated with gravel pits said,

> “These gravel pits that are being used to support these activities, the gravel pits, the geese, when they're migrating from the Lower 48s, from out there, they are now going to these gravel pits. They're not following their usual migration anymore. I watched that first hand also over a period of time. So those animals over there are being displaced, is what I'm saying. And I got to see that firsthand over a period of time.” (Frederick Tukle Sr. 2001 Liberty Scoping, Barrow)

The proposed five satellite drilling and production pads would divert key subsistence resources (caribou, wolves, and wolverines) and could consequently decrease resource availability in currently used subsistence areas in the vicinity of the five pads. The construction of the proposed production pads would reduce access within current subsistence-use areas as hunters avoid construction areas because of perceived regulatory barriers and safety concerns with shooting around industrial development. Based on Pedersen et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development with approximately 78 % of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River, 51 % of the 1999 and 2000 harvests occurring greater than 16 miles and 27 % occurring six to 15 miles from Alpine development. Construction and operation of these pads and associated infrastructure will contribute to a perception by Nuiqsut residents and subsistence users of being surrounded by development. Impacts are expected to be short term and localized as construction will be limited to 1 to 2 years. However, oil and gas production is expected to be localized, but continue for a longer period.

Gravel pad placement would affect waterfowl nesting habitat (CD-4, CD-5, CD-6, and CD-7) (Section 4A.3.3). Production pad CD-4 would be located within 1,000 feet of the Nigliq Channel and a subsistence fish camp. The Nigliq Channel area is an important historical and current subsistence-use area for fish, waterfowl, and caribou. This area is especially important for the subsistence winter fish harvests (Figures 3.4.3.2-13 and 3.4.3.2-14). The proposed location for CD-6 is within the previously stipulated 3-mile sensitive area around Fish Creek and within the documented winter subsistence-use area for caribou, wolf, and wolverine. The Fish Creek area is proportionately the area with the highest use for Nuiqsut's winter harvest of caribou (Figure 3.4.3.2-6), and 25 % of Nuiqsut's caribou harvest for 1993, 1994–1995, 2001, and 2002 come from the Fish and Judy creeks area (Figure 3.4.3.2-7). Fish Creek is also an important Nuiqsut harvest area for geese (more than 45 %) (Figure 3.4.3.2-15), and more than half of wolves harvested by Nuiqsut hunters come from the Fish and Judy Creek areas (Figure 3.4.3.2-21). Production pads CD-3 and CD-4 would be within the current Nuiqsut use area for eider, seal, wolf, wolverine, fish, and winter and summer caribou. Production pad CD-4 also would be within the current Nuiqsut use area for moose. Production pads CD-5, CD-6, and CD-7 would be located within the current Nuiqsut use area for wolf, wolverine, and winter caribou. Production pads CD-5 and CD-6 would be located within the current Nuiqsut use area for moose. Figures 3.4.3.2-1 through 3.4.3.2-4, 3.4.3.2-8, 3.4.3.2-17, and 3.4.3.2-23 illustrate subsistence use areas for Nuiqsut. Frank Long Jr. of Nuiqsut, a hunter and executive director of the Kuukpik Subsistence Oversight Panel, stated during ASDP scoping, "… in the area that CD-5, 6, and 7, especially 7, is a hunting area where we do our hunting inland and with furbearing animals. And CD-6 is the one that's close to the Fish Creek area which we do fishing during the summer." In short, the proposed production pads would be located in key subsistence harvest areas in both the Fish-Judy Creeks Facility Group and the Colville River Delta Facility Group.

Construction of roads could alter or restrict movements of key subsistence species such as caribou, wolves, and wolverine. Construction of bridges and ice roads could affect the availability of fish in the Nigliq Channel and area lakes by reducing overwintering habitats (Section 4A.3.2.1). The proposed Nigliq Channel bridge is located in a key subsistence harvest area for fish; however, construction would occur from December to April after the key winter harvest season (e.g., October and November). As depicted in Figure 3.4.3.2-11, 55 % of fish are harvested in October. More than half of Nuiqsut's subsistence fish are harvested along the Nigliq Channel (Figure 3.4.3.2-13). Ice roads are also noted for accumulating garbage, which attracts some species.

As one interviewed hunter noted, "People that use the ice road leave trash, and animals eat that trash. Caribou and polar bears have trash inside of them. Seals [have] plastic pop rings. Within the last 5 years, on the ice road, [I] see a lot of trash all over." (Stephen R. Braund & Associates 2003a Field Interviews)

Ice roads also have been noted to be grounded to the bottom of waterways, changing the normal patterns of break-up and reducing fish habitat. One resource user described his recent hunting trip by boat: "A few days ago [late June], the ice was out 7 miles; we followed it to Thetis Island. Usually the ice is out around Thetis Island, but the ice road was intact and it kept the ice from going out. We almost got boxed in." (SRB&A 2003a, Field Interviews)

During pipeline construction, availability of subsistence resources, especially caribou, would be reduced along the construction corridor and hunter access would be reduced as hunters avoid shooting near workers and equipment. Effects from construction are expected to last 2 years and are expected to be primarily local in extent. Pipeline construction would affect local availability of key subsistence resources (caribou, waterfowl, fish, wolves, wolverine, and seals) because of displacement and would occur in seasonal and general use areas for key subsistence resources. Subsistence access would be affected as subsistence users avoid construction areas because of perceived regulatory barriers and safety concerns with shooting around industrial development. Subsistence hunters consequently would travel farther at greater costs and effort. The key resources are harvested during more than one season each year; they have been used for multiple generations, and the affected areas are used for multiple resources each year. Effects from construction would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses.

OPERATION PERIOD

The operation of the gravel mines would be intermittent following the completion of the construction phase. The mines would be open and gravel stockpiled as needed for maintenance of the pads, roads, airstrips, and boat ramps. The effects of subsequent mine operation would depend on the season and extent of use. Spring and summer use could disturb or deflect waterfowl, fish, and caribou from the area; winter use could deflect caribou, wolf, and wolverine from the area. Significant use of the mine sites during spring and summer seasons is not expected because most construction will be conducted during the winter and there would be no road access to the mine sites when ice roads are not available.

The operation of facilities on the gravel pads would have a number of effects on subsistence uses. The gravel pads themselves create habitat for arctic foxes, which could den in the loose gravel. There is little perceived advantage in having more foxes available, however, as stated by elder Bessie Ericklook in 1979:

> “Trapping was abundant east of here. Now, we don't go over because of the oilfield. Just recently, it is known that the foxes are very dirty, discolored, and rabid in that area. Trapping is done elsewhere.” (MMS 1979 Sale BF, Nuiqsut)

Noise from operations such as pumps, generators, and drilling machinery could deflect terrestrial mammals, fish, and waterfowl from the immediate area and make them less available to subsistence harvesters at those locations. According to one interviewed hunter, “The vibration of horizontal drilling bothers animals and makes them afraid. The migration route of the Central Arctic (caribou) herd (CAH) changed because of this.” (SRB&A 2003a, Field Interviews)

Section 4A.3.4 describes how caribou at Prudhoe Bay use gravel pads for insect relief. Caribou habituation to gravel pads and other oilfield infrastructure changes the value of the caribou to subsistence users, who view these habituated caribou as contaminated and not behaving correctly. Frank Long Jr. stated in the Nuiqsut ASDP scoping, “We will have the same problem we did in the Prudhoe Bay and the Kuparuk area with our caribou. Right now I call our caribou that are existing around here that don't go nowhere our ‘industrial dope addict caribou.’ They [are] already sick and nobody's doing anything about them.” Sick caribou have been harvested by local hunters, as noted by one interviewed hunter, “I’ve seen a few sick caribou, with green meat, pus in joints, bare spots. Hard to say what the cause is…” (SRB&A 2003a, Field Interviews). Inupiat hunters prefer fast, healthy caribou, instead of habituated caribou, which are perceived to move slower. One hunter stated, “Fast ones are the healthy ones, they are worth taking home.” (SRB&A 2003a, Field Interviews)

Subsistence hunters have expressed a preference for hunting away from industrial activity areas for safety reasons. As noted in NRC (2003:156), “Even where access is possible, hunters are often reluctant to enter oilfields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oilfields spread.” Based on Pedersen et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development with approximately 78 % of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River and 51 % of the 1999 and 2000 harvests occurring greater than 16 miles and 27 % occurring 6 to 15 miles from Alpine development. Therefore, the production pads near the Nigliq Channel and Fish Creek areas would reduce subsistence access to traditionally important subsistence uses at those locations. Isaac Nukapigak noted in the 2003 ASDP scoping in Nuiqsut:

> “The stipulation that's been part of the Northwest ([Northeast] sic) Integrated Action Plan EIS where there's seven line ([seventy-nine] sic) stipulations that have been implemented by BLM having a buffer zone in these sensitive, very sensitive area that, you know, lakes and streams, where that's our channel, you know, that's what we depend on to navigate to our subsistence resource to gather.” (2003 ASDP Nuiqsut Scoping Transcripts)

Airstrip operation would disturb and temporarily displace subsistence species (caribou and spotted seals) from the vicinity of airstrip and landing areas. According to area studies and scoping testimony, low-altitude flights (helicopter and scientific survey flights) divert subsistence species from air transport corridors and survey transects (see Section 4A.3.4). Nuiqsut's mayor Rosemary Ahtuangaruak described the displacements of subsistence species by aircraft and its effect on hunters:

> **"**When I went camping last year, I waited 3 days for the herd, to have a helicopter to divert them away from us. When they were diverted, we went without. We have had to deal with harassment. We had over flights three times while trying to cut the harvest. It is disturbing. The next year we had a helicopter do the same thing, but it was worse. They were carrying a sling going from Alpine to Meltwater, another oilfield. It went right over us three times. The herd was right there and it put us at risk. I had my two young sons with me and it made me very angry. What am I to do when the activities that have been handed down for thousands of years to our people are being changed by the global need for energy?" (Mayor Rosemary Ahtuangaruak 2003 ASDP Scoping, Nuiqsut)

Wildlife studies, some of which are associated with monitoring or planning oil and gas activities, prompted another Nuiqsut resident to make a similar observation:

> **"**These wildlife folk that see it—they've witnessed, I guess they are wildlife folks, that walk in the country and looking at birds and things in the Colville River Delta, maybe the east side, down by Ulumniak (ph) that's next to—not far from the old Nuiqsut site, they're monitoring these birds and go to and fro to these places with a chopper—upsets, disrupts, displaces—perhaps some of their only opportunity to go get their game, especially caribou, in the area are scared and may their run off because of these impediments that arrive are not natural. Naturally, they would walk along the coast where they're at and be able to harvest their caribou." (Ruth Nukapigak 1998 National Petroleum Reserve-Alaska Scoping, Nuiqsut)

Referring to the effect of aircraft on wildlife, Nuiqsut residents stated, "Sometimes the aircraft from Alpine chase the caribou up the river," and "Helicopters are flying around when we are doing caribou and geese hunts. Before Alpine, there was complete silence." (SRB&A 2003a, Field Interviews)

Interviewed hunters correlate aerial activity with subsistence resource deflection. One hunter stated, "It varies whether we have a lot of activities going on. When there are a lot of activities going on, we hardly see any or they [caribou] change their migration route. Oil and gas, airplanes, helicopters, bird survey people—airplane, floatplanes. Either there are less caribou or they are changing migration with activities. I don't know which." (SRB&A 2003a, Field Interviews)

Therefore, local hunters report that aircraft operation affects the availability of subsistence resources in usual hunting areas.

Roads during the operational period would affect terrestrial mammals and waterfowl through deflection and habitat loss (See Sections 4A.3.4 and 4.A.3.3). Vehicular traffic could deflect waterfowl during the operational phase of the applicant's proposed action. Disturbance of waterfowl has been documented most often within 50 meters of roads; however, some disturbance has been reported for birds as far as 150 to 210 meters from roads. Deflection of birds from their usual habitat would affect the availability of birds as a subsistence resource at those locations. Waterfowl also would be subjected to disturbances related to aircraft and boat traffic, noise from facilities, and pedestrian traffic during the summer breeding season, especially during the pre-nesting period. Terrestrial mammals would be disturbed and displaced by vehicle traffic on the roads between CD-1 and CD-4 and CD-2 and CD-7. Activity on the facility pads and airstrips could disturb caribou. Use of the Alternative A roads by local residents in addition to industry would result in higher levels of traffic and increased disturbance and deflection. Inupiat hunters have observed the effect of roads and pipelines in Prudhoe Bay, Kuparuk, and other locations, and one hunter summarized these observations by saying,

> "The Prudhoe Bay spine road is like a gate: the caribou get corralled in the area by roads, traffic, pipeline reflections, and staging. They get confused. They are scared to cross the pipelines, they are as scary as a grizzly bear would be to the animals. Some caribou are driven south, others are driven to the coast. If more roads are built, then there will be more blockage of the caribou. They will get stuck in the oilfields like a corral. The ones stuck south stay south and get little insect relief, while those going north get to the beach and the coast and get relief." (SRB&A 2003a, Field Interviews)

Leonard Lampe, president of the Native Village of Nuiqsut, expressed his belief of the effect of increased traffic on caribou:

> "…I feel cause of all the traffic between Fairbanks and Endicott, much more increased traffic that caribou are hesitant to cross the main roads because of all the traffic. I feel that has something to do with the caribou migration as well, because of increased traffic as well as air, not just ground, as well as air, seismic operations happening all over." (Leonard Lampe 1997 National Petroleum Reserve-Alaska Scoping, Nuiqsut)

Ice roads built and used during operations would continue to draw off water from area lakes. Water removal from lakes could potentially affect the fish populations, especially in late winter when water volumes are lowest under the ice cover and water quality and dissolved oxygen concentrations are low. Excessive water withdrawal or disturbance at this time could potentially eliminate fish populations in these lakes (Section 4A3.2), and thus affect fish availability as a subsistence resource. A Barrow resident expressed the importance of lakes to the Inupiat:

> "These deep lakes are very crucial to us. And, those are the prime targets that you are looking at for your water source. Because, in the shallow areas, the fish don't overwinter in the shallow lakes. They overwinter in the deep water, because they freeze to the bottom of the lake six to seven feet sometimes in the course of a year." (Arnold Brower Jr. 1982, National Petroleum Reserve-Alaska Scoping, Barrow)

However, no impacts to fish availability are expected if CPAI adheres to the water withdrawal permit conditions (Section 4.3.2.1).

The bridge over the Nigliq Channel and other smaller bridges would have an effect on subsistence during operation similar to that of construction (see Section 4A.3.2.1-Bridges). Pilings in the channel would have the potential to change the distribution of river sediments and debris, causing transportation problems as people in boats try to pass under the bridge while fishing in the channel or en route to other harvest locations. As shown in Figure 3.4.3.2-10, fishing effort in the Nigliq Channel sites in net-days is dramatically higher than fishing effort on the Colville River outer delta and main channel sites, further emphasizing the importance of fishing on the channel. Seals could be disturbed if they are hauled out in the area during high-traffic periods as noted in Section 4A.3.4.2. Residents are also concerned about the bridge being washed out, especially if the pipeline, as in this alternative, goes across the channel on the bridge. Isaac Nukapigak in the 2003 ASDP scoping testimony for Nuiqsut observed, "The bridge, you know, that's another thing that I, myself, also be very concerned about because that is our transportation corridor that we utilize to go out and hunt our fish and our furbearers, you know, marine mammals hunting." (2003 ASDP Nuiqsut Scoping Transcripts)

Should the channel be made non-navigable to small boats because of siltation, the difficulty of accessing resources by boat along the channel would increase. However, the USCG must approve construction and make judgments on navigability, which may result in conditions on their approval to assure such blockages do not occur. Resources that are harvested in the channel include marine mammals, waterfowl, fish, and caribou, all of which are harvested in large proportion by boat in or near the Nigliq Channel, Nigliq Delta, and Fish and Judy creeks.

Under Alternative A, a new pipeline would be in operation between CD-1 and the production pads. Pipelines would be a minimum of 5 feet above the tundra and would cross several drainages. Although caribou will cross under pipelines elevated at least 5 feet, they more readily cross under higher pipelines. Crossing of the road and pipeline combination during the winter could alter caribou movement because of reduced clearance or the creation of a visual barrier, especially along east-west oriented pipelines such as the pipeline segment between CD-5 and CD-6. Although the proposed pads and pipelines would alter caribou movement in industrial activity areas, they would not affect the overall caribou population and would result in only minor changes in herd distribution. However, at the local scale, where hunters have customary hunting areas, minor shifts in caribou availability can affect subsistence users' access to caribou. The caribou could not be where the hunter usually harvests them in the number and condition that hunters would anticipate without the industrial activity.

