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4D DIRECT AND INDIRECT IMPACTS – ALTERNATIVE D

4D.1 INTRODUCTION

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

Alternative D excludes the construction of roads for access to production pads. Access to production pads would be by fixed-wing aircraft, helicopter, ice roads, or low ground pressure vehicle tundra travel. The pipeline crossing of the Nigliq Channel would be accomplished using HDD rather than a pipeline bridge. Pipelines would be built with a minimum height of 7 feet (measured at the VSMs). Power cables would be located on VSM-mounted cable trays. Exceptions to stipulations 39(d) and 41 of the NE NPR-A ROD would be required. For the purpose of analysis, Alternative D is presented as two sub-alternatives. Sub–Alternative 1 (D-1) includes gravel airstrips and access by fixed wing aircraft and ice roads. Sub-Alternative 2 (D-2) includes gravel helipads and year-round access by helicopters and winter access by fixed wing aircraft to ice airstrips, and by vehicles on ice roads. All other project elements are common to both sub-alternatives.

The FFD scenario for this alternative also is presented as two sub-alternatives. Sub–Alternative 1 (D-1) includes gravel airstrips and access by fixed-wing aircraft and ice roads. Sub-Alternative 2 (D-2) includes gravel helipads and access by helicopters, ice airstrips, and ice roads. All other project elements are common to both sub-alternatives.

4D.2 PHYSICAL CHARACTERISTICS

4D.2.1 Terrestrial Environment

4D.2.1.1 Physiography

Alternative D – CPAI Development Plan Impacts on Physiography

Construction Period

The effects on physiography would result from changes to landforms by construction of pads, airstrips, helipads and gravel mines. This alternative does not include interconnecting roads; rather, it uses airstrips or helipads at each pad location for transportation. The effects, however, are similar to those discussed in Section 4A.2.1 for Alternative A, because from a physiographic perspective the airstrip or helipad is essentially a large pad.

Areas that would experience direct physiographic impacts from gravel mining operations include approximately 51 acres for Alternative D-1 and 22 acres for Alternative D-2 (refer to Section 4D.2.1.4). Areas that would experience direct physiographic impacts from placement of gravel on the tundra include 172 acres for Alternative D-1 and 67 acres for Alternative D-2. (Tables 2.4.4-1 and 2.4.4-5)

Operation Period

Impacts during the operation period would be similar to those of Alternative A.

Alternative D – FFD Plan Impacts on Physiography

Areas that would experience direct physiographic effects from gravel mining operations include approximately 255 acres for Alternative D-1 and 129 acres for Alternative D-2. Areas that would experience direct physiog

raphic impacts from placement of gravel on the tundra include 816 acres for Alternative D-1 and 408 acres for Alternative D-2.

Alternative D – Summary of Impacts (CPAI and FFD) on Physiography

Impacts to physiography occur primarily during the construction phase and result from changes to landforms by construction of pads, access roads, airstrips, and mine sites. If not properly designed and constructed, these landform changes can adversely affect thermal stability of the tundra and hydrology through thermokarsting and increased ponding.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Physiography

No measures have been identified to mitigate impacts to physiography under Alternative D or Alternative D - FFD.

4D.2.1.2 Geology

The following discussion of effects on geologic resources is limited to lithified, inorganic materials and their associated petroleum resources. Impact to unconsolidated material is discussed in Sections 4D.2.1.3, Soils and Permafrost, and 4D.2.1.4, Sand and Gravel.

Alternative D – CPAI Development Plan Impacts on Geology

Construction Period

Direct Effects

The only surface bedrock identified in the ASDP Area outcrops at the bend in the lower Colville River upstream of Ocean Point (Mayfield et al. 1988). Alternative D does not propose excavation activities in this area and would, therefore, not directly affect surface bedrock.

Indirect Effects

No indirect effects are recognized for the construction period.

Operation Period

Direct Effects

Drilling oil production wells at the five pad locations would directly affect the target and overlying lithologies. Annular disposal or Class II reinjection of drilling wastes would directly affect the receiving lithologies. The volume of rock affected in conjunction with drilling and the disposal of drilling waste is insignificant compared to the volume of lithified resources present within the ASDP Area. For this reason, direct impacts to ASDP Area litholgy are considered negligible.

The CPAI Development Plan would produce hydrocarbons from subsurface reservoirs, thereby depleting the in situ petroleum reserves. Although hydrocarbon production constitutes an unavoidable and permanent impact that would not recover to its pre-impact state within the scale of human longevity, the impact is confined to the geological environment and economic gains would likely outweigh adverse impact to petroleum resources.

