
TITLE	Application for Land Use Permits for Land within the Municipal Boundaries of Norman Wells, Fort Good Hope and Tulita
SECTION	8: Environmental and Resource Effects
SUBJECT	1: Introduction

PURPOSE

This section provides a regional description of the biophysical and human environment baseline setting, potential effects and proposed primary mitigation strategies associated with the project within the SSA. It applies to both Crown and private settlement lands as well as MACA land.

The information presented in this section is based on both historical literature and field surveys conducted for the project. Throughout this section reference is made to the "study area."

Study area refers to the area that was examined as part of the biophysical and heritage resource field programs for the project and generally refers to the lands located within 500 m of a proposed development. However, some studies did examine a slightly larger or smaller area, depending on their needs.

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BIOPHYSICAL ENVIRONMENT SETTING

Air Quality and Climate

This topic deals with the interrelated subjects of ambient air quality, air emissions, climate and meteorology.

Ambient air quality is affected by the concentration of airborne constituents such as aerosols or gases within the environment. Air emissions are characterized as releases to the atmosphere that might contribute to changes in air quality. These emissions can result from natural sources, that is, biogenic emissions, or human activities - anthropogenic emissions. Climate is the measure of long-term observations of key atmospheric variables, including temperature and precipitation.

[Table 8-1](#) shows temperature normals for two communities in the SSA (Fort Good Hope and Norman Wells). Average annual temperatures range from -7.8°C in Fort Good Hope to -6.0°C in Norman Wells. Temperature extremes might range from -55.6°C in the winter to 35.0°C in the summer.

Table 8-1: Temperature Normals for the Sahtu Settlement Area

Location	DJF ^a (°C)	MAM ^b (°C)	JJA ^c (°C)	SON ^d (°C)	Annual (°C)
Fort Good Hope	-29.1	-8.9	14.2	-7.2	-7.8
Norman Wells	-26.1	-6.6	14.9	-6.1	-6.0
NOTES: ^a DJF – December, January, February ^b MAM – March, April, May ^c JJA – June, July, August ^d SON – September, October, November					
SOURCE: Environment Canada (1982, 1993)					

[Table 8-2](#) shows normal annual precipitation levels for the two communities including both rainfall and the liquid equivalent for snow for the SSA. Total normal annual precipitation ranges from 281.9 mm in Fort Good Hope to 316.6 mm in Norman Wells.

Table 8-2: Precipitation Normals for the Sahtu Settlement Area

Parameter	Location	Normal Annual Total	Daily Normals			
			DJF ^a	MAM ^b	JJA ^c	SON ^d
Rainfall (mm)	Fort Good Hope	150.2	0.1	9.7	115.5	24.9
	Norman Wells	183.2	0.2	12.3	141.2	29.3
Snowfall (cm)	Fort Good Hope	131.6	46.4	32.2	0.8	52.2
	Norman Wells	148.9	57.9	37.2	1.3	52.5
Total precipitation (mm) ^{e,f}	Fort Good Hope	281.9	46.5	41.9	116.4	77.1
	Norman Wells	316.6	51.1	45.7	142.6	77.1
NOTES: ^a DJF – December, January, February ^b MAM – March, April, May ^c JJA – June, July, August ^d SON – September, October, November ^e Precipitation is the combined rainfall and snowfall (as liquid water equivalent). Data is taken from the official climate normals produced by Environment Canada (1982, 1993). In some cases, the precipitation does not appear to equal the sum of the reported rainfall and snowfall. ^f Snowfall is included in total precipitation as a liquid water equivalent in mm.						
SOURCE: Environment Canada (1982, 1993)						

Figure 8-1 provides a visual summary of the variability in hourly wind speed and direction observed at Norman Wells from 1997 through 2001. Winds at Norman Wells reflect the channelling effect of the Mackenzie River Valley in which the town is located, with a strong west-northwest and east-southeast component. The west-northwest component is predominant in all seasons. The southeast component is more dominant than the east-southeast component during the spring and summer. The reverse is true during the fall and winter.

The areas in which atmospheric processes act on air emissions affecting air quality are referred to as *airsheds*. An airshed represents the space in which air emissions interact and defines the limits over which air quality models might meaningfully predict potential changes in air quality. The SSA falls within the region designated as the central airshed. The central airshed is a 250 km by 375 km area that covers the northern part of the pipeline corridor, including the Little Chicago facility site and the Norman Wells compressor facility.

Available air quality information for the SSA, as measured at Norman Wells, indicates that ambient levels of sulphur dioxide (SO₂) and nitrogen dioxide (NO₂) are below existing ambient guidelines (GNWT Resources, RWED [now ENR] 2002; CCME 2000; Environment Canada 1981).

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Carbon monoxide (CO) in the environment typically results from partial or incomplete combustion. This compound is usually associated with vehicle exhausts. Because there are few combustion sources which could interact with project emissions, background CO levels were assumed to be near zero for the air quality assessment.

Fine particulate matter is considered in air quality assessment because of possible health effects associated with particles small enough to readily enter the lower respiratory tract, that is, the lungs and bronchi. Such particles typically have a mean diameter of less than 2.5 µm (micrometres) and are referred to as PM_{2.5}.

There is currently no ambient PM_{2.5} monitoring data available in the region. Although ambient PM_{2.5} levels might be affected by natural sources (e.g., forest fires) and windblown dust, most PM_{2.5} comes from combustion emissions. Because there are few combustion sources which could interact with project emissions, background PM_{2.5} levels were assumed to be effectively zero in the air quality assessment.

Volatile organic compounds (VOCs) come from either natural or human sources. Natural VOC sources include coniferous trees and decaying vegetation. Human sources include fugitive emissions and leaks from motor vehicles and oil and gas operations. Given the absence of human activity in the vicinity of the project, background VOC levels are expected to be low.

A field monitoring program completed near Norman Wells indicated background levels of ozone were relatively high. These elevated ozone readings are thought to result from the intrusion of stratospheric ozone from weather systems passing through the region.

Background potential acid input (PAI) results from long-range transport of acid-forming compounds from large industrial facilities located elsewhere in the northern hemisphere, which are then deposited by precipitation in the region. The Government of the Northwest Territories has operated a Canadian air and precipitation monitoring station at the Northwest Territories Power Corporation's Snare Rapids hydroelectric facility since 1989. Precipitation monitoring data from this site provided the background levels of sulphate and nitrate deposition, and therefore, of the PAI expected in the SSA.

[Table 8-3](#) summarizes background concentrations of the key air quality indicators within the SSA. Background concentrations were determined from a variety of sources.

Table 8-3: Baseline Air Conditions for the Sahtu Settlement Area

Parameter	SSA
Sulphur dioxide (SO ₂) ^a (µg/m ³)	0.5
Nitrogen dioxide (NO ₂) ^a (µg/m ³)	0.8
Carbon monoxide (CO) ^b (µg/m ³)	0.0
PM _{2.5} ^b (µg/m ³)	0.0
Benzene ^c (µg/m ³)	2.6
Total BTEX ^{c,d} (µg/m ³)	3.7
PAI ^e (kg/ha/yr)	0.03
Sulphate deposition ^e (kg/ha/yr)	0.96
Nitrate deposition ^e (kg/ha/yr)	0.62
Ozone(O ₃) ^{a,f} (µg/m ³)	45.7
NOTES: ^a Results are based on monitoring data from Norman Wells. ^b Assumed to be zero ^c Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and was converted to µg/m ³ assuming the molecular weight of benzene. ^d Results are based on the Summa canister data from Parsons Lake. ^e Results based on wet deposition monitoring data for Snare Rapids, Northwest Territories (Golder and Conor Pacific 1998). ^f Background ozone concentrations were not selected as a key indicator but are important in determining the quantity of NO _x emissions that are converted to NO ₂ in the atmosphere.	

Table 8-4 summarizes the current levels of emissions representing the contribution from local community activities, regional air and marine transportation and local industrial sources, particularly, power generation, within the SSA.

Table 8-4: Summary of Existing Daily Emissions in the Sahtu Settlement Area

Emissions ^a					
SO ₂ (t/d) ^b	NO _x (t/d) ^b	CO (t/d) ^b	PM _{2.5} (t/d) ^b	Benzene (t/d) ^b	BTEX (t/d) ^b
0.05	0.88	1.13	0.58	0.010	0.025
NOTES: ^a Calculations using published emission factors, population data and fuel information. ^b t/d – tonnes/day					

Table 8-5 shows the current national and territorial levels of GHG emissions and the project projections for 2010.

Table 8-5: National and Northwest Territories Greenhouse Gas Emissions

Reporting Year	GHG Emissions	
	Canada (kt/a of ECO ₂) ^{a,b,c}	Northwest Territories (kt/a of ECO ₂) ^{a,b,c}
1995	673,000 ^d	1,538 ^e
2000	730,000 ^d	1,607 ^e
2010 ^f	764,000 ^e	1,672 ^g
NOTES: ^a kt/a – kilotonnes/annum ^b ECO ₂ – equivalent carbon dioxide ^c ECO ₂ emissions were calculated using greenhouse potentials of one for CO ₂ , 21 for CH ₄ and 310 for N ₂ O (Environment Canada 2002). ^d Canada's Greenhouse Gas Inventory, 1990-2001 (Environment Canada 2003) ^e Canada's Emissions Outlook (NRC 1999) ^f Predictions of GHG emissions for 2010 assess current rate of growth, not including project emissions. ^g Northwest Territories Greenhouse Gas Strategy (GNWT RWED 2001)		

Noise

The acoustic environments of the project sites in the SSA are currently expected to be dominated by the sounds of nature, such as wind rustling through foliage and animal noises. Existing sound levels are expected to be low, in the range of 20-40 dBA (a quiet office or library typically has a noise level of 40 dBA). Sites near the Mackenzie Highway winter road will have higher ambient sound levels due to the presence of seasonal vehicle traffic nearby.

Baseline sound level surveys were conducted about 1 km from the proposed Norman Wells compressor station, about 5 km from the Norman Wells airport and about 1.5 km west of an existing Imperial Oil facility north of Norman Wells. The survey was conducted over 24 hours in the summer. The sound of helicopters and fixed-wing aircraft taking off and landing was occasionally heard during the survey. Major audible sounds were from:

- the Imperial Oil facility
- wind
- birds
- rain
- fixed-wing aircraft
- helicopters
- thunder
- insects

A low-frequency rumble was audible most of the night from 22:00 to 05:00. For short periods, aircraft caused sound levels to rise between 50 and 70 dBA.

Thunder caused one spike in the sound record, giving a 1-minute L_{eq} value of 58 dBA. The lowest hourly L_{eq} measured after data validation was 28 dBA. There were 11 occurrences of aircraft noise recorded during the survey.

Soils, Landforms and Permafrost

The project components covered by this application are found within the North and South Taiga Plains ecological zones (Ecological Stratification Working Group [ESWG] 1995). Most of the surficial material in the region was deposited during continental glaciations, and glacial or postglacial processes created many of the landforms. Moraine, organics, and glaciolacustrine deposits cover large parts of the SSA. Deposits that cover smaller areas include glaciofluvial, fluvial, colluvial, aeolian, bedrock and other deposits.

Moraine is composed of glacial till of variable thickness and is poorly-drained. Till commonly has high silt and clay content and contains a high proportion of ice or water. Organic deposits occur as fens and bogs that occupy depressions and low-lying areas in moraine plains. Thick units of glaciolacustrine sediments were deposited in glacial lakes following deglaciation and comprise fine-grained, ice-rich sediments that are prone to settlement when thawed. Glaciofluvial landforms such as eskers and kames were deposited by meltwater streams and are composed of sand and gravel.

Soils north of Fort Good Hope, consist mainly of Orthic Turbic Cryosols. The part of the SSA between Fort Good Hope and Tulita, consist of Orthic Turbic Cryosols and Gleysolic Turbic Cryosols. South of Tulita, the soils are dominated by Eutric Brunisols, Organic Cryosols and Gleysolic Static Cryosols. Soil groups found in the SSA are described in [Table 8-6](#).

Table 8-6: Soil Groups in the Sahtu Settlement Area

Soil Order	Description of Soil Order	Description of Soil Great Groups
Cryosol	Permafrost-affected soils might be associated with wetlands, tundra or taiga forest conditions. They are formed in either mineral or organic materials that have permafrost either within 1 m of the surface or within 2 m if the active layer of the soil profile has been strongly cryoturbated. Cryosolic soils have a mean annual temperature of $<0^{\circ}\text{C}$.	<ul style="list-style-type: none"> • Turbic Cryosols are mineral soils strongly affected by cryoturbation or frost churning that generates various forms of patterned ground. • Static Cryosols lack the frost churning process. • Organic Cryosols are the soils of peatlands underlain by permafrost.

Table 8-6: Soil Groups in the Sahtu Settlement Area (cont'd)

Soil Order	Description of Soil Order	Description of Soil Great Groups
Brunisol	Soils with horizons sufficiently developed to exclude them from the Regosolic Order but lacking the degrees and kinds of horizon development specified for soils of the other orders are classified as Brunisols.	<ul style="list-style-type: none"> Dystric Brunisols develop in acidic (pH <5.5) parent materials and the Orthic subgroup has no organic surface horizons (Ah or Ap <10 cm). These soils are most often found in noncarbonated parent materials. Eutric Brunisols develop in basic (pH >5.5) parent materials and the Orthic subgroup has no organic surface horizons (Ah or Ap <10 cm). These soils are most often found in carbonated parent materials.
Gleysol	Soils developed under wet conditions and permanent or periodic reduction. They are typically found in low-lying, poorly-drained locations or in areas with groundwater discharge.	<ul style="list-style-type: none"> Luvic Gleysols occur commonly on poorly-drained sites in association with Luvisolic soils and in depressions. They usually contain an eluviated surface horizon followed by an illuviated horizon. These horizons are not sufficiently developed for inclusion in the Luvisolic Order. Gleysols do not contain a thick organic horizon and also do not contain eluviated or illuviated horizons.
Organic	Soils developed primarily from organic material. Most are saturated for most of the year and occur in poorly and very poorly-drained depressions.	<ul style="list-style-type: none"> Fibrisols are composed dominantly of undecomposed fibric organic material. They are dominated by sphagnum moss in peat deposits. Mesisols are more decomposed than Fibrisols. They contain moderately decomposed organic material and are found in areas that favour greater rates of decomposition than areas with Fibrisols.