Interviews (SRB&A 2003a, Field Interviews), scoping comments, and public testimony (including scoping for Point Thomson, ASDP, and several hearings for National Petroleum Reserve-Alaska) have indicated that hunters believe that pipelines deflect both caribou and hunters as well as affect the direction of herd movement and size.

Subsistence users do not believe that a minimum pipeline height of 5 feet is adequate for caribou passage, unless something, such as insects or predators, is motivating the caribou. Several Nuiqsut hunters related the following scenario as evidence that pipelines deflect caribou:

> **"**Some caribou have a hard time crossing the Meltwater pipeline. Some of pipeline is too low—four to five feet; it needs to be 7 to 8 feet for caribou to get to calving grounds and the ocean where it is cooler." (SRB&A 2003a)

Pipelines hinder subsistence access in two ways: (1) subsistence users cannot cross the pipelines if snow conditions have caused the height of the pipeline to be too low and subsistence users often must follow pipelines for some distance to find adequate clearance for passage when traveling by all-terrain vehicles, snowmobiles, or boats (1997 National Petroleum Reserve-Alaska Scoping Nuiqsut);and, (2) subsistence users are reluctant to shoot around pipelines. A Nuiqsut hunter expressed the difficulty of crossing pipelines:

> "Well the recommendation from the community for outside development was either bury a good portion of the pipeline or elevate it high enough. I mean 5 feet is not adequate in the wintertime. There's no way that you can cross, even with a snowmobile. You have to follow the pipeline in order to get to an area where you can you can finally cross it. It could take you an additional 10 miles of the quickest route that you might be able to come home on, but because of the height of the pipeline and the snowdrifts, that makes it that much harder, and I do think that the caribou have that same problem as like we do." (Isaac Nukapigak 1997 National Petroleum Reserve-Alaska Scoping, Nuiqsut)

Pipelines also deter hunting because of the inherent safety concerns involved with hunting near them. One Nuiqsut resident stated,

> **"**We don't go down that way to caribou hunt because of the pipeline in there; it is a big obstruction. A lot of times they [caribou] are on the pipeline side and we don't shoot. They [industry] tell us it is okay to shoot, but common sense says not to shoot into pipeline!" (SRB&A 2003a)

The change in access caused by pipelines would result in increased effort, cost, and risks associated with traveling farther. One Nuiqsut resident referred to this effect when she said,

> "But she's suspect that if activity persists throughout the year, it will alter the hunting and game will no longer be visible and maybe may cause hunters to go much farther. This has regards to the harvest their subsistence and additional resources [and] safety of hunters when they have to go that much farther for their subsistence and additional resources. (Ruth Nukapigak 1998 National Petroleum Reserve-Alaska Scoping, Nuiqsut)"

Subsistence users carefully observe caribou reactions to pipelines, and one hunter stated, "Some [caribou] get used to pipelines, but it takes years. Shiny pipes and pipes that vibrate feel like a living thing to the caribou and it scares them." (SRB&A 2003a, Field Interviews)

Other hunters observed changes in the Nuiqsut area in response to existing development, noting that, "Most caribou don't cross Nigliq to Fish Creek anymore. There is noise, activity, traffic, and pipelines." (SRB&A 2003a, Field Interviews)

Hunters believe that caribou could also be traveling in smaller herds because of issues with crossing pipelines. One hunter observed,

> "Caribou movement patterns have changed. The herd splits along the pipeline where they used to go straight through, and they congregate in smaller groups spread further apart. Main parts of the herd split either north or south of Alpine, all trying to head toward insect relief." (SRB&A 2003a, Field Interviews)

In summary, industrial development in the Fish and Judy creeks and Colville River Delta areas would reduce the availability of and access to the area that has supported more than half of the harvest of fish, caribou, wolves, wolverines, geese, and eiders at Nuiqsut. Subsistence harvests would not be reduced to the same extent, but subsistence access would be affected as subsistence users avoid industrial areas because of perceived regulatory barriers and safety concerns with shooting around industrial development. To avoid industrial areas, hunters would hunt elsewhere and would travel farther at greater cost and effort. Currently, harvest locations are based on local knowledge of resources and their abundance at traditional harvest areas. Moving to another area to avoid development means harvesters would more heavily use areas with presumably fewer and less densely distributed subsistence resources. These changes to subsistence use patterns would require increased investments in time, money, fuel, and equipment. It is possible that Nuiqsut hunters would not have the same rate of harvest success if access to these traditionally used areas is altered. These effects would last for the life of the applicant's proposed action (30 years); in other words, for multiple hunter generations. The key resources in this area are harvested during more than one season each year; they have been used for multiple generations; and the affected areas are used for multiple resources each year. Effects of the applicant's proposed action would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of Nuiqsut subsistence uses.

ABANDONMENT AND REHABILITATION

During the dismantlement and removal phase of abandonment and rehabilitation, subsistence resources and activities will be subject to impacts similar to those incurred from construction activities, assuming gravel fill is removed. Following termination activities, subsistence resources and activities will be subject to fewer impacts. If the roads are left in place and remain serviceable, they could continue to provide access to subsistence resources. However, if local residents have come to utilize the oilfield roads to access subsistence resources and depend on oil-reliant incomes to help support subsistence harvesting and the roads are dismantled and the income lost, local residents may find it difficult to realize any improvement in subsistence harvests.

4A.4.3.2 Alternative A – Full-Field Development Scenario Impacts on Subsistence

Effects caused by the FFD scenario are analyzed in a more general way than those for the Alternative A – CPAI Development Plan because of the hypothetical nature of the scenario. This assessment addresses the potential effects to subsistence uses of 24 locations (2 processing facilities and 22 production pads). For assessment of effects to subsistence from the FFD scenario, the Plan Area is divided into groups: the Colville River Delta Facility Group, the Fish-Judy Creeks Facility Group, and the Kalikpik-Kogru Rivers Facility Group. The Alternative A FFD scenario is discussed in Section 2.4.1.2 and shown in Figure 2.4.1.2-1.

COLVILLE RIVER DELTA FACILITY GROUP

Subsistence uses are especially concentrated in the Nigliq Channel and the main Colville River channel. Forty-one % of Nuiqsut's caribou harvest came from this area (Section 3.4.3), primarily in summer. The Colville River Delta is an important fish harvest area in spring, summer, and fall, with October the primary harvest month. Seals are harvested in the Colville River Delta in spring, summer, and fall, and the area accounts for 28 % of the Nuiqsut eider harvest, 16 % of the geese harvest, and 35 % of the wolverine harvest. Several cabins and subsistence camps in the Colville River Delta (both the Nigliq and main channels) serve as a base for subsistence activities such as fishing. Subsistence user comments reflect this usage:

> **"**All the way down to the mouth of Nagaluk (ph) they put their nets. It's true that during the summer, that (Inupiaq), they put nets there, yes, but for whitefish, this is – this Nagaluk (ph) River is what they use the most. And then if they cannot do it there when the bay opens up, they go through the fish screen and use that area also for fishing. The Ublutuoch River which is really close from here and it bends like crazy like a snake, there's no fishing there. They don't fish there. It's the Fish Creek area is what they use…" (Nelson Ahvakana 1998 National Petroleum Reserve-Alaska, Nuiqsut)

Nuiqsut residents associate existing Alpine development with reduced fish harvests in the Colville River Delta. One resident said,

> **"**I pull nets for cisco in October north of Nuiqsut on the Nigliq Channel. Fishing has slowed down since Alpine went online. I don't even bother to fish much unless other people are getting a lot because the effort is not worth the gas money I have to spend." (SRB&A 2003a, Field Interviews)

Development in the Colville River Delta Facility Group area would affect current subsistence use of eider and geese, berries, seal, wolf, wolverine, fish, winter and summer caribou, and moose. The FFD of the Colville River Delta area would have the same effect on subsistence uses as the Alternative A – CPAI Development Plan, but the effect on subsistence use would increase as development and industrial activity increases.

This area also is used occasionally by residents of Barrow and Anaktuvuk Pass for the harvest of subsistence resources such as fish, caribou, wolf, and wolverine, and, consequently, subsistence of these communities could be affected, though to a much lower level than Nuiqsut's subsistence use. Anaktuvuk Pass people could fish in the Colville River Delta when visiting relatives in Nuiqsut. Several Barrow families have relatives living in Nuiqsut, and people move back and forth between the two communities. Barrow residents have ancestral ties to areas between Barrow and Nuiqsut, and Barrow residents continue to return to those areas for subsistence activities. Barrow hunters hunt in the area for caribou, moose, and furbearers, primarily wolf and wolverine, in recent times. The Colville River Delta is on the eastern edge of Barrow's subsistence-use area. There is no known current use of the Colville River Delta area by Atqasuk residents.

FISH-JUDY CREEKS FACILITY GROUP

The Fish and Judy creeks area is a heavy subsistence-use area for Nuiqsut, as noted 20 years ago in a Barrow hearing, "On your briefs, here, you have failed to point out the area of Fish Creek, one of the most important rivers that we have for the people of Nuiqsut. As a subsistence area, it is hunted and fished very heavily." (Sam Taalak 1982, National Petroleum Reserve-Alaska Testimony, Barrow)

Fishing occurs in summer and winter; caribou are harvested year-round (primarily in the summer by using boats); and the area accounts for 25 % of the Nuiqsut caribou harvest, 63 % of the geese harvest, 55 % of the wolf harvest, and 15 % of the wolverine harvest. Hunters harvest wolf and wolverine in the November-to-April time period with the use of snowmobiles. Moose hunting in August by boat and berry picking in the fall also occurs in the area. Nuiqsut residents have subsistence cabins, camp sites, drying racks, and tent platforms in this area and use the cabins and camps as a base for conducting several subsistence activities at the same time (fish and caribou in summer and fall and berry picking in the fall near camps and cabins). The camp sites and cabins are shared among family and friends, and their use is traced back several generations by family. People know and value the history of the camps and cabins, including a new structure on an old site. Hunters noted that the elders located these cabins and camps in strategic places where multiple resources are available.

Development in the Fish-Judy Creeks Facility Group area would affect current subsistence use of geese, berries, wolf, wolverine, fish, winter and summer caribou, and moose. The FFD of the Fish and Judy creeks area would have the same effect on subsistence uses as the Alternative A – CPAI Development Plan, but the effect on subsistence use would increase as development and industrial activity increases. The Fish and Judy creeks area is an important Nuiqsut subsistence-use area for key subsistence resources.

This area is also used by residents of other communities for the harvest of subsistence resources such as fish, caribou, wolf, and wolverine, though the impact to their subsistence use would be less than that for the residents of Nuiqsut. Barrow hunters occasionally use the Fish and Judy creeks area for caribou, wolf, wolverine, and fox. The hunters usually travel in winter by snowmobile and make use of cabins and camps near Teshekpuk Lake and along the Ikpikpuk and Chipp rivers as a base for snowmobile travel. Anaktuvuk Pass people also make periodic subsistence use of the Fish and Judy Creeks area. These uses are primarily associated with caribou harvest failures at Anaktuvuk Pass and when visiting relatives in Nuiqsut. To the extent that FFD affects Nuiqsut harvest patterns, it could affect sharing, trading, and gifting with Anaktuvuk Pass residents, and reduce an emergency reserve hunting option for Anaktuvuk Pass. In addition, Nuiqsut hunters could go farther south for furs and caribou, thus competing with Anaktuvuk Pass hunters, or farther west, competing with Barrow and Atqasuk hunters. Atqasuk hunters make occasional use of the Fish and Judy creeks area. This use is primarily in the winter by snowmobile for wolf and wolverine, with incidental harvest of caribou. Furbearer hunting requires a large travel and hunting area, and with development, hunters could travel farther and enter the traditional territory of other communities.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

The Kalikpik and Kogru rivers area is less important as a Nuiqsut subsistence-use area for key subsistence resources than the Colville River Delta and Fish and Judy creeks areas. However, Nuiqsut subsistence harvesters use the Kalikpik and Kogru rivers area for caribou in summer and winter if they are not found closer to the community, for geese in spring, wolf and wolverine in winter, fish, berries, and eider and seal hunting trips. There are two reported subsistence camps in the Kalikpik and Kogru rivers area. It is possible that additional camps exist in this area.

Development in the Kalikpik-Kogru Rivers Facility Group area would affect current Nuiqsut subsistence use of eiders, geese, berries, wolf, wolverine, fish, and winter and summer caribou. The FFD of the Kalikpik and Kogru rivers area would have the same effect on subsistence uses as the Alternative A – CPAI Development Plan, but the effect on subsistence use would increase as development and industrial activity increases.

The Kalikpik and Kogru rivers area is occasionally used by residents of other communities for the harvest of subsistence resources, including caribou, wolf, and wolverine. Barrow hunters occasionally use the area for caribou if they are not found closer to Barrow. The Kalikpik and Kogru rivers area is a historical subsistence-use area for several Barrow families. Atqasuk hunters occasionally use the Kalikpik and Kogru rivers area for wolf and wolverine, primarily in the winter by snowmobile. This area is “homeland” for several families. In the past, they traveled to this area in summer by boat for caribou, waterfowl, and fish. There is no known current use of the Kalikpik and Kogru rivers area by Anaktuvuk Pass residents.

4A.4.3.3 Alternative A – Summary of Impacts (CPAI and FFD) on Subsistence

Effects from construction and operation for the Alternative A (CPAI and FFD) are expected to last for the lifetime of the development and are expected to be primarily local in extent for the Alternative A – CPAI Development Plan and regional in extent for the Alternative A – Full-Field Development Scenario. Construction and operation would affect availability of key subsistence resources because of deflection or displacement of these resources from customary harvest locations. Access to subsistence resources would be affected by the perception of regulatory barriers; the reluctance to hunt and shoot firearms near industrial facilities including pipelines; raised road berms; pipelines with snowdrifts in the winter that hinder passage; and a preference for animals not habituated to industrial development. Indirect effects would include hunters who go to another area, which would result in increased effort, cost, and risks associated with traveling farther.

The FFD would affect key subsistence resources (caribou, fish, waterfowl, wolf, wolverine, and geese) and would occur in seasonal and concentrated subsistence-use areas (the Colville River Delta and the Fish and Judy creeks area) for these key subsistence resources. Nuiqsut residents, as well as residents of other North Slope communities, have harvested and used resources in these specific areas for multiple generations and currently harvest multiple resources during several seasons each year in these areas. Effects from construction and operation would occur in key geographic areas relative to other areas of subsistence availability and would pertain to Nuiqsut individual subsistence users, groups of users, and the overall pattern of community subsistence uses. Construction and operation of FFD would compound Nuiqsut resident's perceptions of being surrounded by development. Competition for key resources among Nuiqsut, Anaktuvuk Pass, Barrow, and Atqasuk would increase if Nuiqsut hunters expand from traditional subsistence-use areas close to Nuiqsut to farther outlying areas.

4A.4.3.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Subsistence

The following mitigation measures should be considered:

- To the degree possible, the pipeline should be buried to avoid creating barriers to caribou. In particular, pipeline sections should be buried between CD-2 and CD-7 to increase crossing success. (See potential mitigation measure discussion in 4A.3.4.1.)

- Where burial is not possible, pipelines should be elevated more than 5 feet (e.g., 7 feet) to allow unimpeded crossings by caribou

- Consider FFD in phases such that development of new pads would occur in concert with decommissioning of early development of CPAI.

4A.4.3.5 Alternative A – Effectiveness of Protective Measures for Subsistence

Stipulations in the Northeast National Petroleum Reserve-Alaska IAP/EIS regarding general disturbance, general damage, and the chasing of wildlife as well as the wildlife stipulations for polar bears, caribou, and birds appear to afford effective subsistence-resource protection. This EIS provides additional mitigation that would reduce impacts to caribou and hunter access, and improve coordination between the local community, agencies, and industry. The anticipated results of additional mitigation is described on the following page.

Potential Mitigation Measures	Anticipated Results
Bury pipelines	Decrease barriers and allow unimpeded crossings by caribou and hunters.
Elevate pipelines to more than 5 feet (e.g. 7 feet)	Decrease barriers and allow unimpeded crossings by caribou and hunters.
Enforce a company policy of "No Hunting and Fishing" in industrial areas by industry personnel (included in current Northeast National Petroleum Reserve-Alaska stipulations)	Decrease competition between industry personnel and local users.
Limit aircraft and road traffic in important subsistence-use areas during harvest season (included in current Northeast National Petroleum Reserve-Alaska stipulations)	Decrease disturbance of resources in harvest areas during harvest season.
Empower a committee of local subsistence users, agency personnel, and CPAI that would meet on a regular basis to exchange information, identify concerns and issues, develop research and monitoring plans, oversee research and monitoring implementation, review data, identify options to resolve issues, establish and implement plans to resolve issues, and resolve issues in a mutually satisfactory manner for all parties.	Provides a forum for CPAI, local subsistence users and agency personnel to identify and work together to resolve conflicts/issues, suggest areas of research and monitoring, and disseminate project development information to communities.
Enforce/Implement stipulations. Stipulations are in place to protect subsistence resources and harvests in National Petroleum Reserve-Alaska. Similar stipulations should be enforced/implemented for development areas east of the National Petroleum Reserve-Alaska boundary.	Protect subsistence resources and harvests. It is not clear if current National Petroleum Reserve-Alaska stipulations have had a beneficial impact on resources and harvests.
Enforcement officer based in Nuiqsut to address violations of stipulations and other issues.	Consistently address issues between industry and local residents as they occur (e.g., damage of caches on allotments and at camps by rolligons)

4A.4.4 Environmental Justice

Evaluation of the demographic characteristics of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut in Section 3.4.4 found that the populations of each of these communities qualified as minority populations and require evaluation for disproportionate impacts.