Indirect Effects

No indirect effects are recognized for the operation period.

Alternative D – FFD Plan Impacts on Geology

Direct and indirect impacts incurred during construction and operation of Alternative D - FFD would be similar to those presented above for CPAI's proposal but would be experienced over greater spatial and temporal extents. The volume of rock affected by drilling and disposal of drilling waste under FFD is also considered insignificant when compared to the volume of lithified resources present within the Plan Area. Surface bedrock is not expected to be affected under the FFD scenario. Full-field development would further deplete Plan Area petroleum reserves; however, the hypothetical nature of FFD precludes quantification of petroleum resource reduction.

Alternative D – Summary of Impacts (CPAI and FFD) on Geology

Reduction of petroleum resources in the Plan Area is inevitable. Because these resources are essentially nonrenewable, effects would be permanent and unresponsive to mitigation. Impacts to lithified resources in the Plan Area under the CPAI Development Plan Alternative D and Alternative D - FFD would produce no measurable effect.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Geology

No measures have been identified to mitigate impacts to geological resources under Alternative D or Alternative D - FFD.

4D.2.1.3 Soils and Permafrost

Alternative D – CPAI Development Plan Impacts on Soils and Permafrost

Direct and indirect effects on soils and permafrost will be of the same type and caused by the same activities as under Alternative A. However, because of the different footprint and gravel requirements, the total amount of soils and permafrost disturbed or covered will be less. Development of new gravel mine sites would require excavation of approximately 51 acres (for Alternative D-1) and 22 acres (for Alternative D-2) of overburden. Fill material placed in conjunction with Alternative D-1 would overlie approximately 172 acres of native soil. Alternative D-2 would overlie 67 acres. The total surface area of ice roads constructed over six seasons would overlie approximately 1,260 acres of native soil during the winter months for either Alternative D-1 or Alternative D-2. Approximately 3,093 VSMs would be embedded within the pipeline corridors delineated for Alternative D.

Alternative D – FFD Plan Impacts on Soils and Permafrost

The types of impacts and associated effects of FFD are similar to those presented in Section 4D.2.1.3, the CPAI Development Plan Alternative D, but would be experienced over greater spatial and temporal extents. Additional gravel mine sites would be developed to provide the volume of construction material necessary for FFD. Based upon the condition and depth experience from 1999 to 2000 excavations at the ASRC mine, FFD could disturb surface soils and permafrost of approximately 255 acres for Alternative D-1 or approximately 129 acres for Alternative D-2.

Colville River Delta Facility Group

Fill material placed in conjunction with Alternative D - FFD would overlie approximately 246 acres for Alternative D-1 and 101 acres for Alternative D-2 of native soil in the Colville River Delta area. The total surface area of ice roads constructed over 20 seasons would overlie approximately 7,784 acres of native soil during the winter months. Approximately 2,216 VSMs would be embedded and six additional oil well clusters would be drilled in the Colville River Delta Facility Group.

Fish-Judy Creeks Facility Group

Fill material placed in conjunction with Alternative D - FFD would overlie approximately 384 acres for Alternative D-1 and 197 acres for Alternative D-2 of native soil in the area of Fish-Judy creeks. The total surface area of ice roads constructed over 20 seasons would overlie approximately 5,678 acres of native soil during the winter months. Approximately 8,865 VSMs would be embedded and a minimum of 12 additional oil well clusters would be drilled in the Fish-Judy Creeks Facility Group.

Kalikpik-Kogru Rivers Facility Group

Fill material placed in conjunction with Alternative D - FFD would overlie approximately 187 acres for Alternative D-1 and 110 acres for Alternative D-2 of native soil in the area of Kalikpik-Kogru rivers. The total surface area of ice roads constructed over 20 seasons would overlie approximately 6649 acres of native soil during the winter months. Approximately 3,486 VSMs would be embedded and a minimum of four additional oil well clusters would be drilled in the Kalikpik-Kogru rivers area.

Alternative D – Summary of Impacts (CPAI and FFD) on Soils and Permafrost

Most impacts to soil and permafrost under the CPAI Development Plan Alternative D and FFD Alternative D would be sustained during construction. Effects on the environments are unavoidable and semi-permanent but affect less than 1 percent of the total soil and permafrost system surface area within the Plan Area. Soil and permafrost systems could recover to their pre-impact states, but not without appropriate mitigation.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Soils and Permafrost

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.2.1.3).