The SSA is characterized by discontinuous permafrost (see [Figure 8-2](#)). Permafrost exists in about 65 to 90% of the area North of Fort Good Hope. The amount of permafrost between Fort Good Hope and Tulita is about 35 to 65%. It is estimated that less than 40% of the area south of Tulita is permafrost.

The annual active layer in permafrost areas typically ranges between 0.5 to 1.5 m deep and varies depending on material textures, and local surface and temperature conditions. There is a general trend of increasing average temperature, that is, -5 to near 0°C, for shallow permafrost from north to south depending on location and local conditions.

Low ice contents are expected in well-drained, coarse-grained sediments above the local groundwater table. Ice-rich permafrost is more commonly associated with silt and clay deposits, such as fine-textured moraine, glaciolacustrine and lacustrine sediments, and organic soils. The ice content might be very high if the deposits are located in poorly-drained areas.

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Vegetation

A vegetation classification system was developed for the overall project study area. The project study area is divided into four broad ecological zones that reflect climatic variation and vegetation diversity (see [Figure 8-3](#)). From north to south, the Tundra, Transition Forest, North Taiga Plains (see “A” and “B” as indicated in [Figure 8-3](#)) and South Taiga Plains ecological zones differ from one another in climate, geomorphology, terrain, soil, permafrost and vegetation species composition and growth patterns. These zones were developed based on such studies as The Terrestrial Ecozones of Canada (ESWG 1995), Forest Regions of Canada (Rowe 1972) and Ecosites of Northern Alberta (Beckingham and Archibald 1996).

Each of the ecological zones is further organized into mapped vegetation types, using vegetation canopy cover and a structural or physiognomic approach based on such studies as Reid (1974), Reid and Janz (1974) and Beckingham and Archibald (1996).

The North Taiga Plains Ecological Zone is a zone of stunted forest that extends south from the Travaillant River to the Great Bear River. Extensive fires have burned large areas near the Thunder River, Fort Good Hope and Norman Wells. North of Fort Good Hope are large areas of uplands, characterized by open scrubby forest of black and white spruce, and large burned areas with regenerating mixedwoods. Between Fort Good Hope and the Franklin Mountains there are large, flat, glaciolacustrine plains covered by a patchwork of open black spruce forest and level, poorly-drained areas dominated by Labrador tea, sphagnum and reindeer lichen. The slopes of the Franklin Mountains support mixedwood forests of white spruce, black spruce and Alaska birch. Another area of large burns occurs south of Norman Wells down to the Great Bear River.

There are fourteen vegetation types in the North Taiga Plains Ecological Zone ([Table 8-7](#)), five of which are of concern:

- riparian willow
- white spruce/stair-step moss, found on riparian floodplains
- black spruce/cloudberry – lichen bogs
- bog rosemary/cotton-grass/peat moss, found in collapse scars within bogs
- common juniper/common bearberry, found on dry south or west facing slopes

There are four vegetation communities of concern in the North Taiga Plains Ecological Zone in the study area:

- spring communities
- marshes
- grassland communities
- tall forest stands

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Seven rare plant species were found during project surveys in the North Taiga Plains Ecological Zone:

- weak sedge (*Carex laxa*)
- red goosefoot (*Chenopodium rubrum*)
- poverty oat grass (*Danthonia spicata*)
- prairie gentian (*Gentiana affinis*)
- moor rush (*Juncus stygius* ssp. *americanus*)
- tuberous water-horehound (*Lycopus uniflorus*)
- dwarf clubrush (*Scirpus rollandii*)

The South Taiga Plains Ecological Zone contains the most diverse and productive vegetation types along the pipeline corridor. The zone extends south from the Great Bear River. In the uplands, there are closed forests of aspen, white spruce, Alaska birch and jack pine. In the more level, poorly-drained terrain, there are extensive forests of open to scattered black spruce and tamarack.

Seventeen mappable vegetation types were described in the South Taiga Plains (Table 8-7), six of which are of concern:

- riparian willow
- riparian willow – red-osier dogwood on riparian floodplains
- white spruce/stair-step moss, found on riparian floodplains
- black spruce/cloudberry – lichen bogs
- leatherleaf/bog rosemary – peat moss, found in the collapse scars within bogs
- graminoid fens, including patterned fens

There are four vegetation communities of concern in the South Taiga Plains Ecological Zone in the study area:

- vegetation growing on rock outcrops
- vegetation growing around springs
- vegetation growing around alkaline lakes
- tall forest stands

Two rare plant species were found during project surveys in the South Taiga Plains Ecological Zone in the SSA:

- smooth wild rose (*Rosa blanda*)
- fragrant goldenrod (*Solidago graminifolia*)

Table 8-7: Vegetation Types in the Sahtu Settlement Area

Ecological Zone	Vegetation Type
North Taiga Plains	Common juniper/common bearberry
	White spruce/stair-step moss
	White spruce – black spruce/shrubby cinquefoil
	Upland white spruce – Alaska birch
	Riparian willow
	Riparian willow – grey alder
	Black spruce – tamarack
	Black spruce – Labrador tea/mountain cranberry
	Black spruce/cloudberry – lichen bog
	Bog rosemary/cotton-grass-peat moss
	Graminoid wetland
	Ground birch/water sedge wetland
	Regenerating upland white spruce – Alaska birch
	Regenerating black spruce – Labrador tea/mountain cranberry
South Taiga Plains	Upland jack pine
	Upland trembling aspen/prickly rose
	Upland white spruce-trembling aspen – jack pine
	White spruce/stair-step moss
	Black spruce – white spruce/stair-step moss
	Alaska birch – white spruce
	Riparian willow
	Riparian willow – red-osier dogwood
	Riparian balsam poplar/green alder
	Black spruce – tamarack
	Black spruce – Labrador tea/mountain cranberry
	Regenerating black spruce – Labrador tea/mountain cranberry
	Black spruce/cloudberry – lichen bog
	Leatherleaf/bog rosemary – peat moss
	Graminoid fen
	Shrub fen
Treed fen	

Wildlife

Terrestrial Mammals

The SSA supports a diversity of wildlife species. The SSA is home to about 39 species of terrestrial mammals, including ungulates, large carnivores, furbearers, and small mammals. Characteristic species include moose, woodland and barren-ground caribou, grizzly bear, black bear, grey wolf, red fox, American beaver, and

muskrat. In addition to these species, several species with special status designation occur in the SSA, as outlined in [Table 8-8](#).

Species with regulatory status designation are those that either the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or the Government of the Northwest Territories (GNWT) ranks as sensitive to disturbance. They also include species listed under the *Species at Risk Act* (SARA) and the IUCN-The World Conservation Union (IUCN) *Red List of Threatened Species*.

Table 8-8: Terrestrial Mammal Species with Special Status That Occur in the Sahtu Settlement Area

Species	Status ^a			
	RWED ^b	COSEWIC ^c	SARA ^d	IUCN Red List ^e
Woodland caribou (boreal population)	Sensitive	Threatened	Schedule 1 – threatened	Lower risk – least concern
Grizzly bear (northwestern population)	Sensitive	Special concern	Schedule 3 – special concern ^f	Lower risk – least concern
Wolverine	Secure	Special concern	Schedule 3 – special concern ^f	Vulnerable
Fisher	May be at risk	-	-	Lower risk – least concern
Northern flying squirrel	Sensitive	-	-	Lower risk – least concern

NOTES:
^aA hyphen indicates no status has been assigned for that species.
^bRWED – Resources, Wildlife and Economic Development (known as ENR since April 1, 2005)
^cCOSEWIC – Committee on the Status of Endangered Wildlife in Canada
^dSARA – *Species at Risk Act*
^eIUCN – The World Conservation Union
^fSARA status is to be reassigned (i.e., potentially added to Schedule 1) pending results of public consultation, stakeholder consultation and final Ministerial approval.

Most of the SSA is dominated by low-lying black spruce forests. Although these forests generally support a relatively low diversity of mammal species, they provide important forage for both woodland and barren-ground caribou.

Important terrain features in the SSA include glaciofluvial landforms, that is, eskers, river valleys, and cliffs. These areas represent a small part of the overall landscape, but provide important denning areas, foraging areas and movement corridors for wildlife. For example, gravel till deposits are often used as denning areas by foxes and wolves.

River valleys, such as the Mackenzie River valley and its main tributaries, are considered important wildlife habitat in the SSA and often provide critical winter refugia for wildlife, especially when surrounding uplands have been extensively

burnt. Riparian forest and shrub habitats within valleys provide food, protective cover and thermal cover for wildlife. As a result, these areas typically support a higher diversity of wildlife than surrounding regions. Valleys also act as important movement corridors for a number of wildlife species.

Because of the many terrestrial mammal species that occur in the SSA, several key terrestrial species were selected to assist with the assessment of project specific effects. Key terrestrial mammal species in the SSA are:

- barren-ground caribou
- woodland caribou
- moose
- grizzly bear
- marten
- lynx
- beaver

Species were selected because of their regulatory status, ecological importance, socio-economic importance and/or resource management concern.

Barren-ground caribou are an important food source for communities in the SSA. During the fall, a part of the Bluenose West caribou herd migrates into the study area. Caribou move southwards in October and November, and depart in April and May. Winter track count and spring pellet group surveys indicated that caribou primarily occur in sedge-peat moss, riparian shrub, burned forest and black spruce – tamarack forest habitats, where forage availability, such as lichen, is likely highest. Black spruce forests are widespread in the SSA, suggesting that winter foraging habitat is not currently limited. The winter distribution of caribou in the SSA likely varies from year-to-year and depends on food availability and snow cover. Similarly, caribou populations exhibit year to year variability.

Woodland caribou occur in the SSA throughout the year and thus provide an important food resource for local communities. Traditional knowledge indicates that fewer woodland caribou occur in the Mackenzie Valley in the Tulita/Norman Wells area than in the past (Olsen et al. 2001). Little is known about the distribution and movement patterns of woodland caribou in the SSA. They often associate in small herds and migrate between preferred winter and summer ranges. Woodland caribou typically occur in black spruce forests and peatlands, which offer high concentrations of ground lichens, their preferred forage (Bradshaw et al. 1995; Stuart-Smith et al. 1997; Rettie and Messier 2000). Black spruce forests are widespread in the SSA, suggesting that foraging habitat is not currently limited. Caribou might avoid habitats used by moose, that is, upland deciduous and mixedwood forests to avoid predation by wolves (Bergerud and Ballard 1988; Seip 1992; Rettie 1998).

Moose are resident throughout the SSA and, like caribou, are an important food resource for local communities. Some of the best moose habitat in the Mackenzie Valley region occurs in the SSA. Moose densities in the valley have ranged from 0.04 to 0.27 moose/km², with the highest density between Little Chicago and Point Separation. Important wintering areas include islands and floodplains of the Mackenzie River, riparian habitats associated with watercourses and regenerating burns (Brackett et al. 1985; Jingfors et al. 1987; Latour 1992; Benn 1999). These areas provide abundant browse species (that is willow, balsam poplar, and red-osier dogwood). Valleys of tributaries also serve as travel routes for moose moving between inland summer range and winter range in the Mackenzie River region.

Grizzly bears are wide-ranging, opportunistic omnivores that use a variety of habitats through the seasons. Important habitats for grizzly bears include spring and fall foraging areas, and winter denning areas. During spring, grizzly bears forage primarily on *Hedysarum* roots, herbaceous vegetation and overwintered berries. During the fall, *Hedysarum* roots and berries are considered important food resources. Bear dens are often found in glaciofluvial landforms such as eskers, drumlins and raised beaches (areas frequently used for borrow material). Other important bear-denning habitats are south-facing embankments above lakes and watercourses. Overall, the area traversed by the pipeline corridor in the SSA is characterized as relatively poor quality grizzly bear habitat because of low relief and the presence of homogenous stands of black spruce forest. However, some pockets of higher quality habitat occur in the region, such as near Fort Good Hope. Mountainous areas elsewhere in the SSA provide high quality denning and foraging habitat for grizzly bears.

Marten, lynx and beaver are important furbearer species in the SSA. All three species are considered widespread and common throughout the region, although densities of lynx and, to a lesser extent, marten, decline periodically in response to cyclical prey densities. Marten in the Mackenzie Valley region likely select habitats occupied by their principal prey species, which include red-backed vole, microtine rodents, and snowshoe hares (Poole and Graf 1996). As a result, marten occur in a wide variety of habitat types, including old growth upland and riparian coniferous forests, open black spruce bogs, and shrubby regenerating habitats that provide abundant coarse woody debris. Natal denning sites are also considered a critical habitat requirement of marten. Important denning habitats include riparian old-growth forests that are characterized by large woody structures, that is, trees, snags, and logs or deadfall (Buskirk and Ruggiero 1994).

Similar to marten, lynx habitat use is closely related to the distribution and abundance of the snowshoe hare, its major prey species, which is found primarily in areas with dense shrub understory. Forest cover types with heavy deadfall are important for denning females (Chetkiewicz and Marshal 1998).