Disproportionate impacts under the guidelines for environmental justice evaluations are circumstances where direct and indirect project impacts could affect minority or low-income population groups to a greater extent than the general population. If such disproportionate impacts are found to occur, then mitigation measures are identified that reduce, avoid, or eliminate these impacts.

The evaluation of disproportionate impacts normally occurs in a circumstance where a number of diverse population groups could be impacted by a proposed project that is in or near a major urban center. The evaluation seeks to determine if the minority or low-income groups among all of the affected groups are affected to a greater degree. In this case, potentially affected North Slope residents live in communities that are from 57 to 94 % minority. Thus, impacts caused by the Alternative A – CPAI Development Plan or the Alternative A – Full-Field Development Scenario that are likely to impact residents in the Plan Area are also likely to be disproportionate impacts under Environmental Justice criteria. This does not mean all project impacts are disproportionate impacts; only those that would directly or indirectly affect North Slope residents would be considered disproportionate impacts.

4A.4.4.1 Alternative A – Disproportionate Impacts (CPAI and FFD) on Environmental Justice

The impacts identified in each resource area have been reviewed to determine if they are also "disproportionate impacts" to local residents, especially in Nuiqsut. These impacts have been listed in Table 4A.4.4-1 "Alternative A – Potential Disproportionate Impacts." Within this table, both direct and indirect impacts were identified using the following criteria:

- Direct Impacts—have a direct impact on identified minority or low-income populations; impacts would be expected to directly affect the health, welfare, and cultural stability of the affected population. An example would be contamination of a resource such as water used directly by the affected population.
- Indirect Impacts—impacts on the viability or availability of resources essential for daily use of minority or low-income populations. As example might be environmental contamination that causes increased disease or contamination of fish or animals used in the daily diet. The contamination is an indirect impact.

Impacts to resources that do not have a direct or indirect link as described above are noted as "none identified" in Table 4A.4.4-1.

TABLE 4A.4.4-1 ALTERNATIVE A – POTENTIAL DISPROPORTIONATE IMPACTS

Resource Category	CPAI Development Plan		FFD	Project Features, Procedures, and Mitigation
	Direct Impacts	Indirect Impacts		
Spills	Spills could impact water quality and wildlife affecting subsistence harvest.	Spills could impact water quality and wildlife affecting subsistence harvest. Concerns about contaminants could restrict consumption of subsistence foods.	Same as Alternative A-CPAI	See Section 4.3: Spill prevention, detection, and cleanup measures.
Physical				
Terrestrial	None Identified	None Identified		
Aquatic	None Identified	To the extent that impacts to water quality during construction could impact water quality subsistence resources and subsistence harvest could be impacted.	Same types of potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.2.2: Proper disposal of wastes. Facility design to minimize erosion. Construction during winter. BMPs during construction and operation.
Atmospheric/ Environmental	Potential increase in PM emissions; if concentrations in Nuiqsut increase potential health impacts, such as increased asthma rates may result.	To the extent that aircraft noise deflects subsistence resources, subsistence harvest activities could be disrupted.	Same types of potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.2.3,: Continue monitoring at Nuiqsut. Avoid aircraft operations near subsistence harvest activities.

TABLE 4A.4.4-1 ALTERNATIVE A – POTENTIAL DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	CPAI Development Plan		FFD	Project Features, Procedures, and Mitigation
	Direct Impacts	Indirect Impacts		
Biological				
Terrestrial Vegetation & Wetland	None Identified	To the extent that impacts to wetlands affect subsistence resources, impacts to subsistence harvest could result.	Same types of potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.3.1,: Minimize disturbance to wetlands and permafrost.
Fish	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected.	Same potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.3.3: Avoid impacts to surface water bodies. Develop gravel extraction sites to avoid fish over-wintering and spawning areas. Design standards for river/stream crossings. Proper scheduling and control of water withdrawals.
Birds	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected. Impacts to abundance and distribution could affect subsistence harvest. (See discussion 4A.3.4)	Same potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.3.4: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.
Spills	Spills could impact water quality and wildlife affecting subsistence harvest.	Spills could impact water quality and wildlife affecting subsistence harvest.	Same as Alternative A-CPAI	See Section 4.4.5: Spill prevention, detection, and cleanup measures.
Mammals	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected. Impacts to abundance and distribution could affect subsistence harvest. (See discussion 4A.3.5)	Same potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.4.5: Measures to protect predators. Design criteria to minimize impacts on herbivore movement in the Plan Area. Selective controls on the movement of vehicles.

TABLE 4A.4.4-1 ALTERNATIVE A – POTENTIAL DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	CPAI Development Plan		FFD	Project Features, Procedures, and Mitigation
	Direct Impacts	Indirect Impacts		
Threatened and Endangered Species	None identified	To the extent that impacts to abundance, distribution, and health of subsistence species occurs, subsistence harvest could be affected. Impacts to abundance and distribution could affect subsistence harvest.	Same potential impacts as Alternative A-CPAI; increased potential due to larger development area.	See Section 4A.3.6: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.
Social				
Socio-Cultural	To the extent that income benefits accrue to local residents, expendable income is increased.	Increased income and stress of reduced subsistence hunting/fishing may correspond with increased rates of alcoholism, smoking, and drug abuse, which in turn increases domestic violence, cancer, asthma, and Fetal Alcohol Syndrome	Same as those identified under Alternative A - CPAI	See Subsistence Harvest and Use below.
Regional Economy	Revenues from oil production to NSB and village corporations.	None identified	Same as those identified under Alternative A - CPAI	Mitigation not required
Subsistence Harvest and Use	Displacement and avoidance of subsistence resources could affect subsistence harvest.	Impacts to subsistence harvest could affect community social organization, health, and welfare. Shifts in diet to foods with lower nutritional value instead of subsistence foods could result in increased rates of cancer and diabetes.	Same as those identified under Alternative A - CPAI	See Section 4A.4.3; Prohibit company workers from hunting/fishing in Plan Area.
Cultural Resources	None identified	Loss of cultural resources from construction could impact maintenance of cultural traditions.	Same as those identified under Alternative A - CPAI	See Section 4A.4.5; Maintain buffers around known resource sites. Review ice road routes prior to use.
Land Uses and Coastal Zone	None identified	None identified		
Recreation	None identified	None identified		
Visual	None identified	None identified		
Transportation	None identified	None identified		

4A.4.4.2 Alternative A – Summary of Impacts (CPAI and FFD) on Environmental Justice

Table 4A.4.4-1 shows direct and indirect impacts under the Alternative A – CPAI Development Plan and impacts under the Alternative A – Full-Field Development Scenario. The most prevalent impacts found are the potential direct and indirect impacts related to subsistence harvest and use. Other impacts identified as potentially disproportionate include spill impacts, potential water quality, air quality, and aircraft noise impacts.

Impacts to subsistence harvest and use would arise from impacts to the availability of subsistence species in traditional use areas or a decrease in subsistence hunting success. The reduction in subsistence hunting success in turn reduces the availability of Native foods to the community. Since the Native community is the only community that depends to a significant degree on Native foods, this impact, to the extent that it occurs, falls disproportionately on the Native population. Also, as discussed in Section 4A.4.3, displacement of subsistence hunters from traditional subsistence-use areas by oil industry facilities also means greater time spent traveling longer distances to other subsistence-use areas. It could also mean that local hunters from Nuiqsut could come in competition with hunters from other villages when they use the same traditional subsistence-use areas.

The analysis of spill impacts shows that very small and small spills are unlikely to have long term, extensive impacts that would affect water quality, habitat, or subsistence species. Larger spills that are more likely to have impacts that are more extensive have a very low probability of occurrence. Spill impacts, to the extent that they occur, would be episodic, not continuous. Local residents have shown a propensity to avoid resources from areas where spills have occurred because of a lack of confidence that subsistence resources have not been contaminated. This lack of confidence could affect subsistence use for a period beyond the time when any resources affected from spills would actually persist.

As discussed in the water quality section (see Section 4A.2.2), impacts to water quality can occur as a result of spills or construction-induced erosion.

Air quality in Nuiqsut already meets national ambient air quality standards for all criteria pollutants. Short-term episodes of elevated particulate concentrations have been observed at Nuiqsut and are caused by wind-borne dust. Emissions from natural gas flaring (incidental) and equipment operation are not expected to contribute to the chronic exposure of local residents to particulate.

Low-level aircraft noise is expected to be limited to areas surrounding facility airstrips. However, helicopter operations, which are typically at lower altitudes, can range over a larger area as these aircraft move between different facility locations. Subsistence hunters have reported the interruption of hunts in progress by low-flying aircraft, especially helicopters.

ABANDONMENT AND REHABILITATION

Activities associated with dismantling and removing the satellites may disproportionately impact Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and potential impacts to water and air quality, and noise. Once abandonment and rehabilitation are completed, Nuiqsut residents may be disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Local residents may benefit from a reduction in impacts on subsistence resources compared to impacts during construction and operation.

ALTERNATIVE A – POTENTIAL MITIGATION MEASURES (CPAI AND FFD) FOR ENVIRONMENTAL JUSTICE

Table 4A.4.4-2 summarizes direct and indirect impacts, and descriptions of potential mitigation measures that have been identified for each resource with potentially disproportionate impacts. Table 4A.4.4.2 summarizes project features, procedures, and descriptions of potential mitigation measures that have been identified to reduce impacts for each resource with potentially disproportionate impacts. It should be noted that the impacts identified for minority and low-income populations do not consider the application of potential mitigation; thus, the residual impacts that would occur after mitigation have not been quantified. To the extent that the application of the identified potential mitigation measures do not reduce or avoid the impacts identified, some disproportionate impacts to minority and low-income populations would occur.

TABLE 4A.4.4-2 MITIGATION MEASURES TO REDUCE DISPROPORTIONATE IMPACTS

Resource Category	Project Features, Procedures, and Mitigation	Description
Spills	See Section 4.3.5: Spill prevention, detection, and cleanup measures.	Measures to prevent spills shall be incorporated into the design and operation/maintenance procedures for the oilfield. Vertical loops in produced fluids pipelines or automatic shutdown isolation valves in seawater and diesel pipelines shall be installed on each side of major creek or river crossings to minimize the amount of spilled material that might enter these rivers. Frequent visual inspection of pipelines on the Nigliq Channel bridge shall be performed during break-up floods. Long-term monitoring of impacts and the recovery process shall be conducted for each spill that reaches tundra or water bodies.
Physical		
Terrestrial	None Identified	
Aquatic	See Section 4A.2.2: Proper disposal of wastes. Facility design to minimize erosion. Construction during winter. BMPs during construction and operation.	Proper waste disposal methods shall be incorporated into the operation procedures for the oilfield. Gravel structures shall be designed to withstand flooding. Adequately sized culverts and bridges shall be installed to allow water flow though at rates sufficient to minimize erosion. Construction shall be conducted in the winter when surface water is frozen. BMPs will be developed, documented, and followed during construction and operation to minimize impacts.
Atmospheric/ Environmental	See Section 4A.2.3,: Continue monitoring at Nuiqsut. Avoid aircraft operations near subsistence harvest activities.	Collection of air quality data at Nuiqsut shall continue to monitor for deterioration of the ambient air quality. Aircraft flights shall be avoided, when possible, near subsistence harvest activities.
Biological		
Terrestrial Vegetation and Wetland	See Section 4A.3.1,: Minimize disturbance to wetlands and permafrost.	Slopes would be stabilized to reduce erosion where necessary. Dust impacts would be reduced by applying sealing agents, chip seal, or water to dust prone areas. Ice roads shall be routed as directly as possible but shall avoid shrub areas. Off-road tundra travel shall be restricted by limiting the number of vehicle passes in an area, avoiding tight turns, and using only approved low-pressure vehicles.

TABLE 4A.4.4-2 MITIGATION MEASURES TO REDUCE DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	Project Features, Procedures, and Mitigation	Description
Fish	See Section 4A.3.2: Avoid impacts to surface water bodies. Develop gravel extraction sites to avoid fish overwintering and spawning areas. Design standards for river/stream crossings. Proper scheduling and control of water withdrawals.	Silt fencing shall be installed and maintained where silt may enter a water body. After project completion, gravel mines shall be converted to fish habitat, if practicable. Bridges shall be constructed to span the rivers' main channels and floodplain terraces, if possible. Culverts shall be installed in roads and bridge approaches to ensure natural hydrological regimes are maintained. Water withdrawals from lakes shall be limited in volume and monitoring of permitted lake water quality will be conducted.
Birds	See Section 4A.3.3: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.	Traffic speeds on roads shall be reduced during brood rearing. Traffic levels shall be reduced by limited field access to necessary industry personnel only. Waterfowl and seabirds shall be hazed away from active airstrips to prevent collisions with aircraft and reduce mortality impacts.
Mammals	See Section 4A.3.4: Hunting control measures to protect predators. Design criteria to minimize impacts on herbivore movement in the Plan Area. Selective controls on the movement of vehicles.	Hunting activities in the Plan Area would be coordinated among the NSB, State of Alaska, and federal agencies. Pipelines shall be designed to allow caribou passage. Roads and pipelines shall be separated by more than 300 feet where possible. Vehicle traffic and aircraft flights shall be restricted, particularly during calving periods.
Threatened & Endangered Species	See Section 4A.3.5: Measures to limit project personnel from bird use areas. Measures to reduce disturbance during nesting and rearing.	Aircraft altitude restrictions over the nearshore Beaufort Sea could be implemented to minimize disturbance to migrating Bowhead whales. Traffic speeds on roads shall be reduced during brood rearing. Spectacle eiders shall be hazed away from active airstrips to prevent collisions with aircraft.
Socio-Cultural	See Subsistence Harvest and Use below.	
Regional Economy	Mitigation not required	

TABLE 4A.4.4-2 MITIGATION MEASURES TO REDUCE DISPROPORTIONATE IMPACTS (CONT'D)

Resource Category	Project Features, Procedures, and Mitigation	Description
Subsistence Harvest and Use	See Section 4A.4.3; Establish community, industry, agency coordination group to identify address specific project subsistence effects.	Pipelines shall be designed to allow caribou passage. Aircraft flights shall be avoided, when possible, near subsistence harvest activities. Industry shall conduct community outreach programs to address user concerns, identify topics for research, and review possible solutions for implementation.
Cultural Resources	See Section 4A.4.5; Maintain buffers around known resource sites. Review ice road routes prior to use.	Route surveys will be conducted to identify and avoid known or possible cultural resources prior to construction. Industry shall coordinate with SHPO on plans for addressing inadvertent damage, vandalism, spills, and site monitoring. If sites are discovered during construction or operations, activity shall stop until SHPO is consulted and evaluation of the resource is completed.
Land Uses and Coastal Zone	None Identified	
Recreation	None Identified	
Visual	None Identified	
Transportation	None Identified	

4A.4.4.3 Alternative A – Effectiveness of Protective Measures for Environmental Justice

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to environmental justice. Mitigation measures and stipulations that reduce impacts to resources depended upon for the local lifestyle also reduce the disproportionate impacts to the local community.

4A.4.5 Cultural Resources

This section discusses locations of cultural resources in relation to Alternative A facilities and actions and the direct and indirect impacts to the resources likely to be affected by the construction and operation of the proposed project alternative. Direct effects to cultural resources are impacts that occur at the same time and place (40 CFR 1508.8) and are predicated on changes to the characteristics of a cultural property (e.g., integrity and association) (36 CFR Part 800.5). Indirect effects on cultural resources could include increased access to and close proximity of project components to culturally sensitive areas. Under Alternative A, known cultural resources are within 1 mile of various components.

4A.4.5.1 Alternative A – CPAI Development Plan Impacts on Cultural Resources

Construction and operation of the Alternative A – CPAI Development Plan would occur in the vicinity of known cultural resources. For proposed satellite site CD-3, the nearest cultural resource is HAR-052 (Table 3.4.5-2), which contains a tent ring or sod house foundation and is approximately 1 mile east of the production pad and approximately 1/2 mile east of the proposed airstrip. Construction and operation of the proposed CD-3 production pad would have negligible direct and indirect effects on known cultural resources.