4D.2.1.4 Sand and Gravel

Alternative D – CPAI Development Plan Impacts on Sand and Gravel

Alternative D would produce impacts similar to those discussed in Alternative A (Section 4A.2.1). The estimated quantities of sand and gravel and mine site areas would be different, as discussed below.

Construction Period

The estimated gravel volume for Alternative D-1 and Alternative D-2 from Table 2.4.1-1 is 1.769 million cy and .756 million cy only. Using the same relationship between volumes and surface area detailed in Section 4A.2.1, Alternative D would affect approximately 51 acres and Alternative D-2 would effect approximately 22 acres of surface and subsurface materials to extract gravel. These acreages are 0.002 to 0.006 percent of the total Plan Area.

Operation Period

During the operation period, relatively small amounts of gravel are expected to be extracted from existing permitted mine sites for repair of road or pad embankments.

Alternative D – FFD Plan Impacts on Sand and Gravel

Alternative D - FFD would use and build off of the same road network that would be constructed under the Alternative D. The Alternative D - FFD scenario, depicted in Figure 2.4.4-2, is estimated to need 8.9 million cy for Alternative D-1, and 4.5 million cy for Alternative D-2. Other than the Clover, where this gravel would come from has not yet been determined. Using the same relationship between volumes and surface area detailed in Section 4A.2.1, construction of Alternative D - FFD would affect approximately 255 acres of the sur

face to extract subsurface gravel materials for Alternative D-1, and 129 acres for Alternative D-2. These values are .015 to .030 percent of the total Plan Area.

Alternative D – Summary of Impacts (CPAI and FFD) on Sand and Gravel

Once used, sand and gravel resources for construction of roads, pads, or airstrips could only be available for reuse upon abandonment. Removal of gravel fill is not currently a scheduled phase of abandonment.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Sand and Gravel

No measures have been identified to mitigate effects on sand and gravel resources under Alternative D or Alternative D - FFD.

4D.2.1.5 Paleontological Resources

Alternative D – CPAI Development Plan Impacts on Paleontological Resources

Construction Period

Under Alternative D, the effects on paleontological resources would likely be less than under Alternatives A, B, and C because gravel roads and associated vehicle bridges between pads are excluded. Excavation of sand and gravel material at the ASRC mine site and the Clover potential gravel source could affect paleontological resources under approximately 51 acres under Alternative D-1 or 22 acres under D-2. As in Alternative A, drilling, placement of gravel pads and VSMs, and construction of pipeline bridges are very unlikely to affect paleontological resources.

Subsurface and surface disturbance resulting from HDD beneath the Nigliq Channel could affect paleontological resources. The estimated HDD distance is 1,200 feet, and the maximum depth would be below the active river channel. Disturbance would be limited to the annulus of the boring and the immediately surrounding soils permeated with drilling fluids. “Transition cellars” excavated through the active layer at the entry and exit points of the HDD segment also could affect paleontological resources.

Alternative D – FFD Plan Impacts on Paleontological Resources

Under the Alternative D - FFD scenario, the mechanisms associated with impacts to paleontological resources would remain the same as those described under Alternative D for the ASDP, except the intensity of the actions would increase because of the greater extent of the development. The primary potential cause of impacts would be excavation of gravel on approximately 255 acres for Alternative D-1 or 129 acres for Alternative D-2. Approximately three gravel mine sites would be developed to provide the volume of construction material necessary for FFD. The location of the gravel mine sites for FFD is yet unknown, but could be in locations that would affect 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 816 acres could be covered by gravel in the construction of pads and airstrips under Alternative D-1 or 408 acres for pads and helipads under Alternative D-2.

Alternative D – Summary of Impacts (CPAI and FFD) on Paleontological Resources

Surface activities such as construction of pad and airfield embankments are not likely to affect paleontological resources. Impacts could result from those activities involving subsurface disturbance such as production well drilling, sand and gravel mining, and installation of VSMs. Excavation of sand and gravel under approximately 51 acres/22 acres (Alternatives D-1 and D-2, respectively) for CPAI’s project and 255/129 acres (Alternatives D-1 and D-2, respectively) for FFD constitute the greatest risk to paleontological resources.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Paleontological Resources

No potential measures have been identified to mitigate impacts to paleontological resources under Alternative D or Alternative D - FFD.