Beaver inhabit aquatic and riparian habitats along slow-flowing watercourses, marshes, lakes and ponds (Banfield 1974). They require a permanent water supply with relatively stable water levels where woody vegetation and fine-grained soil are readily available for dam construction and forage (Slough and Sadlier 1977; Boyce 1981; Dennington and Johnson 1974). The many small lakes and waterways through the SSA provide moderate to good habitat for beaver.

Birds

About 150 bird species occur in the SSA, of which 123 species occur as breeders and the remainder (mostly shorebirds, waterbirds and several raptors) as migrants. Characteristic species that migrate through the region include snow geese and tundra swans, while breeding species include several species of waterfowl, raptors, shorebirds and passerines, such as warblers, thrushes, sparrow and finches. Only 18 species occur as year-round residents, these are:

- northern goshawk
- ruffed grouse
- spruce grouse
- willow ptarmigan
- sharp-tailed grouse
- great horned owl
- northern hawk-owl
- great gray owl
- boreal owl
- downy woodpecker
- hairy woodpecker
- three-toed woodpecker
- black-backed woodpecker
- gray jay
- common raven
- boreal chickadee
- white-winged crossbill, and
- common redpoll

Several bird species with special status also occur in the SSA, as outlined in [Table 8-9](#). This list includes species that pass through the region as migrants on their way to northern breeding grounds.

Table 8-9: Bird Species at Risk with Special Status That Occur in the Sahtu Settlement Area

Species	Status ^a		
	RWED ^b	COSEWIC ^c	SARA ^d
Peregrine falcon (<i>anatum</i> subspecies)	At risk	Threatened	Schedule 1 – threatened
Peregrine falcon (<i>tundrius</i> subspecies)	May be at risk	Special concern	Schedule 3 – special concern
Short-eared owl	Sensitive	Special concern	Schedule 3 – special concern
Northern pintail	Sensitive	-	-
Long-tailed duck	Sensitive	-	-
Lesser scaup	Sensitive	-	-
Surf scoter	Sensitive	-	-
White-winged scoter	Sensitive	-	-
Golden eagle	Sensitive	-	-
Rock ptarmigan	Sensitive	-	-
Black-bellied plover	Sensitive	-	-
American golden plover	Sensitive	-	-
Lesser yellowlegs	Sensitive	-	-
Whimbrel	Sensitive	-	-
Semi-palmated sandpiper	Sensitive	-	-
Least sandpiper	Sensitive	-	-
Buff-breasted sandpiper	Sensitive	-	-
Long-billed dowitcher	Sensitive	-	-
Common snipe	Sensitive	-	-
Red-necked phalarope	Sensitive	-	-
Northern flicker	Sensitive	-	-
Bank swallow	Sensitive	-	-
Barn swallow	Sensitive	-	-
Boreal chickadee	Sensitive	-	-
American pipit	Sensitive	-	-
Blackpoll warbler	Sensitive	-	-
American tree sparrow	Sensitive	-	-

Table 8-9: Bird Species at Risk with Special Status That Occur in the Sahtu Settlement Area (cont'd)

Species	Status ^a		
	RWED ^b	COSEWIC ^c	SARA ^d
White-throated sparrow	Sensitive	-	-
Harris's sparrow	Sensitive	-	-
Rusty blackbird	Sensitive	-	-

NOTES:
^aA hyphen indicates no status has been assigned for that species.
^bRWED – Resources, Wildlife and Economic Development (known as ENR since April 1, 2005)
^cCOSEWIC – Committee on the Status of Endangered Wildlife in Canada
^dSARA – *Species at Risk Act*

The wetlands, lakes and watercourses within the SSA provide important nesting and migrating habitats for waterfowl and shorebirds. The Mackenzie River supports many migrating waterfowl in the spring, including snow geese and tundra swans. Upland habitats in the SSA, such as forests, shrublands and grasslands, support nesting hawks (that is sharp-shinned hawk and northern goshawk), owls (that is northern hawk owl and great gray owl), upland game birds (that is spruce grouse and ruffed grouse), woodpeckers (that is three-toed woodpecker and northern flicker), and various passerines (that is warblers and sparrows). Bogs and fens within the SSA are important nesting habitats for several birds, including sandhill crane and lesser yellowlegs. Raptors in the region tend to nest near wetlands, lakes, sandbars, watercourses and other permanent bodies of water where prey is abundant. They use cliffs or large trees near waterbodies for nesting, and open, remote areas for foraging.

Because of the large number of bird species that occur and migrate through the SSA, several species were selected to assist with the assessment of project specific effects. These included snow goose, scaup, peregrine falcon, lesser yellowlegs, Arctic tern and boreal chickadee. Species were selected because of:

- their regulatory status
- ecological importance
- socio-economic importance and/or
- resource management concern.

Snow geese occur as a migrant in the SSA. Concentrations of geese have been reported during spring along the Mackenzie River. The area between Little Chicago and Fort Good Hope, as well as near Norman Wells, is considered an important staging area for waterfowl (Alexander et al. 1991). Snow geese generally move through the SSA during May.

Lesser scaup occur as breeding birds and migrants in the SSA. Peak northward migration into the region occurs in mid-to-late May, while peak fall migration occurs in mid-to-late September. Spring arrival time depends on the availability of open water, and thus varies annually. Scaup breed on small boreal lakes and are widely distributed in the SSA away from the Mackenzie River. Nests are usually built within 1 m of water. Brood rearing and moulting occurs on small to large lakes that support abundant emergent vegetation.

The *anatum* subspecies of the peregrine falcon nests throughout the Mackenzie Valley in the SSA, while the *tundrius* subspecies is considered a migrant. There are more than 50 records of peregrine nests in the SSA, with most occurring along the Mackenzie River.

Peregrine falcons arrive on their breeding grounds in late April or May, and depart in August through early October. Nests are built on a cliff ledge, typically within a few kilometres of foraging areas. Hunting occurs in open areas, such as mudflats, lakes, shorelines and wetlands.

Lesser yellowlegs nest throughout the SSA. Birds arrive on their breeding grounds in early May, and depart in August. Lesser yellowlegs breed in open boreal forest, often adjacent to shallow wetlands, bogs or lakes. Nesting habitat is thus widespread in the SSA.

Arctic terns nest in colonies in the Mackenzie Delta and possibly along the Mackenzie River. They are considered common migrants in the SSA. Terns were observed during spring surveys in late May along the pipeline corridor and the Mackenzie River. Nesting habitat includes sandy beaches, shingle beaches, hummocks, gravel ridges and islands in lakes. Foraging occurs on lakes and watercourses within 10 km of the nest site.

Boreal chickadees are resident in the Mackenzie Valley throughout the year. Nesting likely occurs in May and June within variable-aged spruce-dominated forests, mixedwood forests and, to a lesser extent, deciduous forests. Mature woodlands are preferred. Boreal chickadees nest in tree cavities which they excavate in snags or, secondarily, in live coniferous and deciduous trees.

Amphibians

The diversity of amphibians in the SSA is low. Only two species of amphibians, the boreal chorus frog and wood frog, occur in the region. The boreal chorus frog is considered '*sensitive*' by RWED (now ENR) (GNWT 2004). Amphibians as a group were considered along the pipeline corridor because of their sensitivity to environmental change.

The boreal chorus frog inhabits grassy pools, lakes, marshes and almost any other body of water, permanent or temporary, shallow or deep. They will breed in almost any fishless pond with at least 10 cm of water, including splash pools,

roadside ditches, flooded fields, and beaver ponds. Boreal chorus frogs overwinter in relatively dry sites by burrowing under decaying stumps or litter.

Wood frogs breed in ponds and marshes. In summer, they inhabit damp woodlands or pond margins, and in winter they live under debris on the forest floor.

Little information is available on the distribution and abundance of amphibians in the SSA, including the pipeline corridor. Amphibian habitat, that is, bogs, lakes, marshes, and pools is widespread in the SSA; however, other factors, such as climatic conditions, might limit the distribution of species throughout the region.

Hydrology

The Mackenzie River basin contains the longest drainage system in Canada, flowing about 4,200 km from the Finlay River headwaters in British Columbia to the Beaufort Sea. The basin drains almost 1,800,000 km², an area representing one-fifth of Canada's total area. The drainage basin is the second largest in North America and the sixth largest in the world. The two largest tributaries to the Mackenzie River, in terms of drainage basin area, are the Liard River (about 277,000 km²) and Great Bear River (about 155,000 km²).

The SSA is located within the central hydrologic region. This hydrologic region is dominated by the Franklin Mountains drainage basin. Flow varies considerably because of the steep topography and high groundwater contribution in the area. Watercourses typically have higher peak flow per unit area than in other hydrologic regions, and many flow through the winter. Peak flow tends to occur in late May and early June from snowmelt, but might also occur in late summer or fall after intense rainfall. Watercourse crossings for the proposed pipeline are in low-lying areas adjacent to the Mackenzie River. The topography becomes much steeper eastward to the mountains.

Watercourses within the SSA are grouped into four classes according to their hydrologic characteristics; Large River Channels, Active I Channels, Active II Channels, and Vegetated Channels. Large River Channels and Active I Channels flow all year. Active II Channels are intermittent and might flow at various times of the year, but are likely dry or frozen to the bed of the watercourse during the winter. Vegetated Channels flow infrequently and for short periods during snowmelt or after rainfall. Seventy seven percent of potential crossing sites in the SSA were found to be vegetated drainages with poorly defined flow paths or with drainage dispersed through shrubs or trees. The remaining watercourses are Active II, Active I and Large River Channels (see [Table 8-10](#)). Active I and Large River Channels including the Tieda River, Loon River, Hare Indian (Rabbit-skin) River, Donnelly River, Great Bear River and Big Smith River, might freeze only partly to the bottom in winter.

There are six watercourses with drainage basins close to or greater than 1,000 km² that are crossed by the proposed pipeline within the SSA. These are the Tieda River (959 km²), Big Smith River (963 km²), Donnelly River (1,133 km²), Loon River (3,600 km²), Hare Indian (Rabbitskin) River (23,190 km²) and Great Bear River (156,420 km²). Table 8-10 provides a summary of watercourse types crossed by the project in the SSA.

Table 8-10: Summary of Watercourse Types within the Sahtu Settlement Area

Watercourse Type	Watercourse Class ^a	Number of Sites	Percentage of Watercourses
Lakes	N/A ^b	4	N/A ^b
Watercourse	Large River	6	2.5
	Active I	25	9.5
	Active II	25	11
	Vegetated	202	77
Total		262	100
NOTES: ^a Large River and Active I classes refer to watercourses that have perennial flow or are partially frozen to bottom in winter, Active II class refers to watercourses that are dry or completely frozen to the bottom in winter and Vegetated indicates ephemeral vegetated drainages or dispersed overland flow. ^b N/A – not applicable			

Groundwater

The SSA is situated in a zone of extensive discontinuous permafrost in the North, with an area of intermediate discontinuous permafrost in the south. The prevalence and depth of permafrost plays a role in the distribution of groundwater. In areas of continuous permafrost (over 90% of exposed land area underlain by permafrost) (Heginbottom 2000), groundwater flow is minimal. Groundwater lying beneath the permafrost layer has little interaction with surface flows.

In the northern half of the SSA, the pipeline corridor crosses the Anderson Plain. In the southern half, the pipeline traverses both the Mackenzie Plain and the Franklin Mountains physiographic regions. In the Anderson Plain, in the zone of extensive discontinuous permafrost, groundwater contributions to watercourse flow are seasonal, with no or negligible contributions made in winter. Permafrost varies from extensive discontinuous to intermediate discontinuous and largely controls groundwater movement in the Mackenzie Plain. However, karst processes are dominant in the Franklin Mountains, and these also influence the adjacent Mackenzie Plain, by maintaining all-year flow in spring-fed watercourses. Karst features include sinkholes and perennial springs, some with

high discharge rates. The karst landscapes of the Franklin Mountains and associated lowlands make up an important hydrogeological region in the zone of extensive discontinuous and discontinuous permafrost.

Water Quality

An overview of water quality in the SSA is provided in this topic and is largely based on data collected between 2002 and 2004.

pH and Dissolved Oxygen

In early summer, following the spring freshet, field-measured pH values were below the minimum aquatic life guideline value of 6.5 (see [Table 8-11](#)). The remaining summer and fall pH values were usually above 6.5, with occasional values above the maximum drinking water guideline value of 8.5 and one value above the maximum aquatic life guideline of 9.0. Although winter data is sparse, winter pH values were often above 6.5, with occasional values below the minimum aquatic life and drinking water guidelines.

Table 8-11: Sahtu Settlement Area Seasonal Water Quality (2002 to 2004)

Season	Statistic	2002 to 2004 Field Parameters ^a				
		Dissolved Oxygen ^b (mg/L)	pH	Conductance (µS/cm)	Temperature (°C)	Turbidity (NTU)
Winter ^c	Median	10.9	7.3	866	1.6	3
	Min.	0.1^C	6.2^{C,W}	214	0.0	0
	Max.	14.2	8.0	3,150	3.5	56
Summer ^d	Median	11.4	8.0	390	9.8	4
	Min.	6.1^C	5.0^{C,W}	120	1.4	0
	Max.	14.0	9.5^{C,W}	3,870	23.0	68
Fall ^e	Median	-	8.0	457	2.2	8
	Min.	-	6.8	151	-0.2	4
	Max.	-	8.6^W	1,580	6.0	81

NOTES:

^aBoldface values exceed water quality guideline levels.

^bA hyphen indicates data not available.

^cWinter – October to April

^dSummer – June to August

^eFall – September

^CConcentration higher than the relevant chronic aquatic life guideline or beyond the recommended dissolved oxygen or pH range.

^WConcentration higher than the relevant drinking water guideline or beyond the recommended pH range.

Waterbodies were well-oxygenated during summer and fall, with dissolved oxygen concentrations mostly above the minimum aquatic life guideline of 6.5 mg/L.