In the surrounding area of proposed pad CD-4, according to NSB TLUI data, one documented cultural resource from the first half of the twentieth century, TLUIHAR-083 (HAR-156) (see Table 3.4.5-2), is less than 1/4 mile (approximately 625 feet) west of the proposed rights-of-way (ROW). However, the AHRS states that this site is located approximately 1/2 mile west of the proposed ROW; thus, the nearest cultural resource to CD-4 is TLUIHAR-082 (Table 3.4.5-2), which is currently not described and is less than 1/4 mile (approximately 1,100 feet) from the production pad. Direct effects to known cultural resources could include damage to or destruction of the resource during construction of the proposed production pad. Indirect effects could include damage to the resource caused by erosion, traffic, or looting. The integrity of unknown subsurface, surface, and aboveground cultural resources could be significantly affected by construction activities, though these impacts could be avoided through consultation as required under Section 106 of the NHPA.

As yet undescribed TLUIHAR-087 (Table 3.4.5-2) is less than 1 mile north of the proposed pipeline ROW constructed between CD-6 and CD-5. No documented cultural resources are in the immediate vicinity of this alternative's pads, roads, and pipelines west of the Nigliq Channel. The applicant's proposed action west of the channel could have negligible direct or indirect effects on known cultural resources.

The nearest documented cultural resource to the ASRC Mine Site is HAR-055, which is less than 1/4 mile northwest of the gravel mine. There are no documented cultural resources in the vicinity of Clover. No direct or indirect effect on known cultural resources would occur from the construction and operation of the existing ASRC Mine site or Clover. However, the construction of these gravel mines would involve significant ground-disturbing activities, which could affect unknown surface and subsurface cultural resources. As described in Section 2, ice roads and pads would be developed for transporting gravel from the gravel mines to the production pads, as well as in support of construction, drilling, and operations at CD-3. These ice roads could affect unknown surface or aboveground cultural resources. Prior to construction, CPAI may be required to perform an evaluation and assessment of possible cultural resources in the immediate areas of the proposed ice roads.

ABANDONMENT AND REHABILITATION

It is unlikely that cultural resources would be impacted by abandonment activities.

4A.4.5.2 Alternative A – Full-Field Development Scenario Impacts on Cultural Resources

Impacts to cultural resources also could occur under FFD, which includes 22 hypothetical production pads and 2 hypothetical processing facilities in addition to the 5 pads proposed under the Alternative A – CPAI Development Plan.

The locations of a hypothetical pad, pad footprint, roads, airstrips, ROWs, or pipeline within 1/4 mile of a cultural resource could result in direct and indirect effects to cultural resources. Impacts resulting from construction and operation of these FFD facilities could include damage to or destruction of the resource during construction or damage to the resource caused by erosion, traffic, or looting. Ground disturbing activities would be monitored or cleared for cultural resources prior to development. Impacts to cultural resources for FFD are discussed by facility groups of the Plan Area in the following sections.

COLVILLE RIVER DELTA FACILITY GROUP

There are nine known cultural resource sites in this facility group. These resources could be affected if proposed facilities were constructed in these locations. For example, if hypothetical production pad HP-14 were placed over HAR-008 and HAR-160, which are in the area designated for HP-14, the cultural value of these two sites could be destroyed. Similarly, there is one cultural resource TLUI-86 in the area identified for proposed HP-13, two cultural resource sites (TLUIHAR-084 [HAR-169] and HAR-054) in the area identified for proposed HP-5, and four documented cultural resources (TLUIHAR-077, TLUIHAR-079, HAR-158 and TLUI-61) in the area identified for proposed HP-8. These sites and other cultural sites in the facility group, however, are small and, through Section 106 consultation, it is anticipated that construction impacts could be avoided. No documented cultural resources are in the immediate vicinity of the HP-4, HP-7, and HP-12 production pads.

FISH-JUDY CREEKS FACILITY GROUP

There are seven known cultural resource sites in this facility group. These resources could be affected if proposed facilities were constructed in these locations. There is one cultural resource, HAR-044, in the area identified for proposed HP-3, one cultural resource (TLUI-54) in the area identified for proposed HP-1, one cultural resource (TLUI-78) in the area identified for proposed HP-2, and four cultural resources (HAR-038, HAR-39, HAR-053, and TLUIHAR-041) in the area identified for the proposed HPF-1 processing facility. In addition, the HP-11 hypothetical production pad, northwest of Ocean Point, lies in an area of the Colville River Delta that contains many cultural resources and paleontological sites. No documented cultural resources are in the immediate vicinity of the HP-6, HP-9, HP-10, HP-11, HP-15, HP-16, HP-17, and HP-19 production pads. Through Section 106 consultation, it is anticipated that construction impacts could be avoided to cultural resource sites.

KALIKPIK-KOGRU RIVERS FACILITY GROUP

There are 10 known cultural resource sites in the Kalikpik-Kogru Rivers Facility Group. These resources could be affected if proposed facilities were constructed in these locations. There are six cultural resources (HAR-002, HAR-014, HAR-025, TLUIHAR-059, TLUIHAR-060, and TLUIHAR-061 [HAR-007]) in the area identified for proposed HP-22, one cultural resource (TLUIHAR-062) identified in the area approximately 3/4 mile from the proposed pipeline/road ROW between HP-21 and HP-22, and three cultural resources (HAR-009, HAR-048, and HAR-049) within 1 mile of the proposed pipeline/road ROW between HP-20 and HPF-2. Through Section 106 consultation, it is anticipated that construction and operation impacts would be avoided. No documented cultural resources are in the immediate vicinity of the proposed HP-18, HP-20, and HP-21 production pads and the HPF-2 processing facility.

4A.4.5.3 Alternative A – Summary of Impacts (CPAI and FFD) on Cultural Resources

Under the Alternative A – CPAI Development Plan, cultural resources are situated in the vicinity of the production pads, the road/pipeline ROW, and the ASRC Mine Site. Under the Alternative A – Full-Field Development Scenario, cultural resources are located in each of the three facility groups and the ROWs. Any project facility or pad within 1/4 mile of a cultural resource could result in direct effects including damage to or destruction of the resource during construction of the proposed well pad**,** though construction impacts—at least to known cultural resources—could be avoided through Section 106 consultation.

Under the Alternative A – CPAI Development Plan, one cultural resource (TLUIHAR-082) is less than 1/4 mile from the CD-4 production pad, and one cultural resource (HAR-055) is less than 1/4 mile from the ASRC Mine Site.

Under FFD, cultural resources are within the affected areas of production pads (HP-5, HP-8, HP-13, and HP-14) and ROWs (HP-8 to HP-6) in the Colville River Delta Facility group; production pads (HP-1, HP-2, HP-3 and HP-11) and the processing facility (HPF-1) in the Fish-Judy Creeks Facility Group; and a production pad (HP-22) and ROWs (HP-21 to HP-22 and HP-20 to HPF-2) in the Kalikpik-Kogru Rivers Facility Group. The HP-8 to HP-6 ROW extends through the village of Nuiqsut (TLUI-61), and one cultural resource (TLUIHAR-062) is less than 1/4 mile from the HP-21 to HP-22 ROW.

Indirect effects could include damage to the resource caused by inadvertent oil spills, subsequent cleanup activities, or looting. The integrity of subsurface, surface, and aboveground cultural resources could be significantly affected by construction activities. Unknown or undocumented cultural resources could be situated in the proposed ROWs or footprints of Alternative A CPAI and FFD components. However, ground disturbing activities would be monitored or cleared for cultural resources prior to development.

4A.4.5.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Cultural Resources

Prior to construction of ice roads, CPAI would perform an evaluation and assessment of possible cultural resources in the immediate areas of the proposed ice roads.

CPAI would coordinate with SHPO to provide a cultural resources management plan for the sites less than 1/4 mile from components of the applicant's proposed action to address the issue of potential site damage as a result of development activities, including inadvertent damage, vandalism, spills, and site monitoring.

If cultural resources are discovered as a result of construction, development, or operation activities under the applicant's proposed action, activity would be stopped until the SHPO is consulted and an evaluation of the resource can be completed.

4A.4.5.5 Alternative A – Effectiveness of Protective Measures for Cultural Resources

Stipulation 74 of the Northeast National Petroleum Reserve-Alaska IAP/EIS requires surveys for cultural and paleontological resources prior to any ground disturbing activities. This will insure that any resources are noted and appropriate measures taken for avoidance or collection occur. This EIS has identified potential mitigation that would insure coordination and planning between the SHPO and the applicant on known sites close to development operations.

4A.4.6 Land Uses and Coastal Management

4A.4.6.1 Alternative A – CPAI Development Plan Impacts on Land Uses and Coastal Management

LAND OWNERSHIP AND USES

Under Alternative A, development of the proposed facilities for the Plan Area would occur on lands owned by the federal government, the state, and Kuukpik Corporation. Implementation of the ASDP under Alternative A would not change ownership status on lands within the Plan Area, but would occur under negotiated leases.

As described in Section 3, most of the Plan Area is currently undeveloped with the exception of the existing Alpine Field oil production pads and the village of Nuiqsut. With the exception of the Alpine Field development, oil development is concentrated to the east of the Plan Area and to the northeast of the village of Nuiqsut. Development under Alternative A would represent an increase in the total area developed within the Plan Area. The Alternative A – CPAI Development Plan calls for development of approximately 241 acres, including production pads, roads, airstrips, and 35.6 miles of pipelines. This would result in an increase of 2.4 times the total number of acres currently developed for oil production activities within the Plan Area.

The BLM established various Special Areas, SMZs, and LUEAs within the National Petroleum Reserve-Alaska to provide additional protections to various subsistence, recreational, ecological, historic, and scenic resources. SMZs and LUEAs are not legislative designations and carry no regulatory authority. Special Areas, however, do carry legislative designations and development in these areas would require special attention to design to maximize protection of the natural habitat.

Under Alternative A, Clover and CD-7, with its associated facilities, are located within the Colville River Special Area. CD-6 and its associated access roads and pipelines, would be constructed within the resource protection setback around Fish Creek (Fish Creek LUEA). The BLM stipulations state that no permanent oil and gas surface facilities are allowed within the Fish Creek setback area, except for essential transportation crossings. The potential impacts to fish resources and subsistence activities from construction of oil and gas facilities at CD-6 and CD-7 are discussed in detail in Sections 4A.3.2 and 4A.4.3, respectively. Construction of CD-6 would require that CPAI obtain an exception to the no permanent oil and gas facilities restriction in this area. Construction of the road access between the oil facilities in the National Petroleum Reserve-Alaska would also require an exception from the BLM stipulations.

Development of facilities within the CRSA must provide for maximum protection of the surface resources in this area, consistent with the purpose of the National Petroleum Reserve-Alaska, which calls for oil exploration and production. In keeping with this intent, this development proposal includes a number of design and construction measures intended to reduce the potential for adverse effects to natural resources in the area, while allowing for economically feasible development of the oil resources in the area. These measures include BLM stipulations (Appendix D) with the exceptions noted above, and other specific procedures of the applicant's proposed action, as described in Section 2. No other Special Areas or LUEAs would be directly affected under Alternative A.

Development of the proposed roads and airstrip would provide more access to these developed areas, particularly during summer months. Access would be restricted to oil industry personnel, contractors, agency personnel, and local residents. Adverse effects to subsistence and recreation would occur due to habitat alterations and the increased access, activity, and noise in the developed areas. Effects to subsistence and recreation are discussed further in Sections 4.A.4.3 and 4.A.4.7. Other permitted uses within the Plan Area, such as scientific studies, communications and navigation-related uses, and overland re-supply transport between villages, are not expected to be affected by the proposed development.

COASTAL MANAGEMENT

Development proposed under Alternative A includes construction and operation of five satellite production pads, as well as roadways, pipelines, and an airstrip. Although some of these facilities would be on federal lands that are excluded from the coastal zone under the CZMA, CPAI also proposes development on state and Kuukpik lands that are within the coastal zone. Because development on federal lands must comply with state coastal programs to the extent possible, this section evaluates all of the proposed development against the state and local district coastal zone standards, regardless of whether or not the development occurs on federal lands. Standards of the ACMP include statewide standards found in regulation (6 AAC 80.040 – 6 AAC 80.150) and the enforceable policies of the affected coastal district, the NSB.

ALASKA COASTAL MANAGEMENT PROGRAM

The ACMP provides standards and guidance for development occurring within the coastal zone to achieve a balance between development and the protection of valuable coastal resources. The state requirements in 6 AAC 80 address, but are not limited to, coastal development, recreation, development of energy facilities, transportation and utility routes, mining and mineral processing, habitats, preservation of historical resources, air and water quality, and solid waste disposal. Conformance to the coastal standards is typically achieved through construction and design measures, as well as the imposition of BLM stipulation measures for development on federal lands and alternative state required measures for development that occurs on lands not managed by BLM.

Coastal Development (6 AAC 80.040)

The coastal development standard requires that water-dependent uses or water-related uses have priority within coastal areas. Activities and uses that are not water-dependent or water-related are only permitted if no feasible and prudent inland alternatives exist.

The areas identified for development on federal lands within the National Petroleum Reserve-Alaska have been set back from the coast both to maximize oil development and to minimize effects on coastal resources. Setbacks and buffers have also been established along important river and lake habitats within the area. One production pad (CD-6) with associated roadway and pipeline is proposed within the setback area around Fish Creek. These facilities and other facilities located within 500 feet of some other water bodies would require exceptions from BLM's stipulations described in Appendix D. This alternative would also require an exception to the stipulation that prohibits road access between separate oilfields. CD-7 and some of its associated facilities are located within the CRSA within National Petroleum Reserve-Alaska. This area is designated as a special area to provide maximum protection of natural resources within the area, consistent with the purpose of National Petroleum Reserve-Alaska to provide oil and gas resources. Facilities to be developed on lands that are not managed by BLM would include three production pads, a roadway (including bridges), pipelines, and an airstrip. These facilities would mostly lie within the Colville River Delta.

Although oil production pads and their support infrastructure are not water-dependent or water-related, oil development must occur where the oil resources exist. To access these resources, production pads must be constructed near the resource and transportation facilities must be constructed to transport the oil resource to national markets. Because the oil production and transportation facilities must be located in proximity to the oil resource, there is no feasible or prudent inland alternative to development of oil production and transport facilities within this coastal area. The CPAI-proposed production pads have been designed to minimize potential effects to coastal resources, and development of access roads would be limited in the area closest to the coast (CD-3).

Development under this alternative would require BLM to grant exceptions to three stipulations: the stipulation restricting access between separate oilfields in National Petroleum Reserve-Alaska (stipulation 48); the stipulation restricting permanent oil facilities in the Fish Creek setback area (stipulation 39), and the stipulation restricting permanent facilities within 500 feet of other water bodies (stipulation 41). All other BLM stipulations and alternative measures potentially required by the state will be complied with, including stipulations requiring continued access to the coastal resources used for subsistence and for other traditional land uses. With these stipulations, the development of the proposed facilities is not expected to displace other important coastal uses and is expected to conform with the coastal development standard.

Geophysical Hazard Areas (6 AAC 80.050)

The Geophysical Hazard Areas consistency standard requires that districts and state agencies identify any known geophysical hazard areas and that any proposed developments in these areas incorporate measures to minimize property damage and protect against loss of life.

Possible geophysical hazards within the Plan Area include permafrost, floods, ice gouging, and earthquakes. The facilities proposed under Alternative A specifically address the geophysical hazards identified in the Plan Area. Roads and pipelines were situated to take advantage of ridges to reduce flood hazards where possible. Road, bridge, and pipeline designs have incorporated measures to maintain the permafrost and natural drainage patterns and to protect the built structures from flood events, scour, ice jams, and storm surges. These measures are expected to adequately mitigate the geophysical hazards likely to be encountered in the area and to conform with the coastal geophysical standard.

Recreation (6 AAC 80.060)

The statewide recreation standard requires that coastal districts designate areas for recreation use if (1) the area receives significant use by persons engaging in recreational pursuits or is a major tourist destination, or (2) the area has potential for high-quality recreational use because of physical, biological, or cultural features. The standard also requires that districts and state agencies give priority to maintaining and, where appropriate, increasing public access to coastal water.

The Plan Area is in a remote part of the state and is not a major tourist destination. There are, however, some recreational uses of the area and there could be some local adverse effects on recreation as discussed in more detail in Section 4A.4.7, Recreation Resources. Development proposed under Alternative A of the ASDP would be consistent with National Petroleum Reserve-Alaska stipulations requiring continued access to coastal resources for subsistence and other traditional land uses. These stipulations and alternative measures potentially required by the state should reduce any potential conflicts between the proposed development and other public uses of coastal resources.