4D.2.2 Aquatic Environment

4D.2.2.1 Water Resources

Alternative D – CPAI Development Plan Impacts on Water Resources

This alternative would require the use of aircraft and construction of ice roads instead of gravel all-weather roads (Figure 2.4.4-1). The five satellites would be developed as stand-alone production pads with air access and ice road access only; airstrips would be required at each production pad. The only gravel all-weather road segments to be constructed would be from the airstrips to the well pad at each production pad. All production pads would be located in the same places as in Alternative A; however, pipelines would be routed slightly differently (more directly) because there would be no roads for the pipeline placement to parallel. No bridge would cross the Nigliq Channel.

In general, Alternative D, whether D-1 or D-2, would affect the same water resources (i.e., subsurface waters, lakes, creeks, rivers, and the nearshore environment) as with Alternative A. Because of the elimination of gravel roads, however, the overall impacts to water resources would be diminished as compared to Alternative A and the other alternatives (e.g., fewer impacts to streams and rivers due to reduced road and pipeline crossings, fewer impacts to shallow subsurface waters due to reduced gravel supply requirements). Ice road construction will increase under Alternative D-1, which will create an increased demand for water. Nevertheless, the increased water supply needs will not increase impacts to lakes due to the ample natural recharge volumes that occur annually and the ability to spread out water extraction to other permitted lakes. Ice road construction is not anticipated to increase as rapidly under Alternative D-2 because of the slow pace of overall construction. Tables 4D.2.2-1 and 4D.2.2-2 provide summaries of potential construction and operation impacts to water resources under Alternative D. Impacts are not anticipated to differ substantially whether Alternative D-1 or D-2 is chosen.

Alternative D – Full Field Development Plan Impacts on Water Resources

The FFD for Alternative D would involve construction of the same number of production pads, and in the same locations, as described in Alternative A, but all production pads would require airstrips because roads would not be built. Impacts to water resources by gravel roads, therefore, would be minimized; however, this would increase the demand for water to build the increased number of seasonal ice roads to support development drilling and construction activities. Pipeline alignments for this alternative are more direct than in Alternative A because they are not following road alignments.

Water withdrawal volumes required for ice road construction during the construction phase would be approximately the same as for Alternative A because ice roads would be built to the same locations. Ice road construction for the FFD scenario would require up to approximately 490 acre-feet of water to be withdrawn from lakes. The lengths of ice roads to be constructed would be higher for this alternative (i.e., approximately 63 percent higher) compared with Alternative A because gravel roads constructed early in development of satellites under Alternative A could be used in subsequent construction. Table 4D.2.2-3 provides a summary of potential impacts to water resources under Alternative D - FFD.

TABLE 4D.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – CPAI DEVELOPMENT PLAN

ALTERNATIVE D – CPAI DEVELOPMENT PLAN											
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS					ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow Groundwa-ter	Deep Groundwa-ter	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulamnig-iaq Channel	Tamay-agiaaq Channel	Sa-koonang Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
CD-3											
Gravel Road Segment: CD-3 to Airstrip	8	NI	NI	NI	NI	NI	NI	NI	NI	7	NI
Ice Roads	NI	NI	10	10	3?	NI	NI	NI	3?	3	NI
Airstrip	8	NI	NI	NI	2,3,4,5	NI	NI	NI	NI	6	NI
Pipeline Segment: CD-1 - CD-3	NI	NI	NI	NI	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	NI	3,4,5,6,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	NI	2,3	6	NI
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	9	9	NI	NI	NI	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI
CD-4											
	Shallow Groundwater	Deep Groundwater	Small Shal-low Lakes and Ponds	Large Deep Lakes	Nigliq Channel		Minor Streams			Harrison Bay	
Pipeline Segment: CD-1 - CD-4	NI	NI	NI	NI	NI		2,3,4,5,6			NI	
Gravel Road Segment to Airstrip	8	NI	NI	NI	NI		2,3,4,5,6			NI	
Airstrip	8	NI	NI	1,3,5,6	3,4,5,6		3,4,5,6			NI	
Production Pad	8	NI	8	NI	NI		2,3,4,5,6			NI	
Underground injection	NI	9	NI	NI	NI		NI			NI	
Chemical/Petroleum Tank Storage	9	NI	9	NI	9		9			9	
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI		NI			NI	

TABLE 4D.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – CPAI DEVELOPMENT PLAN (cont'd)