Colour, Turbidity and Total Suspended Solids

Concentrations of colour, turbidity and total suspended solids (TSS) are directly related to the discharge regime of watercourses. Turbidity levels were mostly low during winter, summer and fall, with occasional moderate values observed in some watercourses. Total suspended solids levels were mostly low during summer, with high values observed in some watercourses (see [Table 8-12](#)). Water was usually moderately to highly coloured during summer, with values above the drinking water guideline in most waterbodies.

Total Dissolved Solids, Conductance and Alkalinity

Watercourses in the SSA usually have major ion concentrations that are highest during winter and that decline over the open-water period, as indicated by total dissolved solids (TDS) and conductance levels. Total dissolved solids and conductance levels were variable among waterbodies, ranging from moderately low to very high, which is likely a result of the influence of groundwater springs at some locations. Field-measured conductance values in watercourses were mostly moderate in summer and fall (see [Table 8-11](#)). Median TDS and conductance values in lakes were moderately low in summer (see [Table 8-12](#)). Bicarbonate, calcium and sulphate were usually the most abundant major ions in watercourses and lakes. Alkalinity values indicated that all waterbodies were well buffered.

Nutrients

Waterbodies in the SSA have variable nutrient levels because of the local physical and geologic variations. Median total Kjeldahl nitrogen (TKN) levels were moderate in watercourses and high in lakes. Total phosphorus concentrations were indicative of oligotrophic, that is, nutrient-poor, conditions in most watercourses. In lakes, total phosphorus levels ranged from levels indicative of mesotrophic, that is, containing moderate nutrient levels, to eutrophic, that is, nutrient-rich conditions. Most phosphorus was in the particulate form and, as such, is not readily available for biological uptake. Therefore, productivity levels, chlorophyll *a* concentrations, do not usually reflect nutrient levels. Chlorophyll *a* concentrations indicated nutrient-poor conditions in lakes.

Table 8-12: Sahtu Settlement Area Water Quality (2002 to 2004)

Parameter	Units	Summer ^a							
		Watercourses			Lakes				
		Median or Value	Min. ^b	Max. ^b	n ^c	Median or Value	Min. ^b	Max. ^b	n ^c
Conventional Parameters									
Colour	TCU ^d	30 ^w	5	80 ^w	16	55 ^w	30 ^w	80 ^w	8
Conductance	µS/cm	532	220	2530	16	295	185	2100	8
Dissolved organic carbon	mg/L	8	3	16	16	20	10	42	8
Hardness	mg/L	225	71	660	16	141	77	350	8
pH	N/A ^e	8.2	7.6	8.4	16	7.7	7.5	9.5 ^{C,w}	8
Total alkalinity	mg/L	137	63	309	16	112	87	212	8
Total dissolved solids	mg/L	321	115	1570 ^w	16	200	108	1210 ^w	8
Total organic carbon	mg/L	10	4	17	16	16	11	33	8
Total suspended solids	mg/L	6	3	62	16	<2	<2	5	8
Major Ions									
Bicarbonate	mg/L	167	77	358	16	137	87	259	8
Calcium	mg/L	56	20	169	16	35	15	112	8
Carbonate	mg/L	<5	<1	12	16	<1	<1	12	8
Chloride	mg/L	6	0.2	625 ^w	16	1	0.4	543 ^w	8
Magnesium	mg/L	17	1	58	16	13	8	18	8
Potassium	mg/L	1	1	5	16	1	0.4	5	8
Sodium	mg/L	7	<1	447 ^w	16	4	2	368 ^w	8
Sulphate	mg/L	69	6	434	16	30	10	271	8
Sulphide	mg/L	0.004	<0.003	0.02	16	0.007	<0.003	0.023	8

Table 8-12: Sahtu Settlement Area Water Quality (2002 to 2004) (cont'd)

Parameter	Units	Summer ^a							
		Watercourses			Lakes				
		Median or Value	Min. ^b	Max. ^b	n ^c	Median or Value	Min. ^b	Max. ^b	n ^c
Nutrients and Chlorophyll a									
Nitrate + nitrite	mg/L	<0.1	<0.1	0.1	15	<0.1	-	-	1
Nitrate	mg/L	<0.05	-	-	1	<0.05	<0.05	<0.05	7
Nitrite	mg/L	<0.05	-	-	1	<0.05	<0.05	<0.05	7
Nitrogen – ammonia	mg/L	<0.05	<0.05	<0.1	16	<0.1	<0.05	<0.1	8
Nitrogen – Kjeldahl	mg/L	0.5	<0.2	3.2	16	1.1	0.6	1.5	8
Nitrogen – total	mg/L	0.5	<0.2	3.2	16	1.1	0.6	1.5	8
Phosphorus – total	mg/L	0.005	0.001	0.025	16	0.03	0.017	0.04	8
Phosphorus – dissolved	mg/L	0.002	<0.001	<0.02	16	<0.02	0.011	<0.02	8
Chlorophyll a	µg/L	0.538	1	5	4	1.363	0.355	4.95	7
General Organics									
Total phenolics	mg/L	<0.001	<0.001	<0.002	4	<0.002	<0.002	0.029	7
Total recoverable hydrocarbons	mg/L	0.925	<0.1	2.4	4	<0.1	<0.1	<0.1	7
Total Metals									
Aluminum	mg/L	0.2 ^{C,W}	<0.02	1.87 ^{C,W}	15	0.029	<0.02	0.05	4
Antimony	mg/L	0.0007	<0.0004	0.001	15	<0.0001	<0.0001	0.0012	4
Arsenic	mg/L	<0.0004	<0.0004	0.0034	15	0.001	0.0005	0.0013	4
Barium	mg/L	0.0652	0.0279	0.175	15	0.06	0.0273	0.066	4
Beryllium	mg/L	<0.001	<0.001	<0.001	15	<0.0005	<0.0005	<0.001	4
Boron	mg/L	<0.02	<0.02	0.04	15	0.02	<0.01	0.05	4
Cadmium ^f	mg/L	<0.0002 ^{D>C}	0.000012	0.0008 ^C	16	0.0000121	0.000007	0.0007 ^C	8

Table 8-12: Sahtu Settlement Area Water Quality (2002 to 2004) (cont'd)

Parameter	Units	Summer ^a							
		Watercourses			Lakes				
		Median or Value	Min. ^b	Max. ^b	n ^c	Median or Value	Min. ^b	Max. ^b	n ^c
Total Metals (cont'd)									
Chromium	mg/L	<0.0008	<0.0008	0.0023^C	15	<0.0009	<0.0008	<0.0009	4
Cobalt	mg/L	0.0002	0.0001	0.001	15	0.0003	0.0001	0.0007	4
Copper	mg/L	0.001	<0.001	0.01^C	15	<0.001	<0.001	0.001	4
Iron	mg/L	0.15	0.03	1.65^{C,W}	15	0.16	0.07	0.55^{C,W}	4
Lead	mg/L	0.0002	<0.0001	0.0047	15	<0.0001	<0.0001	0.001	4
Lithium	mg/L	<0.006	<0.006	0.135	15	<0.006	<0.005	0.015	4
Manganese	mg/L	0.008	0.001	0.043	15	0.0068	0.003	0.0256	4
Mercury ^f	mg/L	<0.0000006	<0.0000006	0.000012	16	<0.0000006	<0.0000006	0.000012	8
Molybdenum	mg/L	0.0008	0.0003	0.0045	15	0.0008	<0.0005	0.0015	4
Nickel	mg/L	0.0009	<0.0002	0.012	15	0.0013	0.0007	0.0083	4
Selenium	mg/L	<0.0004	<0.0004	0.001	15	<0.0008	<0.0004	0.0021^C	4
Silver ^f	mg/L	0.0000087	0.0000024	0.0000252	16	0.0000039	0.00000186	0.0000202	8
Strontium	mg/L	0.543	0.0795	1.39	15	0.4345	0.0892	1.75	4
Thallium	mg/L	<0.0001	<0.0001	0.0001	15	<0.00005	<0.00005	0.0005	4
Titanium	mg/L	<0.005	<0.005	0.041	15	0.0035	<0.0008	0.0067	4
Uranium	mg/L	0.0005	<0.0001	0.0053	15	0.0006	0.00006	0.0007	4
Vanadium	mg/L	0.0006	<0.0002	0.0055	15	0.0003	<0.0001	0.0006	4
Zinc	mg/L	0.009	0.003	0.034^C	15	0.003	<0.002	0.008	4
Dissolved Metals									
Aluminum	mg/L	<0.01	<0.01	0.05	15	<0.01	<0.01	<0.01	4

Table 8-12: Sahtu Settlement Area Water Quality (2002 to 2004) (cont'd)

Parameter	Units	Summer ^a									
		Watercourses					Lakes				
		Median or Value	Min. ^b	Max. ^b	n ^c	Median or Value	Min. ^b	Max. ^b	n ^c		
Dissolved Metals (cont'd)											
Antimony	mg/L	0.0005	<0.0004	0.0007	15	0.0003	<0.0001	0.0004	4		
Arsenic	mg/L	<0.0004	<0.0004	0.0029	15	0.0005	<0.0004	0.0007	4		
Barium	mg/L	0.0485	0.0264	0.174	15	0.0475	0.0259	0.058	4		
Beryllium	mg/L	<0.0005	<0.0005	<0.0005	15	<0.0001	<0.0001	<0.0005	4		
Boron	mg/L	0.018	0.006	0.051	15	0.02	0.008	0.057	4		
Cadmium ^f	mg/L	<0.0001	<0.0001	0.0001	15	<0.00005	<0.00005	<0.0001	4		
Chromium	mg/L	<0.0004	<0.0004	0.0077	15	0.0011	<0.0004	0.0054	4		
Cobalt	mg/L	0.0001	<0.0001	0.0004	15	0.00114	<0.0001	0.00614	4		
Copper	mg/L	0.001	<0.0006	0.0059	15	<0.001	0.0006	<0.001	4		
Iron	mg/L	0.02	<0.005	0.202	15	0.089	0.026	0.25	4		
Lead	mg/L	0.0002	<0.0001	0.0003	15	0.00006	<0.00005	0.0002	4		
Lithium	mg/L	0.0043	0.0016	0.137	15	0.0045	0.0015	0.015	4		
Manganese	mg/L	0.003	<0.001	0.04	15	0.0025	0.0006	0.011	4		
Mercury ^f	mg/L	<0.0001	<0.0001	0.0001	15	<0.0002	<0.0001	<0.0002	4		
Molybdenum	mg/L	0.0007	0.0003	0.0043	15	0.0005	0.0002	0.0016	4		
Nickel	mg/L	0.0008	0.0002	0.0111	15	0.0024	0.0007	0.0085	4		
Selenium	mg/L	<0.0004	<0.0004	0.0013	15	<0.0008	<0.0004	<0.0008	4		
Silver ^f	mg/L	<0.0002	<0.0002	0.0004	15	<0.00005	<0.00005	<0.0002	4		
Strontium	mg/L	0.527	0.0814	1.36	15	0.331	0.0922	0.943	4		

Table 8-12: Sahtu Settlement Area Water Quality (2002 to 2004) (cont'd)

Parameter	Units	Summer ^a							
		Watercourses			Lakes				
		Median or Value	Min. ^b	Max. ^b	n ^c	Median or Value	Min. ^b	Max. ^b	n ^c
Dissolved Metals (cont'd)									
Thallium	mg/L	<0.00005	<0.00005	0.00006	15	<0.00003	<0.00002	<0.00005	4
Titanium	mg/L	0.0004	<0.0003	0.0019	15	0.0008	<0.0003	0.0042	4
Uranium	mg/L	0.0004	<0.0001	0.0055	15	0.00021	<0.00005	0.00067	
Vanadium	mg/L	0.0002	<0.0001	0.0047	15	0.0013	<0.0005	0.0019	4
Zinc	mg/L	0.005	<0.002	0.009	15	0.003	<0.002	0.006	4

NOTES:
^aBoldface values exceed water quality guideline levels.
^bA hyphen indicates data not available.
^cn – number of samples
^dTCU – true colour unit
^eN/A – not applicable
^fUltra-low metal analysis was conducted on total mercury and silver. The same level of precision is not available for dissolved mercury and silver.
^gConcentration higher than the relevant chronic aquatic life guideline
^hConcentration higher than the relevant drinking water guideline
ⁱ>C Analytical detection limit is higher than the relevant chronic aquatic life guideline (C).

Metals

Most metals were present at levels below aquatic life (CCME 1999) and drinking water guidelines (Health Canada 2003) in watercourses, with the exception of aluminum and iron. Other metals that were occasionally present at levels above aquatic life guidelines in watercourses included total cadmium, chromium, copper and zinc. Naturally high metals levels are often associated with high suspended solids levels.

Total iron levels were occasionally above the aquatic life and drinking water guidelines in lakes. Total cadmium and selenium levels were also occasionally above the aquatic life guideline.

Fish and Fish Habitat

The Mackenzie River and its tributaries within the SSA support both diadromous and resident fish species. This system, including tributaries and lakes, supports 31 species of fish (Table 8-13). Of these, 15 species are harvested for food, commercially or for local consumption, or are used for recreation. None are listed by COSEWIC or the federal *Species at Risk Act* (SARA) as endangered, threatened or of special concern. Table 8-13 lists the fish species potentially present in waterbodies within the SSA.