Energy Facilities (6 AAC 80.070)

The ACMP states that the siting and approval of major energy facilities must be based, to the extent feasible and prudent, on 16 criteria within the energy facilities standard. These criteria primarily relate to reducing the potential for adverse effects to environmental and social resources. For example, the criteria stipulate that facilities minimize the probability of spills along shipping routes to protect important fishery, marine mammal, and waterfowl habitats from contamination. Another criteria calls for facility design to allow free passage and movement of fish and wildlife, with due consideration of historic migratory patterns. The criteria also call for protection of scenic, recreational, and cultural values. The state criteria also address consolidation of facilities.

The ASDP under Alternative A is consistent with the criteria in the energy standard in that facilities would be consolidated to the greatest extent possible, facilities would be sited and designed to minimize the potential to affect environmental resources, and the oil would be transported to Valdez by pipeline, the safest mode for transporting oil, reducing the potential for contamination of valuable coastal habitats. The proposed development calls for housing of all personnel to be at the existing Alpine housing facility except during drilling and construction, when personnel would be housed in temporary camps. Consolidation of facilities is also addressed in the collocation of pipelines, roads, and power lines. Roads, pipelines, and other facilities would maintain existing drainage patterns and would minimize effects on wildlife habitat and migration routes. Development of the proposed facilities would affect some wetlands and other high-value habitats, but the facilities have been sited and designed to reduce the impact to these resources to the extent possible. Although exceptions would be required for development proposed within the Fish Creek setback area, within 500 feet of other water bodies, and for the road system connection between separate oilfields, the proposed development would conform with all of the other BLM stipulations, and alternative measures potentially required by the state, designed to protect wildlife, scenic, recreational, and cultural resources.

Transportation and Utilities (6 AAC 80.080)

The Transportation and Utilities statewide standard requires that all transportation and utility routes and facilities must be sited, designed, and constructed to comply with district programs. The standard also states that they must be situated inland from beaches and shorelines unless the route or facility is water-dependent or no feasible or prudent inland alternative exists to meet the need for the route or facility.

The development proposed under Alternative A includes roadways connecting most production sites to the processing facility at CD-1, as well as pipelines from the production satellites to the processing facility. Where possible, the roads and pipelines would be co-located. Utilities would be consolidated onto the pipelines to the greatest extent possible, including electric power, fuel, water, and produced products. The road and pipeline to the CD-4 production satellite would follow the route of the existing oil product pipeline that connects the existing Alpine Facility to the pipelines at Kuparuk. The roads, bridges, and pipelines have been designed and sited to minimize potential adverse effects to coastal resources to the extent feasible. These facilities are located inland from the coast, but do cross wetlands and creeks within the Plan Area. The production satellite proposed within the lower Colville River Delta would be accessed by air to avoid road construction within the lower delta.

This alternative requires exceptions from three existing BLM stipulations as described above. Given the requirements of law, regulation, and leases, including alternative measures potentially required by the state, the design measures proposed, and project specific procedures described in Section 2, as well as the lack of road options that would not affect water bodies and wetlands, it is expected that Alternative A would comply with the transportation and utilities standard.

Mining and Mineral Processing (6 AAC 80.110)

The ACMP standards for mining and mineral processing require these activities to be designed and conducted in a manner compatible with the other coastal standards, as well as adjacent uses and activities (6 AAC 80.110 [a]). The ACMP standards also restrict extraction of sand and gravel from coastal waters, intertidal areas, barrier islands, and spits, unless no feasible and prudent alternative to coastal extraction exists that would meet public need for the sand and gravel (6 AAC 80.110 [b]).

Mining and extraction of sand and gravel is essential for development of oil production and transportation infrastructure within the ASDP Area. As stated in Section 2.4.1, Alternative A proposes extraction of gravel for use during construction and development of the proposed facilities, including gravel roads connecting many of the facilities, gravel production pads, and a gravel airstrip. Gravel sources for the development proposed under Alternative A include the currently permitted ASRC Mine Site and potentially a new site, the Clover Potential Gravel Source, on the western edge of the Colville River Delta Facility Group, southwest of the proposed CD-4 production pad. Clover is located within the Colville River Special Area, and would be required to be developed and operated in a manner that provides maximum protection for surface resources in that area, while allowing for oil resource development. All access to the site and staging areas will be constructed as ice roads and pads, reducing potential impacts to natural resources in the area. BLM stipulations regarding gravel mining and alternative measures potentially required by the state, are designed to maximize feasible protection of surface resources. Importing gravel from outside the North Slope for development activities in this area would not be economically feasible.

The gravel sites used have, or would be required to have, operating permits and reclamation plans (Appendix O) that require gravel extraction to be conducted in a manner consistent with the other state standards for protection of coastal resources. Thus, gravel mining operations permits provide for an additional review of potential mitigation measures and stipulations so that impacts are mitigated to the greatest extent feasible. Based on these requirements, it is anticipated that Alternative A will comply with the coastal standard for mining and mineral processing.

Subsistence (6 AAC 80.120)

Under the subsistence standard, state agencies and districts, in conjunction with Native corporations and any other persons or groups, could designate areas as subsistence zones in which subsistence uses and activities have priority over all non-subsistence uses and activities. Before any potentially conflicting activity could be authorized within these designated areas, a study of the possible adverse on subsistence usage must be conducted and appropriate safeguards to assure subsistence usage must be provided (6 AAC 80.120 [d]).

Alternative A would include construction of roads and bridges connecting the proposed satellites to the existing Alpine facilities. Construction of these roads could provide more efficient access to subsistence hunting and/or fishing sites, but the increased development in the area is likely to adversely affect subsistence resources through changes to habitat use and resource abundance resulting from increased foot and vehicular traffic in developed areas. In addition, subsistence activities could require increased efforts due to changes in the abundance of resources or in the areas that would be used for harvesting resources. The potential for impacts to subsistence from the proposed development is discussed in more detail in Section 4A.4.3. Development on federally managed lands within the National Petroleum Reserve-Alaska would occur under stipulations that require the lessee to allow access to subsistence-use areas and to consult with affected subsistence communities to address potential conflicts and identify measures that would prevent unreasonable conflicts with subsistence uses.

The proposed CPAI development does include development of a production pad, road, and pipeline within the buffer areas near Fish Creek, as well as some facilities within 500 feet of some other water bodies. These facilities and the road connecting separate oilfields within National Petroleum Reserve-Alaska will require exceptions from existing BLM stipulations. The proposed CPAI development would comply with all other BLM stipulations, alternative measures potentially required by the state, and the project specific procedures listed in Section 2, to reduce impacts to wildlife and subsistence. These stipulations and procedures are expected to minimize adverse effects to subsistence resources in this area and provide appropriate safeguards as called for in the subsistence standard.

Habitats (6 AAC 80.130)

The ACMP standard for habitats identifies eight habitat types and calls for management of these habitats to maintain or enhance their biological, physical, and chemical characteristics that contribute to their capacity to support living resources. In particular, the habitat standard calls for management of wetlands and tide flats to assure adequate water flow, nutrients, and oxygen levels, and to avoid adverse effects on natural drainage patterns, destruction of important habitat, and discharge of toxic substances. Rivers, streams, and lakes must be managed to protect natural vegetation, water quality, important fish and wildlife habitat, and natural water flow. Uses that do not meet these standards must meet a three-pronged test: (1) there must be a significant public need for the use or activity; (2) there must be no feasible prudent alternative to meet the need that would conform to the standards; and (3) all feasible and prudent steps to maximize conformance must be taken.

The applicant's proposed action, which calls for development of oil production and transportation facilities to bring Alaskan oil resources to the market, is expected to meet the three-pronged test. The project would provide a significant public benefit to the state in terms of economic benefits and to the nation in terms of increasing the domestic oil supply. Because of the extent of wetlands, lakes, rivers, and tidal areas throughout the Plan Area, there is no feasible way to develop the oil resources within the National Petroleum Reserve-Alaska and the Colville River Delta without affecting these habitats. Finally, development proposed under Alternative A has been designed to maximize conformance with the habitat standards for wetlands, tidal areas, creeks and lakes, to the extent feasible through compliance with all but three of the BLM stipulations in Appendix D.

Under this alternative, some development would occur within areas designated as resource buffers. As described above, this alternative requires exceptions from BLM's existing stipulations restricting permanent oil and gas facilities in the Fish Creek setback area, for facilities located within 500 feet of some other water bodies, and for the road connection between separate oilfields within National Petroleum Reserve-Alaska. All other BLM stipulations would be incorporated into the project as would the project specific procedures in Section 2. Roads, bridges, pipelines, and production pads are designed to minimize changes to natural drainage patterns and to migration of fish and wildlife as discussed in previous sections. The potential for releases of toxic substances would be reduced by using leak detection equipment and secondary containment for fuel storage facilities. Alternative A, with the BLM stipulations (with the exceptions noted), alternative measures potentially required by the state, and the project specific procedures described in Section 2, is expected to be in conformance with the habitat standard and the three-pronged test.

Air, Land and Water Quality (6 AAC 80.140)

The ACMP standards for air, land, and water quality incorporate reference to all the statutes, regulations, and procedures pertaining to those resources as enforced by the ADEC.

The ADEC regulates air and water quality as well as discharges of toxic substances to land and water. The ADEC regulates air emissions for industrial operations under the Clean Air Act. The proposed production pads would require review by the ADEC to address air emissions and to verify that emissions associated with the proposed development would not result in any violations of NAAQS or PSD increments. The existing processing facility at CD-1 operates under an Air Quality Construction Permit and a Title V operating permit, which would need revision to address any additional equipment and associated emissions. Water quality regulations include the ADEC stormwater pollution prevention plans for construction and operation, as well as the USEPA's NPDES permitting requirements. Wastes disposed of through the annulus of production wells are regulated by the USEPA's UIC program and the AOGCC. No Class I wells are anticipated to be required under CPAI's proposed plan. The ADEC also regulates hazardous substance releases to both land and water and requires approval of an ODPCP for new production pads so that best efforts are taken to minimize the potential for spills and that adequate spill response equipment and personnel are available to respond to spills in a timely manner. No new landfills are anticipated to be constructed under CPAI's proposed plan. Solid wastes generated at the proposed sites would be managed according to approved plans as described in Section 2.

Alternative A includes acquisition of all required state and federal permits. Compliance with relevant ADEC and USEPA regulations is expected to result in conformance with this coastal management standard for the proposed Alternative A – CPAI Development Plan.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

As stated in this ACMP statewide standard, "districts and appropriate state agencies shall identify areas of the coast which are important to the study, understanding, or illustration of national, state, or local history or pre-history (6 AAC 80.150)."

A review of the potential for cultural resources to be found within proposed development areas and the potential for adverse effects to cultural resources from facility development under Alternative A are discussed in Section 4A4.5. In addition to the regulations associated with Section 106 of the NHPA, stipulations on development within the National Petroleum Reserve-Alaska include requirements to identify the potential for adverse effects on cultural and traditional land use resources before development, avoidance or mitigation of these effects, and training for staff about cultural resource concerns during employee orientation. Archaeological surveys and other evaluations required prior to development would be completed and work would be required to stop in the event of discovery of previously unknown resources. Continued coordination with SHPO and development of appropriate cultural resource management plans, along with other project specific procedures identified in Section 2, BLM stipulations (with the exceptions noted), and alternative measures potentially required by the state, are expected to result in conformance of Alternative A with this coastal standard.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

For the NSB, the primary goal of the district's CMP Enforceable Policies is to balance economic development with protection of the Inuipiat culture, lifestyle and natural environment (NSB 1998). This includes ensuring that development activities do not substantially interfere with subsistence activities or jeopardize the continued availability of subsistence resources. Relevant NSB CMP policies include *Standards for Development*, *Required Features for Applicable Development*, *Best Effort Policies*, and *Minimization of Negative Impacts*. Many of these policies are consistent with the standards of the ACMP discussed above.

The current NSB *Standards for Development* (NSB CMP 2.4.3*)* require development to maintain subsistence resources at a level that meets local subsistence needs and to allow for continued access to those subsistence resources. The standards also call for protection of known and unrecorded cultural and historic sites through avoidance or consultation where resources cannot be avoided. Traditional activities at cultural and historic sites should not be adversely affected. Finally, the standards also call for compliance with all federal land, air, and water quality standards and regulations.

As discussed under the coastal management section above, subsistence resources and access to these resources are addressed through BLM stipulations requiring continued access to local subsistence users, alternative measures potentially required by the state, and design measures incorporated into the project to minimize potential impacts to fish and wildlife movements. Potential effects to cultural resources are addressed through compliance with Section 106, and avoidance or mitigation of these effects would occur in consultation with local and state officials. Proposed facilities and activities would be required to comply with all federal and state environmental regulations to protect public lands, air, and waters as required by the NSB policy.

The CMP *Required Features for Applicable Development* (NSB CMP 2.4.4) calls for restrictions on vehicle and aircraft activities in areas where wildlife species are sensitive to noise and movement during certain times. Required features also include compliance with state and federal regulations on water and air emissions, as well as solid waste facilities, and development of central sewage systems to process effluent to state and federal standards. Finally, fuel storage facilities with a capacity of more than 660 gallons must have an impermeable lining and be diked.

Development under Alternative A would incorporate construction and design measures that are intended to reduce impacts on fish and wildlife migration. As discussed above, the CPAI proposal incorporates compliance on BLM-managed lands with all but three of the stipulations listed in Appendix D. This alternative would require exceptions to the stipulations restricting permanent oil facilities within the Fish Creek setback area (stipulation 39), permanent oil facility infrastructure within 500 feet of some other water bodies (stipulation 41), and roads connecting separate oilfields within National Petroleum Reserve-Alaska (stipulation 48). Subsistence resources are further protected by the state of Alaska's Office of Habitat Management and Planning under Title 41 through its authority to require the proper protection of habitats important for the spawning, migration, and rearing of anadromous fish and its authority to require that durable and efficient fish passage is provided on all fish bearing water bodies. As discussed previously in this section, the proposed developments would be required to comply with all federal and state regulations on air, water, wastewater, and solid waste discharges, and fuel storage facilities are proposed to include secondary containment.

The current NSB *Best Effort Policies* (NSB CMP 2.4.5) reflect criteria similar to the three-pronged test under the ACMP. Development that cannot comply with all of the resource protection policies addressed previously could still be allowed if a significant public need exists for the development, if all feasible and prudent alternatives have been explored, and if all feasible and prudent steps have been taken to avoid the adverse effects that the resource protection policies were intended to prevent. This section of the CMP (NSB CMP 2.4.5.1) also requires minimization of impacts on subsistence resources and access, minimization of impacts to wildlife migration from transportation facilities (including pipelines), elimination of duplicative transportation corridors to proposed sites, and siting of structures to avoid flood and geologic hazard effects. Further requirements on applicable development (NSB CMP 2.4.5.2) include measures to reduce the environmental impacts of mining activities in coastal areas and floodplains; to locate, design, and maintain facilities to prevent significant adverse effects on fish and wildlife and their habitat, including drainage patterns; to locate all non-essential facilities at compact designated service bases and to share these facilities to the maximum extent possible; to consolidate transportation and utility facilities to the maximum extent possible; to minimize interference with use of traditional land use or subsistence areas; and to comply with the habitat standard of the ACMP.

These issues have been addressed above in the ACMP discussion. The proposed development meets an important public need, no feasible inland alternatives to development of the proposed facilities exist, and stipulations have been placed on the development to maximum conformance with the coastal management standards of both the ACMP and the CMP. Access to subsistence resources is protected through BLM stipulations and construction and design measures have been incorporated to reduce potential impacts to fish and wildlife resources. The processing and employee facilities at the existing Alpine Facility would be used to support the satellite developments. Roadways and pipelines have been co-located where possible and are designed to minimize effects to natural drainage patterns and wildlife movements. Therefore, development of the applicant's proposed action under Alternative A is expected to comply with the NSB Best Effort Policies.

The NSB CMP also contains standards for *Minimization of Negative Impacts* (NSB CMP 2.4.6). These standards include requirements for transportation facilities, including airstrips, to be sited, designed, constructed, and maintained to minimize adverse effects to wildlife and their migration, as well as minimizing effects on water courses and wetlands. Permafrost is to be maintained in developed areas and development must be sited, designed, and constructed to minimize the potential for loss of life or property from flooding, icing, erosion, and storms.

The proposed development under Alternative A includes design measures to protect permafrost and to address geophysical hazards as discussed above under the ACMP. Transportation facilities have been sited and designed to preserve existing drainage patterns and to minimize effects on fish and wildlife migration. The proposed development is expected to be consistent with the NSB CMP standards for minimizing impacts.