ALTERNATIVE D – CPAI DEVELOPMENT PLAN								
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS			ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwa-ter	Deep Groundwa-ter	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams		Harrison Bay
CD-5								
Gravel Road Segment: -CD-5 to Airstrip	8	NI	NI	NI	2,4,5,6	2,4,5,6		NI
Airstrip	8	NI	NI	NI	NI	2,4,5,6		NI
Pipeline Segment: CD-2 -CD-5	NI	NI	NI	NI	NI	6		NI
Production Pad	8	NI	8	NI	NI	NI		NI
Bridges/Culverts	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7		NI
Underground injection	NI	9	NI	NI	NI	NI		NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	NI	9		9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI		NI
CD-6								
	Shallow Groundwa-ter	Deep Groundwa-ter	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Ba-sin	Ublutuoch River Ba-sin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-6 to Airstrip	8	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Airstrip	8	NI	NI	3,4,5,6	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Pipeline Segment: CD-5 - CD-6	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	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
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

TABLE 4D.2.2-1 POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – CPAI DEVELOPMENT PLAN (cont'd)

ALTERNATIVE D – CPAI DEVELOPMENT PLAN							
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwa-ter	Deep Groundwa-ter	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creeks Basin	Minor Streams	Harrison Bay
CD-7							
Gravel Road Segment: CD-7 to Airstrip	8	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Airstrip	8	NI	NI	3,4,5,6	NI	2,3,4,5,6,7	NI
Pipeline Segment: CD-6 - CD-7	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Production Pad	8	NI	8	NI	NI	NI	NI
Bridges/Culverts	NI	9	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	NI	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

Notes:
1 = Shoreline Disturbance & 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 of surface soils/gravel and changes in recharge potential
9 = Chemical & Petroleum Spills & Cleanup
10 = Water Supply Demand
NI = No Impact

TABLE 4D.2.2-2 POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – CPAI DEVELOPMENT PLAN

ALTERNATIVE D – CPAI DEVELOPMENT PLAN											
	Groundwater		Lakes		Major & Minor Stream Crossings					Estuaries & Nearshore Environment	
	Shallow Groundwater	Deep Groundwater	Small Shal-low Lakes and Ponds	Large Deep Lakes	Ulamnigiaq Channel	Tamay-agiaaq Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
CD-3											
Gravel Road Segment: CD-1 to CD-3	8	NI	NI	5	NI	NI	NI	NI	NI	7	NI
Pipeline Segment: CD-1 - CD-3	NI	NI	NI	NI	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	NI	3,4,5,6,7	6	NI
Production Pad	8	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6	NI
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	9	NI	NI	NI	NI	NI	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI
CD-4											
	Shallow Groundwater	Deep Groundwater	Small Shal-low Lakes and Ponds	Large Deep Lakes	Nigliq Channel		Minor Streams			Harrison Bay	
Pipeline Segment: CD-1 - CD-4	NI	NI	NI	NI	NI		2,3,4,5,6			NI	
Gravel Road Segment to Airstrip											
Airstrip											
Production Pad	8	NI	8	NI	NI		2,3,4,5,6			NI	
Underground injection	NI	9	NI	NI	NI		NI			NI	
Chemical/Petroleum Tank Storage	9	NI	9	NI	9		9			9	
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI		NI			NI	

TABLE 4D.2.2-2 POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – CPAI DEVELOPMENT PLAN (cont'd)

ALTERNATIVE D – CPAI DEVELOPMENT PLAN								
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS			ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shal-low Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams		Harrison Bay
CD-5								
Gravel Road Segment: -CD-5 to Airstrip	8	NI	NI	NI	2,4,5,6	2,4,5,6		NI
Airstrip								
Pipeline Segment: CD-2 -CD-5	NI	NI	NI	NI	NI	6		NI
Production Pad	8	NI	8	NI	NI	NI		NI
Bridges/Culverts	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7		NI
Underground injection	NI	9	NI	NI	NI	NI		NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	NI	9		9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI		NI
CD-6								
	Shallow Groundwa-ter	Deep Groundwa-ter	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creeks Basin	Ublutuoch River Ba-sin	Minor Streams	Harrison Bay
Gravel Road Segment: CD-6 to Airstrip	8	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Airstrip								
Pipeline Segment: CD-5 - CD-6	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	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
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

TABLE 4D.2.2-2 POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – CPAI DEVELOPMENT PLAN (cont'd)

ALTERNATIVE D – CPAI DEVELOPMENT PLAN							
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwa-ter	Deep Groundwa-ter	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creeks Basin	Minor Streams	Harrison Bay
CD-7							
Gravel Road Segment: CD-7 to Airstrip	8	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	
Airstrip							
Pipeline Segment: CD-6 - CD-7	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Production Pad	8	NI	8	NI	NI	NI	
Bridges/Culverts	NI	9	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	NI	NI
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI

Notes:
1 = Shoreline Disturbance & 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 of surface soils/gravel and changes in recharge potential
9 = Chemical & Petroleum Spills & Cleanup
10 = Water Supply Demand
NI = No Impact

TABLE 4D.2.2-3 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – FULL FIELD DEVELOPMENT

Alternative D - Full Field Development															
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS									ESTUARIES & NEARSHORE ENVIRONMENT	
Colville River Facility Group	**Shallow Groundwater**	**Deep Groundwater**	**Small Shallow Lakes and Ponds**	**Large Deep Lakes**	**Nigliq Channel**	**Sakoonang Channel**	**Tamayagiaaq Channel**	**Ulamnigiaq Channel**	**Elaktoveach Channel**	**Kupigruak Channel**	**Colville River**	**Minor Streams**		**Colville River Delta**	**Harrison Bay**
Hypothetical production pads CD-11, 12, 14, 15, 19, 20, and 21.															
Gravel Road Segments: Production pads to airstrips	8	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
Ice Roads:	NI	NI	NI	NI	NI	NI	3	3	3	3	3	3	1,2,3,4,5,6,7	NI	
Pipeline Segment: CD-11 to CD-4;CD-12 to CD-2;CD-14 to CD-3/1 pipe-line;CD-19 to CD-14;CD-20 to CD-19;CD-21 to CD-19	NI	NI	NI	NI	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	1,2,3,4,5,6,7	NI	
Production Pads: All Proposed and Hypothetical Satellite Locations	8	NI	8	8	2,3	2,3	2,3	2,3	2,3	2,3	NI	2,3	2,3	NI	
Airstrips: At all satellite locations	8	NI	8	8	2,3	2,3	2,3	2,3	2,3	2,3	NI	2,3	2,3	NI	
Underground Injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	
Chemical/Petroleum Tank Storage	9	NI	9	9	9	9	9	9	9	9	9	9	9	9	
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	

TABLE 4D.2.2-3 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – FULL FIELD DEVELOPMENT (cont'd)

Alternative D - Full Field Development										
	Groundwater		Lakes		Major & Minor Stream Crossings					Estuaries & Nearshore Environment
Fish-Judy Creeks Facility Group	**Shallow Groundwater**	**Deep Groundwater**	**Small Shallow Lakes & Ponds**	**Large Deep Lakes**	**Fish Creek Basin**	**Inigok Creek Basin**	**Judy Creek Basin**	**Ublutuoch River Basin**	**Minor Streams**	**Harrison Bay**
Hypothetical processing facility APF-2, and hypothetical production pads CD-8, 9, 10, 13, 16, 17, 18, 22, 23, 24, and 26.										
Gravel Road Segments: From satellites to airstrips (see airstrips below)	8	NI	NI	NI	NI	NI	NI	NI	NI	NI
Pipeline Segment: CD-8 to CD-6/5 ;CD-7 to CD-9;CD-10 to CD-6/5;CD-13 to CD-5/6 ; CD-13 to CD-16; CD-17 to CD-7/9 ;CD-16 to CD-18; CD-6 to CD-22;APF-2 to CD23;CD-23 to CD-24;CD-24 to CD-26	NI	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
Production Pads: All Proposed and Hypothetical Satellite Locations and Hypothetical Processing Facility	8	NI	8	NI	2,3	2,3	2,3	2,3	2,3	NI
Proposed Airstrips: CD-6 through 10, CD-13, CD-16 thru 18, CD-22 thru -24, CD-26, APF-2	8	NI	3,5,6,7	3,5,6,7	3,5,6,7	3,5,6,7	3,5,6,7	3,5,6,7	3,5,6,7	NI
Underground Injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI
Processing Facility: APF-2	8	NI	NI	NI	NI	NI	2,3,4,5,6	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	9	9	9	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI

TABLE 4D.2.2-3 POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES FOR ALTERNATIVE D – FULL FIELD DEVELOPMENT (cont'd)