Table 8-13: Fish Species Potentially Present in the Sahtu Settlement Area

Family	Common Name	Scientific Name	Spawning Period
Carp and Minnows – Cyprinidae	Emerald shiner	<i>Notropis atherinoides</i> (Rafinesque)	Spring and early summer
	Finescale dace	<i>Phoxinus neogaeus</i> (Cope)	Spring and mid-summer
	Flathead chub	<i>Platygobio gracilis</i> (Richardson)	Spring and mid-summer
	Lake chub	<i>Couesius plumbeus</i> (Agassiz)	Spring and mid-summer
	Longnose dace	<i>Rhinichthys cataractae</i> (Valenciennes)	Spring and mid-summer
	Spottail shiner	<i>Notropis hudsonius</i> (Clinton)	Spring and early summer
Cods – Gadidae	Burbot	<i>Lota lota</i> (Linnaeus)	Winter
Lampreys – Petromyzontidae	Arctic lamprey ^c	<i>Lampetra japonica</i> (Martens)	Spring and early summer
Mooneyes – Hiodontidae	Goldeye	<i>Hiodon alosoides</i> (Rafinesque)	Spring and early summer
Perches – Percidae	Walleye ^a	<i>Stizostedion vitreum</i> (Mitchill)	Spring and early summer
Pikes – Esocidae	Northern pike ^a	<i>Esox lucius</i> (Linnaeus)	Spring

Table 8-13: Fish Species Potentially Present in the Sahtu Settlement Area (cont'd)

Family	Common Name	Scientific Name	Spawning Period
Sculpins – Cottidae	Slimy sculpin	<i>Cottus cognatus</i> (Richardons)	Spring
	Spoonhead sculpin	<i>Cottus ricei</i> (Nelson)	Late summer and early fall
Smelts – Osmeridae	Pond smelt ^a	<i>Hypomesus olidus</i> (Pallas)	Summer
	Rainbow smelt ^{a,c}	<i>Osmerus mordax</i> (Mitchill)	Spring
Sticklebacks – Gasterosteidae	Ninespine stickleback ^c	<i>Pungitius pungitius</i> (Linnaeus)	Spring and early summer
Suckers – Catostomidae	Longnose sucker	<i>Catostomus catostomus</i> (Forster)	Spring
	White sucker	<i>Catostomus commersoni</i> (Lacépède)	Spring
Trouts – Salmonidae	Arctic cisco ^{a,d}	<i>Coregonus autumnalis</i> (Pallas)	Fall
	Arctic grayling ^a	<i>Thymallus arcticus</i> (Pallas)	Spring
	Broad whitefish ^{a,c}	<i>Coregonus nasus</i> (Pallas)	Fall
	Bull trout ^a	<i>Salvelinus confluentus</i> (Suckley)	Fall
	Chum Salmon ^{a,d}	<i>Oncorhynchus keta</i> (Walbaum)	Fall and early winter
	Inconnu ^{a,c}	<i>Stenodus leucihthys</i> (Güldenstadt)	Fall
	Lake herring/Cisco ^a	<i>Coregonus artedii</i> (Lesueur)	Fall and early winter
	Lake trout ^a	<i>Salvelinus namaycush</i> (Walbaum)	Fall
	Lake whitefish ^{a,c}	<i>Coregonus clupeaformis</i> (Mitchill)	Fall
	Least cisco ^a	<i>Coregonus sardinla</i> (Valenciennes)	Fall
	Mountain whitefish ^a	<i>Prosopium williamsoni</i> (Girard)	Fall
	Round whitefish ^a	<i>Prosopium cylindraceum</i> (Pallas)	Fall and early winter
Trout-Perches – Percopsidae	Trout-perch	<i>Percopsis omiscomaycus</i> (Walbaum)	
NOTES: ^a Harvested commercially, recreationally, or for food ^b Marine or brackish water species ^c Diadromous and freshwater resident ^d Diadromous			

Twelve of the 31 species spawn in the fall or winter. Fall spawners include all of the salmonid species except Arctic grayling. Burbot is the only species the spawns in the winter. Fall spawning generally occurs in the larger watercourses with perennial flow. The smaller tributaries with ephemeral or intermittent flow that would be dry or frozen to the bottom in the winter are not used by fall spawning species. Perennial flow conditions are necessary to allow egg survival and

incubation over the winter months. Spring spawning species also spawn in watercourses with perennial flow. In addition, spring spawners will also spawn in intermittent and ephemeral watercourses that flow long enough for egg incubation and fry emergence to occur.

Watercourses within the SSA are grouped into four classes according to their hydrologic characteristics: Large River Channels, Active I Channels, Active II Channels, and Vegetated Channels. Large River Channels and Active I Channels flow all year and might provide habitat for the life stages of many species. Active II Channels are intermittent and might flow at various times of the year, but are likely dry or frozen to the bed of the watercourse during the winter. These watercourses might provide suitable fish habitat when they are flowing and might provide spawning and nursery habitat for spring spawning species, for example, northern pike and Arctic grayling, but are unlikely to provide holding, feeding or overwintering habitat for adult fish. Vegetated Channels flow infrequently and for short periods during snowmelt or after rainfall. Consequently, Vegetated Channels are not likely to provide habitat for most fish species.

The proposed pipeline route crosses 262 watercourses within the SSA. Of these 77% (202) are classified as Vegetated Channels, 25 are Active II Channel and 25 are Active I Channels. The remaining 6 watercourses are Large River Channels and include the Tieda River, Loon River, Hare Indian (Rabbit Skin) River, Donnelly River, Great Bear River and Big Smith River. Four small lakes are also crossed.

In the northern part of the SSA, most of the watercourses that enter the Mackenzie River from the east originate on the Ramparts Plateau. Any watercourses that have an active channel are characterized by low channel slopes and gravel and cobble substrates. Watercourses in the central part of the SSA originate along the western slopes of the Franklin Mountains. The terrain is steep, resulting in higher peak flow than in other regions. Local groundwater conditions influence the winter flow conditions, with springs originating at the base of the Franklin Mountains, particularly in the Norman Range area, resulting in perennial conditions for many of the large and small watercourses.

In the southern part of the SSA the Great Bear River drains the largest area, originating at Great Bear Lake. Farther south, many of the watercourses originate along the western slopes of the McConnell Range of the Franklin Mountains.

BIOPHYSICAL ENVIRONMENT EFFECTS AND MITIGATION

This topic identifies potential effects of the proposed project on the regional biophysical setting in the SSA. It includes potential measures to mitigate development concerns associated with the project. The effects of the project on the biophysical environment have been broken down by biophysical discipline for the different site activities. For each biophysical discipline, a description of the potential effects is provided. At the end of each of these descriptions a table is

provided that lists the primary mitigation strategies for each of the potential effects. While effect descriptions include consideration of effects during both construction and operations activities, the majority of effects will occur during construction.

Air Quality

This description addresses the potential project effects on air quality and GHG emissions in the SSA and summarizes the primary mitigation strategies that will be implemented to reduce these effects.

Summary of Effects

Potential effects on air quality in the SSA include the following:

- increased ambient concentrations of emissions, including SO₂, NO₂, NO_x, CO, PM_{2.5}, VOCs and BTEX
- increased acid deposition
- increased dust deposition
- increased greenhouse gas emissions

Increased Ambient Concentrations of Emissions

The effects of air emissions during construction were determined to be small compared with the emissions during peak operations. Construction camps are potential sources of air emissions from power generation, space heating and from the incinerators used to incinerate nonhazardous combustible wastes. Air effects from these sources will be limited to the immediate vicinity of the camps. Construction traffic will be a potential source of air emissions that will have an intermittent and temporary affect on air quality in the immediate vicinity of roads. Given that traffic will not be stationary but will be travelling along the roadways, it is unlikely that these emissions will have any measurable effect on ambient air quality. Any changes in air quality because of traffic will be small compared with the effects expected near the stationary facilities during peak operating conditions.

The primary source of project emissions in the SSA will be the continuous operation of emission-producing equipment at the Little Chicago facility site and the Norman Wells compressor station during the operations phase. These figures represent the likely emissions following the implementation of mitigation measures. During peak operations, the majority of air emissions will occur in the vicinity of the two compressor stations. During the life of the project, there might be brief periods when it will be necessary to release gas to the atmosphere as a result of facility upsets and routine maintenance. There is also the potential for small volumes of gases, known as fugitive emissions, to be released from valves

and fittings during project operations. Fugitive emissions are usually restricted to older operations and are expected to be very small given the modern design and configuration of this project, fugitive emissions were not quantified in the air assessment. Since ground-level concentrations of SO₂, NO₂, NO_x, CO, PM_{2.5} and selected VOCs are all below applicable federal and territorial guideline levels in the SSA, no detectable effects are expected.

Increased Acid Input

Emissions of SO₂ and NO_x from SSA operations have the potential to react in the atmosphere to form acid compounds that could affect the environment when deposited on soils, vegetation or waterbodies. Potential increase in acid deposition because of the project have been evaluated by determining the expected sulphate and nitrate deposition, and from that, area PAI.

Table 8-14 summarizes predicted PAI values associated with SSA emissions. Since the PAI levels predicted over the study area are below threshold for the most sensitive ecosystems, no detectable effects are expected due to PAI.

Table 8-14: Potential Acid Input Predictions in the Sahtu Settlement Area

Area	Parameter	Results ^a
Little Chicago facility site	Maximum potential acid input (PAI) (keq/ha/a)	2.21
	Area PAI (keq/ha/a) ^b	0.007
	Maximum sulphate deposition (kg/ha/a)	0.40
	Maximum nitrate deposition (kg/ha/a)	136.26
	Area with PAI >0.17 keq/ha/a ^c (ha)	45
	Area with PAI >0.25 keq/ha/a ^d (ha)	18
Norman Wells compressor station	Maximum PAI (keq/ha/a)	1.33
	Area PAI (keq/ha/a) ^b	0.008
	Maximum sulphate deposition (kg/ha/a)	0.26
	Maximum nitrate deposition (kg/ha/a)	82.12
	Area with PAI >0.17 keq/ha/a ^c (ha)	25
	Area with PAI >0.25 keq/ha/a ^d (ha)	12
<p>NOTES:</p> <p>^aThe predictions in the table include the effects of combined emissions from project sources in the central airshed.</p> <p>^bArea PAI represents integrated PAI levels over the entire 40,000 ha study area, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude.</p> <p>^c0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems as defined by CASA.</p> <p>^d0.25 keq/ha/a represents the critical load value for sensitive ecosystems.</p>		

Increased Dust Deposition

Increased dust deposition, will be caused by:

- facilities and rights-of-way construction
- extraction of borrow materials used during construction
- vehicle movement along unpaved roadways

Dust deposition will be a localized effect, as most of the dust particles will be deposited quickly and near their sources.

Increased Greenhouse Gas Emissions

Facility operations, project infrastructure and associated traffic will all contribute to GHG emissions, however, the project construction phase contribution to GHG emissions will be small and short term.

GHG emissions in the SSA will primarily come from the operation of the Little Chicago facility site and the Norman Wells compressor station. [Table 8-15](#) shows annual predicted GHG emissions in the SSA.

Table 8-15: Greenhouse Gas Emissions in the Sahtu Settlement Area

Area	Activity	Emissions			
		CO ₂ (kt/a)	CH ₄ ^a (kt/a)	N ₂ O ^a (kt/a)	ECO ₂ ^{b,c} (kt/a)
Little Chicago facility site	Compression	87.28	0.01	0	88.60
	Power generation	4.17	0.05	0	5.88
	Process equipment	13.08	0	0	13.16
	Total	104.53	0.05	0	107.64
Norman Wells compressor station	Compression	87.28	0.01	0	88.60
	Power generation	4.17	0.05	0	5.88
	Process equipment	13.08	0.00	0	13.16
	Total ^d	104.53	0.05	0.01	107.65

NOTES:
^aZero signifies values below the kt/a limit.
^bECO₂ – equivalent carbon dioxide.
^cECO₂ emissions were calculated using greenhouse potentials of one for carbon dioxide (CO₂), 21 for methane (CH₄) and 310 for nitrous oxide (N₂O) (Environment Canada 2002).
^dNumbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Although the operation of the Little Chicago facility site and Norman Wells compressor station will result in a noticeable increase in GHG emissions in the Northwest Territories (about 13.4% based on 2000 GHG emission levels), the

percentage increase on a national level will be very low (about 0.3% based on 2000 GHG emission levels).

Summary of Primary Mitigation Strategies – Air Quality

Table 8-16 provides a summary of the primary mitigation strategies related to potential effects on air quality.

Table 8-16: Air Quality Mitigation Strategies

Potential Effect	Primary Mitigation Strategies
Increased ambient air concentrations of emissions	<ul style="list-style-type: none"> • Use equipment that meets with relevant standards including Northwest Territories regulations, CCME standards and Alberta standards (where regulations do not exist in the Northwest Territories). This might include the use of low NO_x equipment where commercially available. • Consider efficiency in equipment selection. • Apply best management practices to reduce fuel use. • Avoid idling vehicles except under extremely cold conditions.
Increased acid deposition during operations	<ul style="list-style-type: none"> • Use equipment that meets with relevant standards including Northwest Territories regulations, CCME standards and Alberta standards (where regulations do not exist in the Northwest Territories). This might include the use of low NO_x equipment where commercially available. • Consider efficiency in equipment selection.
Increased dust deposition during construction and operations	<ul style="list-style-type: none"> • Apply best site management practices for dust suppression to avoid community effects.
Increased greenhouse gas emissions	<ul style="list-style-type: none"> • Use equipment that meets with relevant standards including Northwest Territories regulations, CCME standards and Alberta standards (where regulations do not exist in the Northwest Territories). • Consider efficiency in equipment selection. • Apply best management practices to reduce fuel use. • Avoid idling vehicles except under extremely cold conditions.

Noise

This description addresses the potential effects of project noise in the SSA and summarizes the primary mitigation strategies to reduce these effects.

Summary of Effects

Potential effects of noise in the SSA include:

- increase in intermittent noise levels
- increase in continuous noise levels

Intermittent Noise

Intermittent noise will be generated by construction activity at work sites. Noise sources will include portable generator sets, and earthmoving and other equipment that might be on site for extended periods, although seasonally and less than three years at most sites.