NORTH SLOPE BOROUGH LAND MANAGEMENT REGULATIONS

Most of the land within the NSB is zoned as Conservation, with the exception of some village sites and the existing oilfields at Prudhoe Bay and Alpine. The NSB's Resource Development zoning classification covers areas designated for oil development activities. Alternative A development east of the National Petroleum Reserve-Alaska in the Colville River Delta would require a re-zoning of the development areas to the Resource Development classification and permitting of activities through the approval of a master plan. Application of the

NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

ABANDONMENT AND REHABILITATION

Land ownership would not be affected by abandonment and rehabilitation. Upon completion of abandonment and rehabilitation, land uses and management may return to something similar to the current situation. For discussion of subsistence and recreation use after abandonment and rehabilitation, see sections 4A.4.3.1 and 4A.4.7.1, respectively.

4A.4.6.2 Alternative A – Full-Field Development Scenario Impacts on Land Uses and Coastal Management

LAND OWNERSHIP AND USES

Development under Alternative A FFD would result in construction of proposed facilities on lands owned by the federal government, the state, and Kuukpik Corporation. Implementation of CPAI's proposed plan under Alternative A FFD would not change ownership status on lands within the ASDP Area, but would occur under negotiated leases.

Development of the FFD scenario would result in development occurring throughout the ASDP Area, with an additional 22 satellite production pads and associated roads and airstrips totaling an approximate impact area of 1,261 acres and 150 miles of pipelines. The FFD scenario would result in a substantial increase in the area developed and would provide additional access to areas farther west and north of the Plan Area. Access would remain limited to oil industry personnel and local subsistence users. Effects on subsistence resources and recreation for FFD are discussed in Sections 4A.4.3 and 4A.4.7.

In the areas of BLM-designated Special Areas, SMZs, and LUEAs within the National Petroleum Reserve-Alaska, Alternative A FFD would include development of a production pads, roads, and pipelines within LUEA buffer areas, SMZs, and Special Areas. In addition to the exceptions from the BLM stipulations discussed for the CPAI proposal above, the FFD would require an exception for development of a production pad and associated pipeline in the area near the Kogru River designated for no surface activities. Additional development within the Colville River Special Area, the Fish Creek buffer area, Sensitive Consultation areas around Fish Creek and the Colville River, and the special caribou stipulation area would be subject to additional consultation and review to minimize impacts to the greatest extent feasible.

The potential impacts to fish resources and subsistence activities from construction of oil and gas facilities adjacent to Fish Creek and in the other designated areas are discussed in detail in Sections 4A.3.2 and 4A.4.3, respectively.

COASTAL MANAGEMENT

Development proposed under Alternative A FFD includes construction and operation of 22 satellite production pads, two additional processing facilities, as well as roadways, pipelines, and an airstrip. As with Alternative A, most of these facilities are proposed on federal lands within the National Petroleum Reserve-Alaska; however, additional development would also be on state and Kuukpik lands within the coastal zone. Although federal lands are excluded from the coastal zone under the CZMA, development on federal lands is required to comply with state coastal programs to the extent possible; thus, this section evaluates proposed FFD against the state and local district coastal zone standards, regardless of whether or not the development occurs on federal lands. Standards of the ACMP include statewide standards found in regulations (6 AAC 80.040 – 6 AAC 80.150) and the enforceable policies of the affected coastal district, the NSB.

ALASKA COASTAL MANAGEMENT PROGRAM

As previously stated, the ACMP provides standards and guidance for development occurring within the coastal zone to balance development needs and the protection of valuable coastal resources. The state requirements in 6 AAC 80 address, but are not limited to, coastal development, recreation, development of energy facilities, transportation and utility routes, mining and mineral processing, habitats, preservation of historical resources, air and water quality, and solid-waste disposal. Effects of FFD under the listed state requirements are provided in the following section. The standard itself is stated under the effects of proposed Alternative A – CPAI Development Plan.

Coastal Development (6 AAC 80.040)

The FFD scenario proposes construction of additional oil production and transportation facilities throughout the ASDP Area, both within the National Petroleum Reserve-Alaska and outside the National Petroleum Reserve-Alaska in the Colville River Delta. Many of the proposed production sites under the FFD scenario are much closer to the coast, particularly at the northern coast of the Kalikpik-Kogru Rivers Facility Group of National Petroleum Reserve-Alaska and in the Colville River Delta. Development of access roads has been restricted in many of these areas, with airstrips included at the production sites for access. Again, development of potential oil reserves in these areas requires the development of production and transportation facilities near the oil reserves; therefore there are no feasible inland alternatives to the development. Development of the FFD facilities, in compliance with the BLM stipulations (with the exceptions noted) and alternative measures potentially required by the state to minimize potential effects to coastal resources, is expected to result in the compliance of this alternative with the coastal development standard.

Geophysical Hazard Areas (6 AAC 80.050)

Development of facilities under the FFD scenario would be required to meet the same design standards as proposed under the CPAI project to protect permafrost and to reduce the potential for damage to structures or personnel from floods geophysical hazards, and severe weather events. Incorporation of these design standards would be expected to adequately address this geophysical hazard standard.

Recreation (6 AAC 80.060)

The area affected by the FFD scenario has limited recreational use due to its remote location. Development of facilities under the FFD scenario would be required to comply with the same stipulations discussed for the CPAI development regarding continued access for subsistence and traditional land uses within the National Petroleum Reserve-Alaska. Development under Alternative A, given compliance with BLM stipulations addressing subsistence and traditional land uses access, as well as alternative measures potentially required by the state, is expected to comply with the recreation standard.

Energy Facilities (6 AAC 80.070)

Alternative A FFD would consolidate facilities to the extent possible; however, additional processing facilities beyond the existing Alpine Facility would be required. Roadways, pipelines, and other structures would be designed to minimize potential adverse effects on coastal resources to the greatest extent possible. Although more exceptions from existing BLM stipulations on locations of permanent oil and gas facilities would be required, compliance with the majority of the stipulations protecting scenic, recreational, and cultural resources and with alternative measures potentially required by the state, are expected to address the energy facility criteria and result in compliance with this standard.

Transportation and Utilities (6 AAC 80.080)

The FFD scenario calls for additional roads, bridges, and pipelines throughout the ASDP Area. Roads and pipelines serving each production site would be co-located, and regional processing facilities would be constructed in the vicinity of the production pads. The proposed coastal production pad near the Kogru River and the production sites proposed in the lower Colville River Delta would be accessed by air to avoid road construction in the areas closest to the coast. Exceptions to stipulations on construction of permanent facilities within some buffer areas and road access between separate oilfields would be required for this alternative. Based on the lack of alternatives that could avoid these sensitive areas, the BLM stipulations and alternative measures that will potentially be required by the state to reduce the adverse effects of construction of required roads, development under the FFD scenario is expected to conform with this standard.

Mining and Mineral Processing (6 AAC 80.110)

The Alternative A – Full-Field Development Scenario would likely require gravel resources beyond those currently identified. Any new gravel mining operation within the coastal zone would be required to receive a permit, which would maximize conformance with state coastal management standards and protection of coastal resources. In addition, the gravel mining permit process may impose additional mitigation measures. The lack of feasible alternatives, along with compliance with the majority of the BLM stipulations and alternative measures potentially required by the state, are expected to result in conformance with this standard.

Subsistence (6 AAC 80.120)

Development of FFD would result in more widespread development of roads, bridges, and pipelines through the ASDP Area. FFD would result in construction of facilities within the Fish Creek LUEA buffer area, within the buffer area on the upper Colville River, within a high-value caribou area within the Kalikpik-Kogru Rivers Facility Group, within an area restricted to surface development near the Kogru River, and throughout the lower Colville River Delta. Production pads in the lower Colville River Delta and other coastal areas would not be accessible by road and would require airstrips for access. Construction and operation of these facilities would be required to comply with the stipulations outlined in the Northeast National Petroleum Reserve-Alaska ROD (BLM and MMS 1998b) to minimize effects to subsistence to the greatest extent possible. Potential effects on subsistence from development under the FFD scenario are discussed further in Section 4A.4.3. Compliance with existing stipulations (with the exceptions noted) and alternative measures potentially required by the state is expected to result in conformance with the coastal standard for subsistence.

Habitats (6 AAC 80.130)

The Alternative A – Full-Field Development Scenario would result in additional impacts to the habitats identified above. Again, the development would be expected to meet the three-pronged test of serving an important public need, having no feasible inland alternative to development in these habitats, and being designed to maximize conformance to the standards through design and operations measures to minimize potential environmental impacts. As the FFD scenario does not specify exact locations of facilities, it is expected that the exact layout would be adjusted based on field studies and would be designed to maximize conformance with the coastal habitat standard. This alternative would require exceptions from some BLM stipulations regarding permanent oil facilities within resource setback areas and regarding road connections between separate oilfields. Other stipulations in Appendix D, as well as alternative measures potentially required by the state, would be incorporated into the project to reduce adverse effects on natural and cultural resources to the greatest extent feasible. Development of FFD would be expected to comply with the habitat standard through incorporation of the BLM stipulations with the exceptions noted and alternative measures potentially required by the state.

Air, Land, and Water Quality (6 AAC 80.140)

Oil production and transportation facilities proposed under the FFD scenario would likely require new Title V permits to address air emissions from the proposed new production and processing facilities. Stormwater pollution prevention plans and additional NPDES permits might be required to address potential water quality effects from the proposed facilities. Additional ODPCPs would be required to address prevention and spill response for the new facilities. The need for an additional landfill for solid wastes has not been determined at this point; however, any new landfill would be required to meet the ADEC solid waste permitting requirements. Compliance with ADEC and USEPA regulations are an essential requirement of FFD and would result in conformance with this coastal management standard.

Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

Under the FFD scenario, development would be spread over a much wider area and would be anticipated to encounter more cultural resources. As discussed above, adverse effects to any cultural resources identified through an inventory would require avoidance through siting refinements or mitigation through data recovery or other means. Potential effects on cultural resources from FFD are addressed further in Section 4A.4.5. Section 106 regulations, BLM stipulations (with the exceptions noted), and alternative measures potentially required by the state, are expected to protect cultural resources in accordance with the coastal management standard.

NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

As previously stated, for the NSB, the primary goal of the district's CMP Enforceable Policies is to ensure that development activities do not substantially interfere with subsistence activities or jeopardize the continued availability of subsistence resources, but are balanced with protection of the Inupiat culture and lifestyle (NSB 1998).

For the Alternative A – Full-Field Development Scenario, the current *NSB Standards for Development* (NSB CMP 2.4.3) requires that development maintain subsistence resources at a level to meet local needs, protect cultural resources, and comply with federal regulations on land, air, and water quality. Consultation would be conducted as required to address potential cultural resource effects. Development would require appropriate state and federal permits ensuring compliance with federal regulations. Compliance with project specific procedures in Section 2, the BLM stipulations (with the exceptions noted above), and alternative measures potentially required by the state, is expected to reduce impacts on fish and wildlife so that adverse effects to subsistence do not reduce subsistence resources below the level required for local needs.

Development under the Alternative A FFD scenario would incorporate construction and design measures that are intended to reduce impacts on fish and wildlife migration. Access to subsistence resources and to traditional land uses areas would be protected under the BLM stipulations and alternative measures potentially required by the state. The development would acquire all required USEPA and ADEC reviews and permits on air, water, and waste discharges as required under the CMP *Required Features for Applicable Development* (NSB CMP 2.4.4).

As addressed previously in the evaluation of Alternative A, the current NSB *Best Effort Policies* (NSB CMP 2.4.5) reflect criteria similar to the three-pronged test under the ACMP. As compared to the CPAI development proposal, the FFD scenario increases the extent of development throughout the ASDP Area. Major facilities, such as processing facilities, would be shared by multiple production sites to the extent feasible. Additional roadways and pipelines would be constructed and would require design measures to reduce potential effects on fish and wildlife habitat and movements. Many of the proposed sites, particularly in the Colville River Delta, would be limited to access by air. FFD would be expected to meet the current CMP best effort standards for public need, lack of alternatives, and minimization of adverse effects.

The NSB CMP also contains standards for *Minimization of Negative Impacts* (NSB CMP 2.4.6). The proposed development under FFD for Alternative A includes design measures to protect permafrost and to address geophysical hazards as discussed previously under the ACMP. Transportation facilities have been sited and designed to preserve existing drainage patterns and to minimize effects on fish and wildlife migration. Although this alternative would require exceptions from some BLM stipulations as described above, compliance with the project specific procedures in Section 2, the other BLM stipulations in Appendix D, and alternative measures potentially required by the state, is expected to further reduce the development's impact on coastal resources. Thus, the proposed development is expected to be consistent with these CMP standards.

NORTH SLOPE BOROUGH LAND MANAGEMENT REGULATIONS

Most of the land within the NSB is zoned as Conservation, with the exception of some village sites and the existing oilfields at Prudhoe Bay and Alpine Field. The NSB's Resource Development zoning classification covers areas designated for oil development activities. Development to the east of National Petroleum Reserve-Alaska in the Colville River Delta under FFD would require a re-zoning of the development areas to the Resource Development classification and permitting of activities through the approval of a master plan. Application of the NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

4A.4.6.3 Alternative A – Summary of Impacts (CPAI and FFD) on Land Uses and Coastal Management

Construction and operation of the Alternative A – CPAI Development Plan is not anticipated to result in adverse effects to existing land uses and ownership. A direct impact, however, would be the increase in the acres of developed land within the Plan Area. Implementation of the CPAI proposal under Alternative A would result in an increase of 2.4 times the total number of acres currently developed for oil production within the Plan Area. The Alternative A – CPAI Development Plan would require a BLM exception for construction and operation of permanent facilities within the designated Fish Creek setback area. CPAI would also have to obtain exceptions from BLM for development of some facilities within the 500 foot setback from other water bodies, and for the road connection between separate oilfields within the National Petroleum Reserve-Alaska. Development of facilities within the Colville River Special Area requires maximum protection of the area's surface resources, while allowing for development of the area's oil reserves. Incorporation of the BLM stipulations in Appendix D (with the exceptions noted), design and construction measures identified in Section 2, and alternative measures potentially required by the state, are expected to achieve maximum protection of the Colville River area's resources while allowing for oil facility development.

The proposed FFD of a production pad and associated pipeline in the area near the Kogru River, designated for no surface activities, would require another exception from BLM from the surface use restrictions for this area. Adoption of other elements of FFD also would require approval for additional development within the CRSA, the Fish Creek buffer area, Sensitive Consultation areas, and the special caribou stipulation area.

The proposed development, constructed and operated in compliance with the project specific procedures in Section 2, the BLM stipulations for the area (with the exceptions noted), and alternative measures potentially required by the state, is expected to be consistent with state and NSB coastal management policies. Implementation of Alternative A (CPAI and FFD) for areas east of the National Petroleum Reserve-Alaska would require NSB re-zoning from "Conservation" to "Resource Development" and permitting of activities through the approval of a master plan. Application of the NSB's land management regulations to oil and gas activities on federal lands is subject to legal constraints and therefore must be evaluated on a case-by-case basis as particular activities are proposed.

4A.4.6.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Land Uses and Coastal Management

No mitigation measures have been identified for Alternative A CPAI or FFD for land uses and coastal management.

4A.4.6.5 Alternative A – Effectiveness of Protective Measures for Land Uses and Coastal Management

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to coastal zone management, and since impacts are not expected from the CPAI proposal this EIS has not identified potential mitigation relative to coastal zone management.

4A.4.7 Recreation Resources

Potential effects on recreation from the applicant's proposed action were assessed by determining the various types of recreational uses occurring in the Plan Area. These uses were then evaluated to determine their sensitivity to the short-term and long-term effects of the projects. This assessment used both the results of discussions with outfitter guides operating in the Plan Area and previous knowledge of the Plan Area's natural resources.

4A.4.7.1 Alternative A – CPAI Development Plan Impacts on Recreation Resources

As noted in Section 3.4.7 the Plan Area is characterized by vast stretches of low wetland tundra with abundant wildlife resources and very low evidence human activity. Much of the recreational activity in the Plan Area is along the Colville River, with most organized recreation occurring or originating in the vicinity of Umiat to the south and Nuiqsut to the north. Most of the recreation in the project area occurs from May through September.

Most construction features associated with the proposed alternatives such as roads, pipeline construction, and gravel pad construction would occur during the winter months to minimize effects to the tundra environment. Very little organized recreation occurs during these harsh winter months, and only limited recreation occurs in the area during the summer months, as described in Section 3.4.7.

Potential effects on recreation from the Alternative A – CPAI Development Plan will likely include a loss of opportunities to experience wilderness-type values, such as naturalness and solitude, as well as a loss of area available for recreation because of development related activities (construction and operations). As explained in Section 3.4.7, the Plan Area provides opportunities for recreational visitors to experience naturalness and solitude associated with the SPM ROS class. Those engaging in non-subsistence hunting, hiking, and photography independent of outfitter guides would likely be subject to similar recreation-related impacts as outfitter guides, whose clients account for the majority of recreation users. The area also provides areas for wildlife viewing and limited fishing and hunting opportunities. Some opportunities for recreation would likely be reduced and some recreationists would be displaced (through loss of acreage available for recreational use) if the additional five satellites are developed. Under FFD, the effects are expected to be similar, but larger in scope.