Alternative D - Full Field Development								
	Groundwater		Lakes		Major & Minor Stream Crossings			Estuaries & Nearshore Environment
Kalikpik-Kogru Rivers Facility Group	**Shallow Ground Water**	**Deep Groundwater**	**Small Shal-low Lakes And Ponds**	**Large Deep Lakes**	**Kalikpik River Drainage**	**Kogru River**	**Minor Streams**	**Harrison Bay**
Hypothetical processing facility APF-3 and hypothetical production pads CD-25, 27, 28, and 29								
Gravel Road Segments: From satellites to airstrips (see airstrips below)	8	NI	3,5,6	3,5,6	2,3,4,5,6	NI	2,3,4,5,6	NI
Ice Roads:	NI	NI	NI	NI	NI	3,4,5,6,	3,4,5,6,	3,4,5,6,
Pipeline Segment: CD-25 to APF-2;CD-27 to APF-3/CD-25 road;CD-28 to APF-3;CD-29 to CD-28; APF-3 to CD-25	NI	NI	NI	NI	2,3,4,5,6	2,3,4,5,6	2,3,4,5,6	NI
Production Pads: All hypothetical Satel-lite Locations and hypothetical proc-essing facility	8	NI	NI	NI	2,3,4,5,6	2,3,4,5,6	2,3,4,5,6	NI
Airstrips: CD-25, CD-25 thru -29, APF-3	8	NI	NI	NI	3,4,5,6	3,4,5,6,7	3,4,5,6,7	NI
Underground Injection	NI	9	NI	NI	NI	NI	NI	NI
Processing Facility: APF-3	8	NI	NI	NI	3,4,5,6	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI

Notes:

1. Shoreline Disturbance & 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 of surface soils/gravel and changes in recharge potential
9. Chemical & Petroleum Spills & Cleanup
10. Water Supply Demand

NI =No Impact

Alternative D – Summary of Impacts (CPAI and FFD) on Water Resources

Alternative D-1 would result in more potential impact on water resources because of more ice roads, and less potential for ice and storm surge and other hydraulic impacts because of no gravel roads. Alternative D-2 would have a lower intensity impact on water resources – annual ice road miles is less, but the duration would continue for many more years due to a delayed drilling program that would extend the construction and operations schedules as well. The impacts would be similar for both CPAI and FFD.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Water Resources

No measures have been identified to mitigate impacts to water resources under Alternative D or Alternative D - FFD.

4D.2.2.2 Surface Water Quality

Alternative D – CPAI Development Plan Impacts on Surface Water Quality

Construction Period

Water withdrawal volumes required for ice road construction would be approximately the same for the applicant's proposed action because ice roads would be built to the same locations. There would be no change in the chance that ice roads would be routed across lakes, potentially resulting in more incidences of reductions in dissolved oxygen concentrations.

The decrease in total gravel placed in the planning area for this alternative would decrease the potential impacts to water quality from increased turbidity caused by erosion and sedimentation. Alternative D would have approximately 172 acres and Alternative D-2 would have 67 acres covered with gravel for the proposed project. The area of tundra potentially affected by thermokarst erosion linked with gravel placement would be equivalent to twice the area directly covered by gravel for the development assumptions made in this alternative for the applicant's proposed action.

Operation Period

Dust fallout from roads would not be a water quality impact source except for the vehicle travel on access roads between production pads and airstrips. This alternative would include construction of less than 4 miles of gravel roads for the applicant's proposed project, which represents a decrease from Alternative A of 86 percent. This decrease in the total miles of gravel road constructed and the likelihood that active flow regimes would be avoided greatly reduces the potential for impacts to water quality from upslope impoundments.

Alternative D – Full Field Development Plan Impacts on Surface Water Quality

Ice road construction for the FFD scenario would require up to approximately 490 acre-feet of water to be withdrawn from lakes. The lengths of ice roads to be constructed would be higher for this alternative compared with Alternative A because ice roads would be used for drill rig access to pads after initial construction activities were completed. Because the miles of ice roads constructed in this alternative for the FFD scenario would be approximately 63 percent higher, there would be an increased chance that ice roads would be routed across lakes, potentially resulting in more incidences of reductions in dissolved oxygen concentrations (as described for Alternative A).

The decrease in total gravel placed in the planning area for this alternative would decrease the potential impacts to water quality from increased turbidity caused by erosion and sedimentation. Alternative D-1 would have approximately 816 acres covered with gravel for the FFD scenario. Alternative D-2

would have 408 acres covered by ground. The area of tundra potentially affected by thermokarst erosion linked with gravel placement would be equivalent to twice the area directly covered by gravel.

Dust fallout from roads would not be a water quality impact source except for the vehicle travel on access roads between production pads and airstrips. This alternative would include construction of less than 12 miles, which represents a decrease from Alternative A of 92 percent. This decrease in the total miles of gravel road constructed and the likelihood that active flow regimes would be avoided greatly reduces the potential for impacts to water quality from upslope impoundments

Alternative D – Summary of Impacts (CPAI and FFD) on Surface Water Quality

Alternative D proposes developing the production pads with access roads only by air, Rolligons, and ice roads. The only gravel placed in the planning area would be for construction of the production pads and the corresponding airstrips at each pad. In comparison with Alternative A, this alternative would have fewer sources of potential impacts to surface water quality because of the decreased gravel placement but more sources of impacts because of the increased water withdrawal for ice road construction and the disturbance of permafrost during power line burial.