Noise will also be created from the use of infrastructure. Noise caused by infrastructure would be from the following project-related sources:

- road traffic, barge landings and traffic, air traffic, airstrips and helipads
- borrow sites
- construction camps, stockpile sites, communication centres and fuel storage sites

Most infrastructure noise will be intermittent, involving extended periods of quiet followed by short-term, audible noise levels, such as an airplane overflight or landing. However, infrastructure noise will occur only during construction and in many cases seasonally.

Construction noise will be centred at the Little Chicago and Norman Wells facilities and the pipeline right-of-way. Pipeline construction will be intermittent and transient, as construction progresses, and therefore will only affect a given area for a short period. Transportation noise impacts from, for example, aircraft overflights, winter road traffic and barge landings will be short in duration and intermittent.

During operations, the testing or use of emergency generator sets or the venting of gas would cause an intermittent increase in noise levels at the two compressor stations. These occurrences are expected to be uncommon and limited in duration.

Continuous Noise

Operations noise will last many years compared with the short duration of construction activities. Noise caused by operations will be continuous sound, which is defined as a consistent noise level from constantly operating machinery. According to EUB Noise Directive ID 99-8 and EUB Guide 38, with the exception of intermittent noise, excessive sound generation is not allowed for remote facilities, and new facilities planned for remote areas should be designed to meet a target sound level of 40 dBA L_{eq} at 1.5 km. This standard has also been endorsed by the GNWT.

Operations in the SSA will raise sound levels in the vicinity of the Little Chicago facility site and Norman Wells compressor station. Noise caused by operations is continuous sound, from constantly operating machinery. Models were used to

predict sound levels at various distances up to 1.5 km from the facilities fence line based on normal operations.

The Little Chicago facility site and Norman Wells compressor station include:

- pipeline compressor buildings with associated equipment
- compressor suction and discharge pipes
- compressor discharge aerial cooler fans
- a utility building with associated equipment
- a power generator building

The noise modelling included industry standard noise mitigation measures.

Table 8-17 shows the predicted maximum levels of noise from normal operations from both sites.

With the exception of intermittent noise, the effects of noise during operations at the compressor stations are expected to be limited, as sound levels at a distance of 1.5 km from the site will be less than 40 dBA.

Some infrastructure noise might be continuous, such as noise from an active construction camp. However, infrastructure noise will occur only during construction and in many cases seasonally.

Table 8-17: Predicted Maximum Noise Levels at 1.5 km, Normal Operations – Little Chicago Facility Site and Norman Wells Compressor Station

Location	Season	Predicted Maximum Noise Level (dBA) ^a	Noise Guideline Limit (dBA)
Little Chicago facility site	Summer	38	40
Little Chicago facility site	Winter	37	40
Norman Wells compressor station	Summer	38	40
Norman Wells compressor station	Winter	38	40
NOTES: ^a Operations noise is continuous. Therefore, average maximum sound exposure values are the same, that is, $L_{eq}(1)$, L_{eq} day, L_{eq} night and $L_{eq}(24)$.			

Summary of Primary Mitigation Strategies – Noise

Table 8-18 outlines the primary mitigation strategies related to project effects on noise levels.

Table 8-18: Noise Mitigation Strategies

Potential Effect	Primary Mitigation Strategies
Increase in noise levels	Design facility to meet EUB Guide 38 noise guideline levels for remote sites, that is, 40 dBA at 1.5 km. Implement noise controls, as necessary, which might include silencers, pipe insulation and upgraded building shells. In sensitive areas, schedule discretionary activities to avoid noise effects.

Soils, Landforms and Permafrost

This description addresses the potential effects on soils, landforms and permafrost in the SSA and summarizes the primary mitigation strategies to reduce these effects. The proposed project components within the SSA fall into the North Taiga Plains A and B Ecological Zone and the South Taiga Plains A Ecological Zone ([Figure 8-3](#))

Summary of Effects

Effects of the project on soils, landforms and permafrost in the SSA might include:

- effects on ground stability
 - drainage disruption potential from thaw settlement
 - drainage disruption or damming potential from frost bulb growth or surface heave
 - mass movement and slope instability
 - erosion from water or wind
- alteration of uncommon landforms from project activities
- effects on soil quality
 - changes in soil drainage
 - soil loss
 - changes in soil physical and chemical characteristics that is, structure, texture, depth of active layer, organic matter content, mineral content, chemical composition, soil reaction and nutrient regime

Effects on Ground Stability

Drainage Disruption Potential from Thaw Settlement

Thaw subsidence and pond formation might result from changes in thermal equilibrium. Construction activities will disturb surface layers, existing thermal regime and drainage conditions. These disturbances might promote some thawing of the permafrost. As thawing progresses, the surface settles and water might migrate into depressions resulting in pond formation. The amount of thaw settlement depends on ground texture and ice content.

Effects will be reduced by ensuring drainage is not blocked or restricted by the project. In addition, locations prone to potential pond formation will be monitored to ensure any effects are identified early. When the area is experiencing problematic thaw settlement, ponds might be backfilled with borrow material to reduce effects.

Drainage Disruption or Damming Potential from Frost Bulb Growth or Surface Heave

The two general mechanisms by which frost effects might disrupt drainage are:

- heave of the ground surface and disruption of surface drainage, potentially leading to erosion or slope instability
- freezing of the ground around buried pipelines, that is, frost bulb formation, and disruption (damming) of subsurface water flow

Both mechanisms are most likely to occur on cross slopes. Based on project design specifications, portions of the pipeline will be below freezing for some or all of the year.

South of Little Chicago, pipe temperature varies with location and time of year, but is close to zero over most of the route. On this basis, it was concluded that in discontinuous permafrost conditions, there are locations where pipe temperature will be below freezing and the right-of-way would be prone to drainage disruption effects from frost bulb growth or ground surface heave.

A frost bulb refers to an area of frozen ground, which was previously unfrozen, around the operating pipeline. The presence of a frost bulb might change soil drainage because ponds might form upslope of the pipe, slope instability might result or drainage pathways might be redirected. Damming of surface or subsurface water flow might be caused by formation of a frost bulb around buried pipeline.

Where frost bulbs form or surface heave occurs in unfrozen ground, the potential for disrupted drainage depends mainly on soil texture, existing drainage conditions and ground slope. Poorly drained flat areas are either fine-textured

materials that would not be affected by a change in ground surface, or saturated coarse-textured materials where a frost bulb would not likely affect groundwater flow. Well-drained flat areas are usually coarse-textured soils that do not cause frost heaving. Frost bulbs will likely not affect well-drained steep slopes. Poorly drained steep slopes are typically fine-textured materials that shed water by surface drainage. In these locations, the amount of ground surface heave would have to be high to alter drainage conditions. These areas are not considered susceptible to disrupted drainage from frost bulb or heave effects.

Conditions most susceptible to altered drainage from frost effects include gentle to moderately steep cross slopes combined with moderate to poor drainage conditions. Such conditions have medium-textured soils, and existing drainage conditions could be affected by a change in ground surface level or development of a frost bulb.

The frost bulbs will begin to thaw after the flow of cold gas is shut off at the end of operations. The bulbs will gradually reduce in size and the surface and groundwater flow characteristics will approach conditions that existed before project construction and operations.

Mass Movement

Mass movement is classified as flows or slides. Flows have a fluid character, whereas slides have a rigid character, with downslope movement mostly as intact blocks. Grading, excavation or removal of surface vegetation might trigger mass movement.

Slope instability, or slides, might be caused by physical, thermal or drainage changes, and is often the result of a combination of the mechanisms. Slope instability might be retrogressive, or might expand and maintain ongoing and periodic movement patterns once initiated.

Soil flows are common in the North Taiga Plains Ecological Zone and the South Taiga Plains Ecological Zone. The mechanism differs from slide movement discussed previously. Flows occur where the toe of the slope does not have material to resist movement, and in ice-rich soils. Such conditions are usual for a flatter slope with a steep face in the lower slope, as would occur at the edge of lakes, watercourses or depressions.

Field observations and experience suggest that soil flows occur near watercourse valleys, lakes and depressions when slope angles are less than 20%.

To help limit the potential effects from slides or flows, grading and surface disturbance will be reduced as much as practical on slopes that might be prone to these occurrences. Thaw stable fill will also be used where necessary to prevent these effects. Areas that might be susceptible to flows or slides will be monitored

during project operations to ensure any effects are identified early and will be dealt with appropriately.

Erosion from Water or Wind

The four main factors that influence surface erosion are:

- precipitation
- soil texture
- vegetation
- ground surface topography

Water erosion is likely to take place where project activities intersect with landforms that have slopes and material texture susceptible to erosion. Wind erosion might occur when vegetation is removed from aeolian deposits.

Within the SSA there are locations with slopes and soil textures that might be susceptible to erosion following construction. Where these areas are identified, slopes will be stabilized to reduce the potential for erosion. In addition, the pipeline will be monitored during operations to ensure any erosion-related effects are identified early and will be dealt with appropriately. It is likely that water erosion will require mitigation during operations.

Some soils prone to wind erosion might be present along the pipeline right-of-way or along access roads, however, these areas are expected to be very limited in the SSA. Areas used by the project that are prone to wind erosion will be stabilized as required to reduce potential effects.

Alteration of Uncommon Landforms

Uncommon landforms in the SSA, including patterned ground, glaciofluvial and aeolian landforms, occur in the SSA. Although the majority of the pipeline does not encounter uncommon landforms, some uncommon landforms might be affected during construction of the project. Operations activities might affect uncommon landforms in the SSA, but much less than during construction, as very little new land disturbance will take place.

Road alignments and pad areas could affect uncommon landforms such as glaciofluvial deposits. Aeolian deposits could also be affected because they tend to be elevated areas with good drainage.

Construction effects on uncommon landforms are likely to be localized. Pipeline operations and maintenance activities might have limited impact on uncommon landforms, but much less than during construction. Overall, these effects are expected to be limited. Decommissioning and abandonment activities are not expected to affect uncommon landforms.

The development of borrow sites will affect uncommon landforms. During operations, borrow material will be required for maintaining roads, barge landing sites and other sites. The effects will be similar to those during construction but the magnitude will be much lower.

Effects on Soil Quality

Changes in Soil Drainage

Changes in soil drainage could affect soil quality over extensive distances along the pipeline, at infrastructure sites and at borrow sites. Increased moisture in a dry soil is likely to increase the capability of a soil to support plants and soil biota, with increased plant cover and numbers of species. However, soil that is initially in a moist to wet condition could become saturated or completely flooded, adversely affecting soil quality. In situations where surface water is diverted or channelled, soil could become drier, reducing plant cover and increasing erosion risk, especially in sloped terrain.

The development of poorly-drained areas might result in wetter soils in the summer and possibly higher ice contents at shallow depths. Soils located at the crest or upper slope positions in the landscape could benefit from a deeper active layer, which would also provide a deeper rooting zone.

Changes in soil drainage are expected to result from right-of-way and facility preparation activities including clearing, levelling, grading and ditching. Infrastructure components such as pads and all-weather roads, borrow material excavations and winter roads also have the potential to cause changes in soil drainage.

Environmental effects causing diversion or damming of surface water could cause changes in soil drainage along the pipeline right-of-way. Changes in surface drainage patterns could increase soil moisture content and might lead to some ponding in certain locations. Effects on soil drainage will be most noticeable in the years immediately following construction and are closely related to the effects of permafrost degradation and subsidence.

Some lands along the pipeline right-of-way in the SSA might be susceptible to thaw settlement following construction. If thaw-settlement processes have occurred, ponds might increase in size during operations. Drainage will be re-established when the area is experiencing problematic thaw settlement.

The flow of gas during pipeline operations might result in frost bulbs forming around the pipe in unfrozen ground, which could cause changes in soil drainage in some locations, as discussed previously. Drainage is expected to stabilize within 30 years following decommissioning and abandonment. The effects of changes in soil drainage during operations are likely to be limited.

Within the SSA, the pipeline will traverse areas that have blanket slope drainage. Changes in soil drainage could occur where the pipeline is built on cross slopes with blanket slope drainage. Locations with potential for blanket slope drainage will be monitored following construction for changes in soil drainage that might result in adverse effects.

In unstable soils, where borrow material might be used as backfill to replace the soil in the trench, soil drainage conditions might be changed because the composition of the trench material has been altered.

Facility pads have the potential to change soil drainage through diversion or damming of surface water flow, but the small area required reduces the potential impact on soil drainage.

Winter roads and all-weather roads will be constructed across diverse terrain. During spring runoff, temporary changes in soil drainage might occur as a result.

Borrow site development will potentially affect soil drainage through damming or by contributing to thaw settlement and subsequent ponding. Infrastructure will typically be located on higher ground in well-drained areas where the potential for changes in soil drainage because of thaw settlement is low.

Soil Loss

The primary cause of soil loss will be burial of native soils under gravel pads. Other possible causes are mass movement of landforms caused by unstable slopes, and transfer of soil material from one location to another. Constructing all-weather roads and pads for infrastructure sites and facilities are the main project activities that will cause burial of soils. Loss initiated by grading is another pathway whereby soils on slopes are removed and transferred or buried. Another pathway begins with pipeline effects on slope stability. Unstable slope conditions might lead to land slips and slides, with soils moving downslope and burying or mixing with underlying materials, or submerging in waterbodies.

A loss of soil cover will occur where pads are constructed on thaw-unstable terrain, as surface material will not be removed at these locations before covering with borrow material. Surface material will also not be removed along all-weather roads before placement of the fill. In the SSA, some pads are expected to be constructed on thaw-unstable terrain and therefore soil loss will occur. However, due to the very localized occurrence of soil loss, the overall effects are expected to be limited.