Although the quality of the recreational experience in the Plan Area could also be indirectly affected through short- or long-term changes in ambient conditions, such as noise, interruption of views, or dust and odor, these issues are evaluated in detail in other sections of this document.

During construction, the estimated 100 to 150 summer recreation users, as well as the few winter recreation users (no specific numbers on winter recreationists are available) of the ASDP Area could be affected by noise, marred views, and disturbance to birds (affecting birdwatchers) and game and fish (affecting hunters and anglers). During the operations phase of the project, these effects would be lower in intensity, but they would be long-term in duration (over the life of the facility).

Long-term potential effects are expected to be greatest within 2 miles of the production pads, an area measuring approximately 8,000 acres per site. As a result, the applicant's proposed action to develop five pads could potentially affect the recreational experience, including values of solitude, quietude, naturalness, and wilderness, over approximately 40,000 acres. However, the recreational use of the Plan Area is very low, and most recreation occurs directly along the Colville River corridor where activities associated with Nuiqsut already have decreased the values of some of these recreational activities.

Therefore, actual effects to the recreational experience would be minor and would primarily be limited to activity associated with development across the Nigliq Channel, where there would be a decrease in opportunities associated with solitude, quietude, naturalness, and wilderness. Recreational opportunities in the Plan Area would remain consistent with the BLM's SPM classification.

ABANDONMENT AND REHABILITATION

While abandonment and rehabilitation activities are occurring, the small number of recreational users in the area of CPAI's development could have their experience diminished by noise, marred views, and disturbance to animals that they have come to observe (bird watchers) or harvest (fish and game). If upon completion of abandonment, roads are left in place and made available for the public, there would be greater access opportunities, especially if recreationists are able to utilize the airstrip at Alpine Field.

4A.4.7.2 Alternative A – Full-Field Development Scenario Impacts on Recreation Resources

Under FFD, the effects on hunting, fishing, and birding opportunities and the qualities of solitude, quietude, naturalness, and wilderness would be the same as those described for the Alternative A – CPAI Development Plan, as described previously. However, the potential for such effects would increase under this alternative as a result of the increased geographic scope of development. In addition to the potential effects on approximately 40,000 acres from the applicant's proposed action, the recreational opportunities on up to an additional 192,000 acres could be affected if as many as the 24 proposed processing or production pads are developed.

Actual effects to users would be greatest from the development of production pads, such as hypothetical pads HP-8 and HP-11, near the Colville River. Pads projected under FFD, particularly near the Colville River, and especially those near or above Nuiqsut, would increase the potential for indirect, short-term effects to recreation. These effects would mainly be from increased noise disturbance by aircraft traveling to and from the pad locations.

The noise associated with aircraft could alter wildlife movement, affecting hunting and bird-viewing opportunities in the Plan Area, specifically near HP-8 and HP-11. Because the species sought by big game hunters tend to roam over large areas within and near the Plan Area, and because the number of big game hunters visiting the Plan Area is small, no long-term effects on hunting under this alternative would be expected. However, there would likely be long-term effects to the solitude, quietude, naturalness, and wilderness (birding opportunities) values within approximately 2 miles of new facilities.

Overall, potential effects on recreation in the Plan Area would be localized (near new facilities), and no regional effects above current conditions would be expected.

4A.4.7.3 Alternative A – Summary of Impacts (CPAI and FFD) on Recreation Resources

Construction and operation of the facilities proposed under Alternative A (CPAI and FFD) in the Plan Area are not expected to result in more than local adverse effects to the lightly used recreational resources of the Plan Area.

4A.4.7.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Recreation Resources

No mitigation measures for recreation have been identified.

4A.4.7.5 Alternative A – Effectiveness of Protective Measures for Recreation Resources

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to recreation resources and this EIS does not identify potential mitigation measures for recreation.

4A.4.8 Visual Resources

4A.4.8.1 Visual Analysis Methodology

The visual analysis methodology includes three elements: (1) definition of management distance zones, which relates to how close or distant features are to likely viewers; (2) contrast ratings, or how much change results from new features in the visual landscape; and (3) photographic simulations of typical views with and without the proposed project facilities.

VISUAL RESOURCE MANAGEMENT DISTANCE ZONES

Distance from an object affects how well elements of a landscape are perceived, with visible details of a particular object decreasing with increasing distance. The VRM system recognizes three distance zones:

- **Foreground and Middle-Ground Zone**. This is the area that can be seen from a travel route for up to 5 miles. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape.

- **Background Zone.** This is the remaining area that can be seen from a travel route to approximately 15 miles. It does not include areas in the background that are so far distant that the only thing discernible is the form or outline. To be included within this distance zone, vegetation should be visible at least as patterns of light and dark.

- **Seldom-Seen Zone**. These are areas that are not visible within the foreground, middle ground, and background zones, and areas beyond the background zones.

CONTRAST RATINGS

For the ASDP, a visual effect is considered adverse if a proposed project element (such as a drill rig) creates a strong contrast with the elements of the natural landscape. The BLM defines contrasts in the following manner.

- **None.** The element contrast is not visible or perceived.

- **Weak.** The element contrast can be seen but does not attract attention.

- **Moderate.** The element contrast begins to attract attention and begins to dominate the characteristic landscape.

- **Strong.** The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

For the following analysis, major infrastructure elements associated with the proposed developments were evaluated for the amount of contrast with the elements of the natural landscape. To aid in this assessment six visual simulations of different infrastructure elements were developed.

SIMULATIONS OF POTENTIAL CONTRASTS

KOPs are the most likely locations (communities, cabins, travel routes) where viewers would be able to observe the proposed project and would be visually affected by its presence. Initially, 24 KOPs located throughout the Plan Area were considered for preparation of visual simulations. From those 24, six were initially selected and ultimately three were chosen. It was decided that the tree that were eliminated (KOP 3, 14, and 18) were unrepresentative of potential visual impacts for analyses. Three were selected for impact analysis, KOP 12, 20, and 21. These KOPS were spread across much of the Plan Area and were selected to represent the 24 KOPs in the visual simulations. For each of these three KOPs, visual simulations were prepared and evaluated for the amount of visual contrast within the characteristic landscape. Simulations were conducted using BLM standards for visual simulations representing what would be seen through a 50mm camera lens. Table 4A.4.8-1 lists the six representative KOPs and their distance from each of the proposed five production pads and proposed structures associated with FFD. Most of the viewing distances are in the background or seldom-seen zone. However, KOPs #20 and #21 each have views within 5 miles or less of their locations, and views of KOP 12 are within 4 miles.

In accordance with BLM Visual Manual Section 8400, analyses of the visual effects of the applicant's proposed action were completed using visual simulations. Visual simulations used photographs of major oil- and gas-related structures, photographs of existing site conditions, and a digital terrain model with x, y, and z coordinates to generate photorealistic depictions of how proposed oil and gas satellites appear to observers. Major drilling equipment and facilities necessary for development of each oil and gas satellite were photographed during a site visit in July 2003. Photographs were taken with a 50 mm lens and represent what the unaided human eye would see. Engineering drawings and specifications for these equipment types and facilities were used to accurately model or "size" each structure before placing in it in the digital terrain model. Image editing software was used to blend the computer renderings of various structures with the photographs taken at KOPs.

TABLE 4A.4.8-1 VRM CLASSES FOR PROPOSED FACILITIES AND DISTANCES FOR REPRESENTATIVE KOPS

Proposed Facility	VRM Class	KOP #3	KOP #12	KOP#20	KOP #21	KOP #18	KOP #14
CD-1	II	15**	9	4*	5	6**	24
CD-2	II	15**	8	2*	4	3	22
CD-3	II	20	13	8**	5	9**	26
CD-4	II	11**	4*	2	7**	4*	22
CD-5	II	14**	8	3	5	1*	18
CD-6	III	16	13	12**	13**	10**	9**
CD-7	III	17	16	17	19	15	6**
HP-1	III	16	10**	8	9**	6**	13**
HP-2	III	19	18	19	21	17	5
HP-3	III	17	11**	6	5*	4*	17
HP-4	II	12	6	4	8**	6**	24
HP-5	II	17	11**	5*	1*	5*	22
HP-6	II	9**	3*	5*	10**	5	18
HP-7	II	18	11**	7	5	8**	26
HP-8	II	6**	2	7	13**	8**	23
HP-9	IV	4*	5*	11	16	11**	19
HP-10	III	20	21	24	27	22	11**
HP-11	II	10**	13**	16	21	16	15**
HP-12	II	20	15**	11	11**	13**	32
HP-13	II	24	18	14	12**	16	33
HP-14	II	24	20	16	15**	18	36
HP-15	IV	23	18	15	12**	13**	13**
HP-16	III	25	23	24	25	22	4

TABLE 4A.4.8-1 VRM CLASSES FOR PROPOSED FACILITIES AND DISTANCES FOR EPRESENTATIVE KOPS (CONT'D)

Proposed Facility	VRM Class	KOP #3	KOP #12	KOP#20	KOP #21	KOP #18	KOP #14
HP-17	III	29	29	30	31	28	10**
HP-18	III	28	25	23	23	21	5
HP-19	III	32	33	35	37	33	17
HP-20	III	35	33	32	32	30	12**
HP-21	IV	39	35	32	29	30	19
HP-22	IV	6**	31	27	22	25	21
HPF-1	III	37	34	32	30	30	14**
HPF-2	IV	21	19	19	20	17	2

Notes:
Distances are reported in miles.
* Distances represent the foreground-middle-ground zone.
** Distances represent the background zone.

VIEWS FROM VILLAGE OF NUIQSUT (KOP #12)

KOP #12 is on the north side of the village of Nuiqsut (N 70.23092°, W 151.01349° WGS84) (Figure 3.4.8.2-1). While viewer numbers are small (fewer than 200 per month), the importance of a natural landscape to the viewers is reflected in the VRM Class II designation. As displayed in Table 4A.4.8-1, KOP #12 is approximately 13 miles from CD-3, 4 miles from CD-4, 8 miles from CD-5, 13 miles from CD-6, and 16 miles from CD-7. CD-3, CD-4, and CD-5 could be within the same view, with the closest viewing distance being 4 miles (CD-4), while the farthest viewing distance would be 13 miles (CD-3). CD-4 and CD-5 would probably be discernable as structures at these distances. The viewing distance to CD-3 (13 miles) is far enough that it would probably be viewed as a blurry image from this location. These facilities would begin to attract attention on the landscape and result in a moderate contrast rating. For the Alternative A – CPAI Development Plan, the proposed facilities would be scattered in an almost 180-degree view.

Under the Alternative A – Full-Field Development Scenario, there would be an additional three production pads in the foreground-middle-ground zone. Drill rigs associated with the three pads and pipeline are 4 miles (foreground-middle-ground zone) from the KOP. The drill rigs would appear as distinct orange structures contrasting with the greens, browns, and grays of the stream corridor, and its vertical lines would contrast with the flat, horizontal landscape. The overall contrast of these FFD elements with the natural landscape would be noticeable, since the elements would begin to attract attention and would not be easily overlooked.

VIEW FROM NIGLIQ CHANNEL (KOP #20)

KOP #20 is near the Nigliq Channel (N 70.31232°, W 151.03888° WGS84) (Figure 3.4.8.3-5). This KOP represents views from water level and not from the uplands. (For a view from an upland area, see Figure 3.4.8.3-1, displaying CD-2 from approximately 5 miles.) While viewer numbers are small (fewer than 200 per month), the importance of a natural landscape to the viewers is reflected in the VRM Class II designation. As displayed in Table 4A.4.8-1, KOP #20 is approximately 8 miles from CD-3, 2 miles from CD-4, 3 miles from CD-5, 12 miles from CD-6, and 17 miles from CD-7. Under FFD, HP-4, HP-5, and HP-6 would be located in the foreground-middle-ground zone. Vertical contrast would be visible and would result in moderate contrast to the landscape characteristics. None of the proposed facilities would be within the same view, but the five proposed facilities would be scattered in an almost 360-degree view.

A drill rig and pipeline at CD-4 would be visible at a distance of approximately 2 miles, contrasting with the surroundings such as those simulated for KOP #12. The overall contrast of these facility elements with the natural landscape elements of form, color, line, and texture would be moderate.

VIEW OF NIGLIQ CHANNEL WITH VIEW OF CABINS (KOP #21)

KOP #21 is near the Nigliq Channel in view of cabins on the west side of the channel (N 70.39138°, W 151.08667° WGS84) (Figure 3.4.8.3-6). This KOP is situated along the uplands above river level. As displayed in Table 4A.4.8-1, KOP #21 is approximately 5 miles from CD-3, 7 miles from CD-4, 5 miles from CD-5, 13 miles from CD-6, and 19 miles from CD-7. Vertical contrast is visible and would create a moderate contrast in that the facilities begin to become noticeable on the landscape. CD-5, CD-6, and CD-7 could be within the same view, though the viewing distance to CD-7 (19 miles) is so great that it would probably not be visible from this location. The proposed structures of the Alternative A – CPAI Development Plan alternatives would be scattered in an almost 180-degree view. Under FFD, there would be an additional three production pads in the foreground-middle-ground zone.

The drill rig and pipeline at CD-3 would be slightly noticeable from KOP #21, contrasting with the surroundings in a manner similar to that described for KOP #12. The overall contrast of these facility elements with the natural landscape elements of form, color, line, and texture would be weak.

DETERMINATION OF IMPACTS

Impacts to visual resources were determined by evaluating whether VRM objectives were met. Table 4A.4.8-1 shows VRM class objectives for all proposed facilities. The majority of the facilities are in VRM Class II or VRM Class III areas. In VRM Class II areas, the level of change to the natural landscape should be weak, while for Class III areas the level of change should be moderate. A moderate contrast rating would not meet the intent of the objectives associated with VRM Class II, but would meet the objectives for Class III areas.

4A.4.8.2 Alternative A – CPAI Development Plan Impacts on Visual Resources

CONSTRUCTION PERIOD

Under the applicant's proposed action, the presence of drill rigs (approximately 208 feet in height) would be the most noticeable effect of construction. Since drilling would be present and operational during the summer season at all but CD-3, the drill rigs would create a moderate contrast when viewed in the foreground zone, resulting in an adverse impact. The summer season represents the time of year when viewers would be traveling through the Plan Area and facilities are free of snow and there is adequate daylight for viewing. Drill rigs would introduce vertical lines and dominate the landscape. Activities such as pad construction and road construction would have a negligible impact because the construction activities would occur in the winter when snow and darkness make viewing activities difficult.

OPERATION PERIOD

Facilities associated with operation of the production pads would introduce a strong contrast with the natural landscape. Most of the buildings associated with the proposed action are less than three stories high (less than 60 feet), while communications towers could be up to 200 feet high. These vertical structures would then be 200 feet higher than the surrounding landform and would contrast with the predominant horizontal line of the surrounding landform. Power poles (limited to the area between CD-6 and CD-7) would be spaced 250 feet apart and would add vertical contrast to the natural landscape, though they would not be as noticeable as communication towers. Bridges across water bodies, especially the Nigliq Channel, would repeat the horizontal line of the landform but would contrast with the colors of the surrounding landscape. Emergency spill response containers located along channels also would contrast with the colors of the surrounding landscape. Pipelines would be elevated 5 feet above the ground surface and would follow the horizontal landform of the landscape.

Buildings, drill rigs, and communication towers also would contrast in color with the dominant vegetation. Roads would contrast with much of the surrounding vegetation colors, but would not dominate views with distances of more than one mile, since they would only be 5 to 10 feet higher than the tundra. When viewed from more than 1 mile away, roads and airstrips would appear as elevated horizontal lines. Vehicle traffic on roads, and aircraft take-offs and landings, would be noticeable for short durations primarily from the creation of fugitive dust. Because of the nature of gravel mining, only stockpiled material would be visible. Lighting of facilities for night operations would produce sky glow in an otherwise dark landscape.

ABANDONMENT AND REHABILITATION

During abandonment and rehabilitation, vehicle traffic on roads would create short-term noticeable visual impacts through the creation of fugitive dust. Once these activities are completed, contrasts with the surrounding vegetation colors created by structures, such as pipelines and buildings, will be eliminated.

4A.4.8.3 Alternative A – Full-Field Development Scenario Impacts on Visual Resources

Both construction and operation of multiple production pads would introduce numerous moderate contrasts with the natural landscape. Under FFD, viewers would more likely be able to see evidence of construction or operation of production pads. The addition of two more central processing facilities would introduce a moderate visual contrast with the natural landscape, resulting in an adverse impact.