- Increased miles of ice roads to be built compared to Alternative A, raising the chance that ice roads would be routed across lakes, and potentially affecting dissolved oxygen concentrations
- Decreased area potentially affected by thermokarst erosion compared to Alternative A, lowering impacts to water quality from increased turbidity caused by erosion and sedimentation
- Minimal potential for dust fallout and upslope impoundments compared to Alternative A, resulting in a low potential for impacts to turbidity.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Surface Water Quality

No mitigation measures have been identified for Alternative D or Alternative D - FFD.

4D.2.3 Atmospheric Environment

4D.2.3.1 Climate and Meteorology

Alternative D - CPAI Development Plan Impacts on Climate and Meteorology

Construction Period

The construction impacts to climate and meteorology are the same as those discussed for Alternative A.

Operation Period

The operational impacts to climate and meteorology are the same as those for Alternative A, although additional aircraft flights would occur from operation of the additional airstrips and far less road vehicle traffic will occur. These changes, however, would not alter the overall impact on GHG.

Alternative D – Full-Field Development Plan Impacts on Climate and Meteorology

The impacts to climate and meteorology are the same as those discussed for the FFD of Alternative A in Section 4A.2.3, except aircraft and helicopter flights will replace road traffic as mobile sources of GHG.

Alternative D – Summary of Impacts (CPAI and FFD) on Climate and Meteorology

The impacts are the same as for Alternative A.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Climate and Meteorology

No mitigation measures have been identified.

4D.2.3.2 Air Quality

Alternative D – CPAI Development Plan Impacts on Air Quality

Construction Period

Air impacts from construction of Alternative D would be similar to those for Alternative A, except that the amount of fugitive dust could be reduced because there would be less gravel used in construction, especially under Alternative D-2.

Operation Period

The air quality environmental consequences would be about the same for this Alternative as for Alternative A. However, Alternative D would require additional equipment and infrastructure at each roadless satellite (for example, pickup truck, vacuum truck, hot oil truck, slickline unit, rig truck, front end loader, air compressor, heaters, bleed tank, shelters, and chemical storage). Depending upon their size and utilization, air quality could be affected more than under other alternative actions.

Mobile source emissions from aircraft and helicopters would occur from the operational period of Alternative D, in lieu of emissions that would occur from use of the gravel roads.

Alternative D – Full-Field Development Plan Impacts on Air Quality

Construction and operational impacts would be the same as for Alternative A. Particulate emissions would potentially occur from gravel airstrip construction in lieu of gravel road construction. Nevertheless, winter construction would mitigate particulate emissions. Air quality would be impacted by aircraft takeoffs and landings at the airstrips and helipads, depending upon the number of aircraft flights per month.

Alternative D – Summary of Impacts (CPAI and FFD) on Air Quality

The impacts for Alternative D are the same as for Alternative A, with aircraft emissions occurring throughout drilling and operational phases, not just construction.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Air Quality

Air quality impacts from Alternative D 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. No additional measures have been identified.

4D.2.3.3 Noise

Alternative D – CPAI Development Plan Impacts on Noise

Construction Period

The noise impacts from construction of Alternative D would be similar to Alternative A described in Section 4A.2.3, except the construction of gravel roads would be replaced with construction of gravel airstrips and helipads.

Operation Period

Aircraft and helicopter noise at all satellite drilling and production pads would occur in lieu of vehicular traffic noise (except at CD-3, which would be equipped with an airstrip under Alternative A) and would be louder but less frequent than under Alternative A.

Alternative D – Full-Field Development Plan Impacts on Noise

The primary difference in noise in Alternative D from that in Alternative A is that it is generated by aircraft, rather than road vehicles. Noise from the helicopters relied upon in Alternative D-2 is substantially different from that of airplanes. Helicopter noise is detectable for about 30 seconds at 1,300 feet and is noisier but more short-term than other aircraft. The overall noise impact from the addition of helicopters to Alternative D-2 could be less than Alternative A, which does not rely on helicopters.

Alternative D – Summary of Impacts (CPAI and FFD) on Noise

The noise impacts for Alternative D are the same as those under Alternative.

Alternative D – Potential Mitigation Measures (CPAI and FFD) for Noise

No potential mitigation measures have been identified for Alternative D or Alternative D - FFD.