Where loose surface material is removed and replaced, soil moisture conditions are expected to be somewhat limiting because the substrate is coarse-textured and relatively well-drained. However, it is expected that the resulting developed soil will approach the quality of the soil present before construction. Due to the localized occurrence of soil loss, the overall effects are expected to be limited.

Changes in Soil Physical and Chemical Characteristics

Small-scale leaks and spills could lead to an effect on soil chemistry, however, the implementation of spill contingency and management plans will likely prevent any measurable effects from occurring. The potential effects on soil physical and chemical characteristics during decommissioning and abandonment will be limited to minor disturbances of soil surfaces by machinery used to remove above-ground structures. The combined effects on soil physical and chemical properties are expected to result in a <5.0% change in soil quality.

Soil admixing could occur during removal of the loose surface material and the consequent replacement of that material. Surface materials are most likely to be removed and replaced at borrow sites. Following their use, borrow sites will be regraded and the soil will be replaced. This will help limit the effects of removal at borrow sites. Some road dust could originate from all-weather roads.

A combination of soil mixing, compaction and rutting could occur during construction and use of winter roads. These processes could occur if winter roads are prepared before complete freeze-up, or if they continue to be used once thaw begins. Ensuring that vehicles only travel on roads that are adequately frozen will prevent these effects.

Minor disturbance of soil surfaces by machinery used to remove infrastructure components is expected during decommissioning and abandonment. The combined effects on soil quality are expected to result in a <5% change in soil quality.

Changes in soil physical and chemical characteristics are likely to be limited and localized. Mitigation is frequently successful for effects on soil characteristics such as might occur from erosion and inadvertent leaks and spills. Other effects such as mixing and changes in chemical properties because of air emissions have minor effects on soil quality. Monitoring programs will be established to confirm the effectiveness of mitigation measures.

Summary of Primary Mitigation Strategies – Soils, Landforms and Permafrost

[Table 8-19](#) provides a summary of the primary mitigation strategies related to potential effects on soils, landforms and permafrost.

Table 8-19: Mitigation Strategies for Soils, Landforms and Permafrost

Potential Effect	Primary Mitigation Strategies
Altered drainage, erosion or slope instability caused by pipeline right-of-way and access road clearing and grading	<ul style="list-style-type: none"> • Conduct most pipeline construction activities during winter. • Reduce grading and surface disturbance especially on steep slopes and thaw-unstable ground. • Design for thaw settlement.
Altered drainage, erosion and slope instability caused by pipeline ditching and backfilling	<ul style="list-style-type: none"> • Use thaw-stable backfill as required. • Reclaim, stabilize and armour slopes and banks as necessary. • Place an insulating cover on cut surfaces in thaw-unstable ground, where required.
Altered drainage and erosion caused by thaw settlement along the pipeline ditch	<ul style="list-style-type: none"> • Place additional fill material in areas experiencing problematic thaw settlement. • Use thaw-stable backfill as required.
Loss of uncommon landforms along the pipeline right-of-way	<ul style="list-style-type: none"> • Avoid disturbing uncommon landforms, where practical.
Altered drainage and ground instability caused by access road construction	<ul style="list-style-type: none"> • Install borrow material on access roads, as appropriate. • Use geotextile to limit loss of borrow material. • Construct winter roads, where required.
Altered drainage and ground instability caused by facilities construction	<ul style="list-style-type: none"> • Provide sufficient insulation for pads to protect permafrost. • Install drainage ditches around compressor stations, where required.
Changes in soil drainage, physical and chemical properties caused by clearing and grading of pipeline and access road rights-of-way	<ul style="list-style-type: none"> • Conduct most pipeline construction activities during the winter. • Use winter roads. • Reduce surface grading in thaw-unstable terrain, where practical. • Place an insulating cover on cut surfaces in thaw-unstable terrain, where required. • Incorporate drainage culverts in all-weather roads, as required.
Loss of soil on slopes caused by pipeline and access road construction	<ul style="list-style-type: none"> • Reduce surface grading where practical. • Remove loose surface material where grading is required on thaw-stable ground and replace after completing activity. • Reclaim, stabilize and armour slopes and banks as necessary.

Table 8-19: Mitigation Strategies for Soils, Landforms and Permafrost (cont'd)

Potential Effect	Primary Mitigation Strategies
Loss of soil at borrow sites during development	<ul style="list-style-type: none"> Remove loose surface material on thaw-stable ground and replace during reclamation. Store loose surface material away from subsoil in thaw-stable ground, where practical.
Changes in soil drainage along ditch after backfilling and settlement	<ul style="list-style-type: none"> Use thaw-stable backfill in the trench as required. Place additional fill materials in areas experiencing problematic thaw settlement along the pipeline rights-of-way.
Changes in soil physical and chemical properties caused by inadvertent leaks and spills	<ul style="list-style-type: none"> Implement management practices, contingency plans and emergency response plans to prevent and address leaks and spills.

Vegetation

This description addresses the potential effects on vegetation in the SSA and summarizes the primary mitigation strategies to reduce these effects.

Summary of Effects

Potential effects of the project on vegetation in the SSA might include:

- removal, burial, mechanical damage or alteration of vegetation
- change in thermal regime
- changes in drainage patterns
- changes to and loss of substrates
- potential introduction of persistent or invasive non-native species (weeds)
- establishment of early successional plant communities
- effects on vegetation health from dust, air emissions, or herbicide use

Removal, Burial, Mechanical Damage or Alteration of Vegetation

Direct and indirect losses of vegetation will result from project development. Vegetation will be cleared from the pipeline rights-of-way. Clearing will also occur on and adjacent to facility sites, all-weather roads, and along winter roads and temporary work space and access areas, such as shooflies. Physical damage and compaction that occurs during clearing could also affect surface vegetation. Parts of the pipeline right-of-way will also be levelled to facilitate vehicle and equipment movement. The tops of tussocks and hummocks will be removed, with this material used to fill hollows between the tussocks. Some removal of groundcover vegetation and soils could also occur during clearing of other sites. Where surface vegetation, such as roots and ground cover, is left intact, natural recovery of species present before disturbance will occur.

Most pipeline and winter road rights-of-way and temporary workspaces will be cleared of shrubs and trees when the soil is frozen. Grading and levelling will be limited to that required to prepare a safe and efficient working surface. For winter roads, snow or ice will be compacted to a minimum thickness of 10 cm, or as authorized by applicable authorities. Winter road preparation and use might also result in localized scraping and compaction of hummock and tussock vegetation. In permafrost areas, alteration of vegetation might initiate induced thawing, slumping or alterations in drainage patterns.

Driving vehicles on winter roads might damage vegetation that projects above the snow pack, exposed vegetation tussocks and the organic layer, in addition to compacting the soil or mineral layers. Damage or loss of vegetation and compaction of organic material and substrates might increase active layer depths, with resultant changes in plant growth rates. Increased active layer depths might also induce thawing of the permafrost, resulting in long-term, rutting and ponding. However, proper maintenance and monitoring will help prevent these effects. Local conditions, such as snow depth, temperature and ice content also influence the impacts of winter vehicle use. Deep snow acts as a protective layer, reducing the mechanical damage to shrubs and forbs.

Gravel pad construction will result in vegetation burial, permanent substrate alteration and effects from remote quarrying and hauling borrow material. This permanent change in substrate will result in different vegetation associations developing.

Limited losses of riparian vegetation will occur at watercourse crossings and through construction of barge landing sites. Both trenched and trenchless methods will be used for watercourse crossings. Trenchless methods, such as directional drilling, will result in minimal effects on riparian vegetation. Riparian vegetation will be affected on trenched crossings.

Borrow material will be removed from borrow sites for pads, roads and bedding material. Little surface vegetation or soil occurs on some granular deposits, but loose surface material will be removed and replaced where conditions permit. The effects on vegetation from removal of borrow material will be twofold:

- removal of existing vegetation
- change in substrate and topography from a dry upland hill or ridge to a mix of dry elevated areas and moist to wet lowlands or depressions

Shrubs and trees will be prevented from growing on the right-of-way during operations to allow visibility during aerial pipeline patrols. Vegetation will also be controlled around facilities to allow easy access for maintenance and to prevent damage by forest fires. This practice will maintain vegetation in parts of the study area in an early seral stage until decommissioning of the project.

Damage to vegetation will be reduced by conducting most pipeline construction activities during winter, leaving the surface organic layer intact where practical, and limiting root grubbing to the ditch line and areas to be graded. For winter road surfaces, compacted snow or ice will buffer the vegetation surface. Construction traffic will be restricted to existing roads, new access roads, shooflies and the pipeline right-of-way.

Change In Thermal Regime

In permafrost terrain, removal or compaction of surface vegetation might alter the thermal balance, potentially leading to some thawing of permafrost, as discussed under the section on soils, landforms and permafrost. Thawing might increase the depth of the active layer for plant growth, resulting in taller shrub growth and more shading of surface vegetation. It might cause project induced thawing, resulting in water accumulation. On hillsides, shorelines and valleys, thawing might result in slumping and landslides. Areas of unstable soil affected by melting of permafrost often result in loss of mature vegetation, exposures of mineral soils and colonization by pioneer plant species such as grasses.

Change in Drainage Patterns

Construction might alter topography and drainage conditions. These changes in site conditions will have indirect effects on plant growth, and ultimately will have localized effects on plant distribution and abundance. The species composition in a community will shift over time to one adapted to either wetter or drier site conditions, depending on the new drainage conditions. Changes in drainage patterns might trigger thawing and slumping, and induced thawing and slumping might trigger changes in drainage patterns.

Operation of buried segments of the pipelines at temperatures below freezing might cause the development of heaving or frost bulbs in small drainage channels. This elevated terrain might cause ponding on upper slope positions, changing original upland vegetation species such as shrubs and lichens to wetland species such as sedges and mosses, whereas downslope drying will result in changes from original wetland species to species adapted to drier conditions.

Drainage patterns might be altered by damaging the surface vegetation layer, or by grading and depositing materials for pads. In areas with underlying permafrost, changes in drainage patterns might cause changes in the thermal regime resulting in thermokarst, slumping, erosion and landslides. Conversely, movement of soils and substrates might change drainage patterns as well. The amount of surface vegetation loss resulting from changes in drainage patterns will depend on drainage regime, slope, aspect, soil texture, permafrost and ice conditions. Application of mitigation will result in localized and limited effects.

Change or Loss of Substrates

Steep slopes and side hills might be graded. Loose surface material might not be separated during winter construction periods at all project sites or along the entire length of the pipeline right-of-way, and admixing of soils and subsoils might occur. Along most of their length, pipeline trenches will be backfilled with excavated material. However, in areas with thaw-unstable soils, stable fill from borrow sites might be used. The resulting substrates for growth, both admixed soils and imported fill, might be different than those found before development. Different plant associations might establish relative to predisturbance plant communities.

Pad construction using imported borrow material results in vegetation burial and permanent substrate alteration. This permanent change in substrate will result in different vegetation associations developing relative to predisturbance plant communities. Borrow material used for road or pad construction will be left in place when the road is abandoned, resulting in a changed substrate for plant growth. At pad locations on thaw-stable ground, loose surface material will be removed if the area is graded and stockpiled where feasible, and replaced once construction activities at the site are completed.

Substrates will be lost during excavation of borrow material. Borrow excavation will result in localized changes to the original terrain and site conditions that might affect the growth of specific plant communities.

Establishment of Early Successional Plant Communities

Natural recovery and reclamation seeding of disturbed sites will result in a cover combination of colonizing plant species and established species recovering from seeds, roots and rhizomes persisting in the surface soil. A cover of non-persistent annual species will be seeded on erosion-prone slopes, and seed mixes designed for the project will be used in selected areas where natural recovery is not the primary mitigation strategy. Since growth rates for plants usually decrease as latitude increases and active layer depth decreases, these early stage communities will persist on the project disturbance for many years as the diversity, complexity and maturity of the plant communities increase. These communities might be vulnerable to erosion, slumping and weed invasion, and offer alternative habitat and access for wildlife species relative to surrounding undisturbed areas.

Exposed mineral soils might be seeded with reclamation grasses to promote re-establishment of a vegetated surface, except in areas where natural recovery is the selected revegetation method. Reclamation species that are nonpersistent (that is, lasting one to two years) and non-native (that is, not found naturally in the boreal forest or tundra) and that grow rapidly (e.g., annual cover crops such as fall rye) will be used for site stabilization and erosion control on erosion-prone areas, such as steep slopes. Reclamation seeding will use commercially available native

plant species depending on their availability. If there are seed shortages, non-native species or natural recovery options will be considered.

Natural recovery, without the use of reclamation seed, might be used in both dry and wet areas of the project, and in areas of sensitive vegetation communities.

Natural recovery of vegetation from seeds, roots and other propagules in the soil, will be the primary revegetation strategy in areas where:

- surface vegetation has not been removed
- scalping of hummocks has occurred
- grading has not occurred
- peatlands
- riparian communities where erosion is not a concern

Natural recovery might also be used where loose surface materials have been removed and replaced within one to two growing seasons, and risk of erosion or thermokarst is low.

Effects of Persistent and Invasive Species Introductions

Invasive species might be naturally present in the area and spread by survey, construction and operations equipment. New species might be brought in with equipment from other locations, in reclamation seed mixes, or as a planned component of the seed mix.

Undesirable species might be introduced accidentally by spreading from existing sites. Previous disturbances on many of the proposed staging and barge landing sites along the Mackenzie River already have a cover of undesirable species such as foxtail (*Hordeum jubatum*), smooth brome (*Bromus inermis*) and clovers. Equipment from other locations might carry weed seeds in the undercarriage of the vehicles, or in dried mud on the tires. Risk of spreading these species will be reduced by cleaning equipment before arrival in the project area.