4A.4.8.4 Alternative A – Summary of Impacts (CPAI and FFD) on Visual Resources

Under Alternative A (CPAI and FFD), construction and operation would result in adverse effects to visual resources. Activities such as pad construction and road construction would have a negligible impact because the construction activities would occur in the winter when snow and darkness make viewing activities difficult. The summer season represents the time of year when viewers would be traveling through the Plan Area and facilities are free of snow and there is adequate daylight for viewing. The facilities and structures associated with operation would introduce contrast with the natural landscape. When viewed from the foreground-middle-ground zone, these structures would produce a moderate contrast with the natural landscape.

4A.4.8.5 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Visual Resources

Potential mitigation measures for visual resource impacts would include:

1. All structures would be painted to blend with the natural environment. All colors would be pre-approved by the AO. This includes emergency spill containers located along watercourses. BLM will use computer generated colors to determine the color for structures that blend in best with the background colors of the natural landscape and may do a color test onsite. Self-weathering steel, or best management practice, will be used on all metal structures not otherwise painted, including but not limited to pipelines, communications towers and drill rigs, thus providing a more natural color of brown.

2. Except for safety lighting, illumination of all structures, including drilling structures, production facilities, or buildings shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward.

4A.4.8.6 Alternative A – Effectiveness of Protective Measures for Visual Resources

There are no Northeast National Petroleum Reserve-Alaska IAP/EIS stipulations that apply to visual resources. However, this EIS recommends mitigation that would blend structures and permanent facilities with their surroundings and reduce impacts from the lighting of the facilities.

4A.4.9 Transportation

Potential effects to transportation resources include changes to traffic volume and circulation on existing and proposed roads, airports, marine, and rail facilities. Increased traffic volumes are assessed to determine whether they would exceed transportation facility capacities, or adversely affect traffic flow and safety. Potential secondary effects associated with provision of new transportation resources and increased access to formerly remote areas include adverse effects on wildlife, recreation, and subsistence from increased activity levels in areas that are currently difficult to access. These impacts are discussed in their respective sections.

Because proposed development would occur in an area with no public transportation infrastructure and no public information on traffic volumes by type of transportation, the applicant's proposed action does not lend itself to quantification of traffic impacts. Professional transportation planning judgment was applied to reach reasonable conclusions about the potential effects on transportation resources.

4A.4.9.1 Alternative A – CPAI Development Plan Impacts on Transportation

ROADWAYS

The Alternative A – CPAI Development Plan would result in the construction of one new airstrip at CD-3, 26.0 miles of new gravel roads, and 35.6 miles of pipelines within the Plan Area. Use of the roadways and airstrip would be restricted to agency staff, oil industry personnel and contractors, and residents of the village of Nuiqsut.

CONSTRUCTION PERIOD

Construction activities proposed under the Alternative A – CPAI Development Plan would occur in phases during the next several years. The construction workforce would range from 50 to 625 personnel during various construction seasons. Non-local construction personnel would likely travel to the North Slope by jet and then travel to their assigned housing locations by smaller air transport or by road. Personnel transport to specific construction sites would primarily occur by road, or by air at CD-3. Personnel transport associated with construction activities would occur primarily within the Plan Area. No adverse effects on any industry or public roadways are anticipated.

Construction material would likely be transported by road, sea, and air, depending on the season and the stage of construction. Most freight and materials delivered to the North Slope are delivered by truck along the Dalton Highway. Traffic on the Dalton Highway is well below the roadway capacity, averaging fewer than 300 vehicle trips per day in 2002. Truck traffic on the highway would increase during construction, raising the %age of trucks beyond its current 40 %. The increased truck traffic on the road would be similar to construction traffic peaks that have occurred during previous oilfield construction periods on the North Slope and are not expected to adversely affect traffic flows on the Dalton Highway.

Transport of materials from the oil industry roadway system at the North Slope to construction sites within the Plan Area would primarily occur over ice roads during winter construction periods until the proposed gravel roads and bridges have been constructed. These ice roads and gravel roads would be designed specifically to provide construction and operations access to production sites and are expected to provide the required capacity for transport of construction materials throughout the construction period.

Construction traffic would vary by season, with up to 18,600 round trips per month possible during the initial winter construction season during 2004 and 2005. Because most of this construction traffic would occur on industry-constructed roadways with no public access, no adverse effects on public roadway systems are anticipated.

OPERATION PERIOD

Operation of the facilities proposed under the Alternative A – CPAI Development Plan for the applicant's proposed action would result in a much lower level of traffic than is anticipated during construction. Road traffic within the Plan Area would be limited to transport of employees and operating supplies from APF-1 to the other production pads on the gravel roads connecting most of the sites to the existing facilities. Much of the supply transport from outside the Plan Area would occur by truck on the Dalton Highway to the North Slope. During winter, supplies would be transported into and within the Plan Area by using low ground pressure vehicles or truck transport on ice roads. High-value, low-weight supplies or other essential supplies that cannot wait to be sent until winter could be shipped in by air to the existing facility and transported to the production pads by air (particularly for CD-3) or by ground. As described above, the oil industry roads on the North Slope have limited access. The increased truck traffic on the Dalton Highway resulting from operation of the five proposed pads is expected to be well within the capacity of the road. Likewise, increased traffic on oil industry roads during operations would be far less than during construction and should not result in any adverse effects on ongoing traffic operations of the North Slope oilfields.

Construction of the roads and bridges linking the existing Alpine Facility to production pads west of Nigliq Channel would result in the first year-round road access to areas west of the channel. These proposed roadways would provide additional access for Nuiqsut residents to areas within the Fish-Judy Creeks Facility Group that are currently difficult to access during the summer months. This additional access would result in more human activity in these areas related to operation of the production pads during summer months. Although the proposed roads would provide new access to these areas, the potential effects would be lessened somewhat because the proposed roads would not provide direct access to Nuiqsut, the oil industry roads east of the Plan Area, or the Dalton Highway. Potential effects to subsistence resources from this increased access are addressed in Section 4A.4.3 and Section 4A.3.

RAILROAD TRANSPORTATION

CONSTRUCTION PERIOD

Under the Alternative A – CPAI Development Plan, some construction materials from outside Alaska would likely be transported from Alaska ports of entry to Fairbanks by railroad and then transferred by truck to the North Slope. The Alaska Railroad Corporation has provided these services as required during previous oil industry construction activities on the North Slope. The railroad is expected to have sufficient capacity to accommodate construction transport needs for the applicant's proposed action.

OPERATIONS PERIOD

Although rail transport plays a minor role in transportation of materials during operations, it is the most economic means for shipping some large, heavy goods. The railroad is expected to have sufficient capacity to accommodate additional transport needs associated with operations of the new pads.

MARINE FACILITIES

CONSTRUCTION PERIOD

Marine transportation of heavy construction equipment or other materials with a low value-to-weight ratio could occur by barge proposed under the Alternative A – CPAI Development Plan. Marine transportation would likely play a role in movement of construction material from the Lower 48 states to Alaska and from Anchorage to the North Slope. Alaska ports and marine transport firms have historically provided sufficient capacity during previous construction activities on the North Slope and are expected to have sufficient capacity to meet any demands for marine transport associated with construction activities during the next 10 years.

OPERATIONS PERIOD

Transport of supplies during normal operations does not typically involve marine transport. Therefore, operation of the facilities proposed under Alternative A would not affect any other marine transport facilities.

RIVER TRANSPORTATION

CONSTRUCTION PERIOD

Most construction in the vicinity of rivers would occur during winter until gravel roads and bridges have been installed. Construction activities may interfere with some winter travel on frozen channels, but the interference is expected to be limited and it is expected that local residents' travel needs will be accommodated through construction areas.

OPERATIONS PERIOD

The Alternative A – CPAI Development Plan proposes construction of bridges over the Nigliq Channel, the Ublutuoch River, and five smaller water bodies. Pipelines between CD-1 and CD-3 would also cross the Sakoonang, Tamayagiaq, and Ulamnigiaq channels. Road and pipeline bridges across channels and rivers commonly navigated by industry and local residents will provide at least 20-foot clearance. Under this alternative, the bridges over the Nigliq Channel would be approximately 1,200-foot long and the Ublutuoch River Bridge would be approximately 140-foot long. Bridge designs would address water surface elevations and velocities, scour protection, ice impacts and jams, storm surges, and waterway opening requirements. The 20-foot clearance for the bridge over the Nigliq Channel would accommodate the boats typically used for spill response. Only one spill response boat, the Agviq, would require modifications to be used in the area of this bridge. Most village boat heights are about 10 feet above water level with aerials that reach to 20 feet. These aerials are easily retractable and would not inhibit travel under the 20-foot bridges.

Two docks would be constructed to provide river access for spill response. One dock would be deployed seasonally at CD-3 to provide access to the East Ulamnigiaq Channel. The second dock would be a permanent installation at either CD-2 or CD-4 to provide access to the Nigliq Channel. The limited use of these facilities for spill response and spill response training is not expected to adversely affect local use of the river. Therefore, operation of the facilities proposed under this alternative are not expected to adversely affect river transportation.

AVIATION FACILITIES

CONSTRUCTION PERIOD

Shared Services Aviation currently transports approximately 20,000 passengers to and from the North Slope per month. The maximum construction workforce for any one season is 625 workers. If this entire workforce required transportation to the North Slope in one month it would increase existing passenger loads by less than 5 %.

Shared Services Aviation transports personnel within the North Slope area with the use of Twin Otters and CASAs. These aircraft currently provide as many as nine daily flights into the Alpine Facility. During a 1-year construction and drilling period, it is estimated that this alternative would require approximately 700 landings by small aircraft (CASA or Twin Otter) for personnel, 250 landings for cargo aircraft (DC-6), and 20 landings by C-130 Hercules Aircraft (CPAI 2003b). The CASA and Twin Otter currently fly more than 100 flights per week on the North Slope, and this construction activity is expected to increase flights by less than 13 % from current activity levels. Increased demand for cargo and helicopter flights are also expected to be easily accommodated with existing commercial and charter aviation services. This level of increased demand for flight support would not be expected to have an adverse effect on aviation facilities or services to and within the North Slope.

OPERATIONS PERIOD

Transport of personnel and materials during operations is expected to require up to 40 roundtrip flights per month, including trips into and out of CD-1 and trip to CD-3, three times per week. This would not be expected to result in any adverse effect on aviation facilities or services to and within the North Slope.

This alternative proposes locating electric lines on 60-foot poles between CD-6 and CD-7. Local general aviation pilots have expressed concerns regarding the potential for these lines to create a safety hazard for aircraft flying at low elevations during marginal weather conditions. Although poles of this height are generally not regulated by the FAA due to the limited aviation operations that occur at that elevation, if aircraft do operate in this area at that elevation in poor visibility conditions, the poles could create a safety hazard.

PIPELINES

CONSTRUCTION PERIOD

There would be no effects on existing pipeline facilities during the construction phase.

OPERATIONS PERIOD

The existing 14-inch pipeline from the Alpine Central Processing Facility to Kuparuk currently carries approximately 100,000 bbl of oil per day to Kuparuk and then on to TAPS Pump Station 1 for transport to Valdez. Production from the applicant's proposed action would be phased in over time as production decreases at the existing Alpine well sites. Production flows under this alternative would be managed to remain within the capacity of the existing sales oil pipeline from the Alpine Facility to Kuparuk.

TAPS was designed to accommodate a maximum throughput of 2.2 million MMbbl per day. Currently the year-to-date average oil throughput of TAPS is 995,000 MMbbl per day, or less than 50 % of capacity. The increase in oil throughput associated with the facilities for the applicant's proposed action during the production period is expected to be offset by decreasing output from older, established North Slope facilities; therefore, the projected increase in throughput to TAPS is expected to remain well within the capacity of the pipeline.

ABANDONMENT AND REHABILITATION

During the dismantelment and removal phase there would be increased traffic demands on the current public transportation system, including the industry spine road, the Dalton Highway and, to a lesser extent, the Alaska Railroad and marine facilities, and to the road system built by CPAI for the satellites. These transportation systems would be adequate to handle the traffic and no adverse impacts are anticipated on public transportation systems. If the roads CPAI proposes to build are left in place and maintained, additional transportation infrastructure would be available in the area, though not connected to other roads.

4A.4.9.2 Alternative A – Full-Field Development Scenario Impacts on Transportation

ROADWAYS

Construction impacts to roadways under the Alternative A – Full-Field Development Scenario would be similar to those identified for the Alternative A – CPAI Development Plan. The Dalton Highway would be expected to see increased truck traffic associated with transport of construction materials and supplies. Although no construction schedule has been identified for FFD, it is likely that construction of these facilities would occur incrementally over a long time. Because of the low traffic volumes on the Dalton Highway, it is likely that the highway could accommodate the increase in truck traffic for FFD with little adverse effect on highway traffic.

Operations traffic associated with FFD would be substantially higher than that associated with the CPAI Development Plan. The affected roads would be industry roads specifically designed to accommodate construction equipment and commercial truck traffic. No public access would be allowed on the proposed roads, other than for residents of Nuiqsut.

RAILROAD TRANSPORTATION

Development of the production and processing facilities proposed for the FFD Plan would be expected to occur in a phased manner over a long time. Alaska Railroad Corporation would be expected to play a role in transporting project construction materials and operating supplies. The demands on the railroad for construction and operation of FFD have not been estimated; however, it is likely that Alaska Railroad Corporation could meet the construction and operation needs without adversely affecting ongoing railroad operations.

MARINE FACILITIES

Phased construction of the FFD Plan would likely occur over many years. Although the demand for marine transport has not been quantified, it is assumed that existing marine support services could accommodate the construction and operations demand associated with the FFD Plan.

RIVER TRANSPORTATION

Construction activities near navigable channels are most likely to occur during the winter. These activities could impact use of frozen waterways and would require consultation with residents of Nuiqsut to determine appropriate detours or other means to allow access through construction areas. In addition, use of ice bridges across navigable waterways could delay access to these waterways in the summer. The additional road and pipeline crossings of navigable channels are expected to be designed in a manner that minimizes impacts to navigability. However, there could be adverse impacts to some river transport, particularly larger vessels such as the Agviq.

AVIATION FACILITIES

The FFD Plan would require additional air support during construction and operations, especially for construction of the production pads in the lower Colville River Delta, where no roads are proposed for construction. Although transport of personnel from Anchorage or Fairbanks to Deadhorse, Kuparuk, or both is not expected to result in a substantial change in jet flights to the North Slope, the demand for flights from Kuparuk to the facilities proposed to be located throughout the Plan Area could change substantially, increasing an estimated 40 %.

The only electric line proposed to be placed on 60-foot poles would be the line between CD-6 and CD-7 as described under the CPAI development plan above. This line could create a safety hazard for aircraft flying at extremely low elevations in poor visibility conditions.

PIPELINES

Under the FFD Plan, development and production would be phased so that the supply of sales oil would not exceed the capacity of the existing sales oil pipeline. Because oil production from existing North Slope fields continues to decline, the capacity of TAPS is expected to be adequate to transport oil from the FFD Plan.

4A.4.9.3 Alternative A – Summary of Impacts (CPAI and FFD) On Transportation

Construction and operation of the facilities proposed under Alternative A (CPAI and FFD) in the Plan Area are not expected to result in adverse effects to transportation resources. Existing and proposed roads, airstrips, and pipelines are expected to adequately transport personnel, materials, and product throughout the Plan Area and into statewide transportation systems. Both local and statewide transportation systems are considered to have adequate capacity to accommodate the level of activity anticipated during construction and operation of the facilities. The electric lines placed on poles between CD-6 and CD-7 would have some potential to increase safety hazards for aircraft operations during poor weather conditions.

4A.4.9.4 Alternative A – Potential Mitigation Measures (CPAI and FFD) for Transportation

To address the potential safety hazard associated with electric lines on 60-foot poles, these poles could be marked according to normal FAA requirements for structures above 200 feet. This could consist of red lights on the poles and high-visibility markers on lines where appropriate.

Most bridge construction activities will be conducted when the impacted waterways are frozen. If not, the applicant should work with local village and other vessel operators in order to facilitate marine navigation during construction. If bridge construction activities requires limiting vessel traffic, the applicant should issue sufficient notification of such closures to reduce conflict with marine navigation activities. A condition of the applicant's Coast Guard Bridge permit will require that construction of falsework, cofferdams or other obstructions, if required, shall be in accordance with plans submitted to approved by the Commandant prior to construction of the bridges. All work shall be so conducted that the free navigation of the waterway is not unreasonably interfered with and the present navigational depths are not impaired. Timely notice of any and all events that may affect navigation shall be given to the District Commander (Seventeenth District) during construction of the bridges.

4A.4.9.5 Alternative A – Effectiveness of Protective Measures for Transportation

There are no Northeast National Petroleum Reserve-Alaska AP/EIS stipulations that apply to transportation resources and there were no mitigation measures developed in this EIS.