Seed mixes always contain small amounts of unwanted species. Although these species comprise a small percentage of the seed mix, they have the potential to establish in reclamation sites. Some reclamation species might also produce persistent growth that does not permit recolonization of local native plants. Known aggressive non-native species will not be used.

Effects on Vegetation Health from Dust, Air Emissions, or Herbicide Use

Dust Deposition

Dust might be deposited during construction, as land is recontoured and pads are laid down, throughout operations from traffic, and during decommissioning when

sites are reclaimed. Effects on sensitive species in adjacent vegetation are possible as a result of dust deposition. This will be reduced by using good site management practices for dust suppression when needed. As most construction activity will occur in the winter the amount of dust produced will be limited.

Air Emissions

Operation of the Little Chicago and Norman Wells facility sites will also result in increased GHG emissions in the Northwest Territories.

In addition, operation of the Little Chicago and Norman Wells facilities will emit small quantities of:

- unburned hydrocarbons
- NO_x
- SO₂
- CO
- suspended particulates
- water vapour

In sufficient concentrations, these emissions have the potential to affect sensitive vegetation species and alter the species composition of vegetation communities in the affected areas. However, air emissions predicted for the project in the SSA are below the level considered to affect sensitive vegetation, which includes mosses and lichens.

Herbicide Use

Herbicides will be used if manual vegetation control is unlikely to control seed production or spread of invasive non-native species of plants. In most cases, manual control by hand pulling or mowing will be sufficient to control the populations. In some cases, such as persistent perennial species with rhizomatous roots, it might be necessary to use herbicides to control the plants and prevent their spread to other areas.

Herbicides could affect other vegetation species if they are transported from intended targets by drifting, leaching, runoff or root transfer. Effects on vegetation as a result of herbicides will be limited because herbicides will be used only on persistent or invasive non-native species in small areas where manual control is not effective, and will not typically be used in areas adjacent to plants or communities of concern.

Summary of Primary Mitigation Strategies – Vegetation

Table 8-20 provides a summary of the primary mitigation strategies related to potential effects on vegetation.

Table 8-20: Mitigation Strategies for Vegetation

Potential Effect	Primary Mitigation Strategies
Removal, burial and mechanical damage to vegetation by clearing	<ul style="list-style-type: none"> • Reduce surface disturbance through design (that is, reduce route length, reduce facility footprints). • Conduct most pipeline construction activities during winter. • Reduce grading and levelling to that required to prepare a safe and efficient working surface. • Flag or fence sensitive areas for avoidance. • Limit grubbing to the ditch line and areas to be graded. • Mitigation for rare plants discovered during construction will be determined based on a rare plant discovery contingency plan that will be prepared for the project.
Removal, burial and mechanical damage to vegetation by road construction and use	<ul style="list-style-type: none"> • Restrict construction traffic to existing roads, new access roads, work pads and the pipeline right-of-way. • For winter roads, compact snow or ice to a minimum thickness of 10 cm, or as authorized by applicable authorities. • As needed, install swamp mats or corduroy over geotextile on the surface where temporary access to a borrow source during unfrozen conditions is required.
Loss of vegetation by pipeline construction, borrow site development and facilities	<ul style="list-style-type: none"> • Reclaim sites according to regulations, policies, industry standards and best management practices during abandonment. • Remove loose surface material on thaw-stable ground and replace once activity is completed. • Reseed reclamation sites where needed. • On abandonment of roads or pads, where borrow material was placed on vegetation, leave fill in place and scarify the surface. • Reclaim temporary workspace once no longer in use. • Reuse borrow material from pads and roads, where practical. • Seed a cover crop of annual cereal species on erosion-prone slopes, where appropriate. • Use seed mixes designed for the project on exposed mineral soils where natural recovery is not sufficient for vegetation regrowth.
Change in thermal regime caused by project activities	<ul style="list-style-type: none"> • Reduce the clearing of right-of-way on steep slopes where practical. • Install borrow material on access roads, as appropriate. • Provide sufficient insulation for pads to protect permafrost.

Table 8-20: Mitigation Strategies for Vegetation (cont'd)

Potential Effect	Primary Mitigation Strategies
Change in drainage patterns along roads, pipeline right-of-way and pads	<ul style="list-style-type: none"> • Install culverts or bridges where all-weather access roads cross a defined watercourse. • Install drainage diversions around compressor stations, where required. • Ensure, as required, adequate cross drainage occurs in corduroy that is left in place following construction. • Crown gas and NGL pipeline trenches and place breaks at intervals to maintain natural flow paths. • Re-establish drainage where it might be blocked and ponding occurs along the right-of-way and roads, where problematic and when conditions are appropriate. • Remove culverts and bridges to re-establish drainage ways and install physical erosion-control structures when all-weather roads are reclaimed.
Introduction of persistent or invasive exotic species by project activities	<ul style="list-style-type: none"> • Clean all construction equipment before arrival on the project area. • Control weeds and invasive non-native species when required. • Use seed mixes that are as free of weeds and invasive non-native species as practical.
Dust emissions	<ul style="list-style-type: none"> • Apply best site management practices for dust suppression when needed. • Conduct most pipeline construction activities during the winter.
Air emissions	<ul style="list-style-type: none"> • Use equipment that meets with relevant standards including NWT regulations, CCME standards and the Alberta standards (where regulations do not exist in the Northwest Territories). This will include the use of low NO_x equipment where commercially available.
Herbicide use	<ul style="list-style-type: none"> • Restrict herbicide use near rare plants, vegetation communities of concern or traditionally used plants and collecting sites.

Wildlife

This description addresses the potential effects on wildlife and wildlife habitat in the SSA and summarizes the primary mitigation strategies to reduce these effects.

Summary of Effects

Potential effects of project development on wildlife in the SSA include:

- direct and indirect habitat loss
- disruption of wildlife movements
- wildlife mortality

Direct and Indirect Habitat Loss

Limited and localized direct habitat loss will occur as a result of vegetation clearing and terrain disturbance, while indirect habitat loss will result from noise and visual disturbances at work sites (sensory disturbance), which might cause habitat avoidance.

Project activities will primarily occur during the winter. However, some borrow, infrastructure and facility site activities will occur during the summer. As a result, sensory disturbance will generally be lower in the summer than in the winter, but will still occur throughout the year. Localized direct habitat loss from vegetation clearing will occur primarily during the winter, but will affect habitat use by birds and mammals throughout the year. Disturbance during operations will be very low in the SSA as facility sites (such as compressor stations) will normally be unstaffed, requiring only periodic maintenance checks. The effects of direct habitat loss will persist over the long-term because of slow vegetation re-growth in northern environments. In contrast, sensory disturbance will only occur in periods of activity, particularly in the summer, and thus will only affect wildlife for a short period of time.

Detailed habitat modelling indicates that foraging habitat for caribou, moose, grizzly bear, marten, and lynx, and denning habitat for grizzly bear, is generally not limiting in the SSA. As a result, the small amount of habitat loss at each site and right-of-way will have little impact on key terrestrial mammal species. Re-growth of shrubby vegetation along rights-of-way might enhance forage availability for moose and beaver over the long-term, and increase prey availability (such as snowshoe hares) for lynx and marten.

Sensory disturbance during project construction might result in habitat avoidance by mammals. Barren-ground caribou, woodland caribou, moose, grizzly bear (summer only), marten and lynx will likely move away from work sites, depending on human activity levels, resulting in indirect habitat loss. Disturbance effects could extend up to 1,000 m from construction sites for sensitive species such as caribou, and up to 200 m for grizzly bears.

Effects associated with project construction will occur primarily in winter. At borrow sites, sensory disturbance will occur only while the sites are active. Because of short-term activity at most borrow sites, it is likely that wildlife will not habituate to disturbance of those sites.

In the absence of hunting and harassment, wildlife might become habituated to predictable disturbances during project operations, resulting in smaller displacement distances and, possibly, attraction to work sites. If little or no human activity occurs along rights-of-way during operations, wildlife might also make use of these corridors.

Localized direct habitat loss resulting from project construction will have little effect on habitat availability and movements of key bird species. Foraging and nesting habitat is generally not limiting for birds in the regional study area; as a result, the small amount of habitat loss at each site or right-of-way will have little impact on bird populations. In addition, waterfowl generally remain on lakes when moulting and thus will also not be affected by clearing activities.

Construction activities will primarily occur during the winter when most bird species are absent from the study area. As a result, sensory disturbance during construction will mainly affect resident species, such as boreal chickadee and ptarmigan, resulting in the displacement of some individual birds from the immediate vicinity of work areas. However, these impacts will be localized and short-term in duration. Barge traffic along the Mackenzie River during construction could also disturb migrating waterfowl, displacing them from key foraging and resting areas. However, most migrating birds will pass through the region during May, before the onset of barge traffic (that is, June), resulting in little, if any disturbance of migrating birds.

Because facility sites will be unstaffed, sensory disturbance in the SSA during project operations will be low for both nesting and migratory birds. Disturbance might occur along all-weather access roads, resulting in the displacement of some birds from nearby areas, depending on the level of disturbance. These impacts will be localized and infrequent in occurrence.

Amphibian habitat (such as bogs, fens, wetlands, lakes, and watercourses) is widespread in the SSA. As a result, direct habitat loss resulting from project construction will have little effect on regional habitat availability. In addition, because amphibians hibernate during winter, sensory disturbance during winter construction will have little effect on habitat availability. In contrast, loud, persistent noises during spring and summer might interfere with the ability of amphibians to detect conspecific mating calls, thus affecting reproduction. Construction and operations activities during spring and summer might result in low levels of disturbance near unstaffed facility sites and all-weather roads, resulting in localized and short-term (during construction) or long-term (during operations) disruptions of breeding activities.

Disruption of Wildlife Movements

Wildlife movements might be disrupted by localized direct habitat loss, physical barriers, and noise and visual disturbances.

Direct habitat loss resulting from project construction in the SSA will have little effect on movements of key terrestrial mammal species. Infrastructure sites, facility sites and borrow sites are relatively small in size and will not block wildlife movements. Similarly, access roads (20 m wide) and the pipeline right-of-way (40-50 m wide) are relatively narrow and will not interfere with movements of most key species, including marten and lynx. Pipeline trenching

will result in localized disruption of wildlife movements; however, these impacts will be short-term in duration (hours or days).

Sensory disturbance during project construction might result in habitat avoidance by key mammal species as well as potential changes in movement patterns. Barren-ground caribou, woodland caribou, moose, grizzly bear (summer only), marten and lynx will likely move away from work sites, depending on human activity levels, resulting in localized disruption of movement patterns.

Construction activities will primarily occur during the winter when most bird species are absent from the study area. Barge traffic along the Mackenzie River during construction could also disturb migrating waterfowl, displacing them from key foraging and resting areas. However, most migrating birds will pass through the region during May, before the onset of barge traffic (that is, June), resulting in little, if any disturbance of migrating birds. Because birds are highly mobile (except waterfowl during moult), their movements are not expected to be affected by project development.

Amphibians typically move between wintering and breeding areas in the spring and fall. As a result, amphibian movements will not be disrupted by winter construction activities such as pipeline trenching and right-of-way clearing. In addition, cleared rights-of-way will also likely not interfere with movements in the spring and fall, based on observations of amphibians crossing roads elsewhere in North America. The presence of grasses and other vegetative cover on rights-of-way will also facilitate movements. Amphibians, especially boreal chorus frogs, are often observed breeding in small pools on pipeline rights-of-way, indicating they do not avoid these areas. Early snowmelt on these rights-of-way might facilitate early breeding activities.

Wildlife Mortality

Mortality of wildlife might result from destruction or disturbance of nesting and denning sites during site and right-of-way clearing, as well as by removal of nuisance wildlife that are attracted to work sites. Development of access roads and other rights-of-way might also cause increased mortality through wildlife-vehicle collisions.

Wildlife mortality might occur along winter roads, all-weather roads, and the pipeline right-of-way. With the exception of all-weather roads (which will be less than 15 km in combined length in the SSA), travel along project rights-of-way will be difficult during spring, summer and fall because of wet terrain. As a result, mortality of wildlife associated with hunting and trapping might be greatest during the winter when access is greatest.

Construction activities during project construction could result in the mortality of denning grizzly bears. Denning bears might be affected directly by destruction of den sites, or indirectly through nearby noise. Construction activities within 500 m

of den sites could disturb hibernating bears, causing energetic stress, den abandonment, or both. Den abandonment might result in the mortality of bears and their cubs if replacement dens cannot be found quickly.

Because the study area is characterized by relatively poor quality grizzly bear habitat, the probability of encountering a denning bear in the SSA during project construction is very low. However, to ensure that bears (if present) are not disturbed, ground surveys will be conducted in appropriate habitats during the fall prior to construction activities to determine the occurrence of den sites. Denning areas will be avoided during construction.

Mortality of bears might also result from attraction of bears to work sites. Bear-human interactions are unlikely in the SSA because the majority of construction camps will be operated during winter, when bears are hibernating, and because facility sites will be unstaffed during operations. However, bears might be attracted to facility sites during operations because of the presence of odours. Ingestion of toxins might result in bear mortality. As a result, strict waste management policies will be implemented at sites to minimize attraction and potential mortality of bears.

Development of winter and all-weather access roads might result in increased mortality of key mammal species through increased hunting, trapping and predation, as well as through vehicle collisions. Winter roads might increase hunting of caribou and moose, and trapping of lynx, marten and beaver. All-weather roads will have a similar effect, and could also facilitate hunting of grizzly bears during summer. Once borrow sites, facility sites and infrastructure sites are no longer operational, reclamation of roads will minimize impacts on wildlife mortality over the long-term. In addition, setting low speed limits on project roads will reduce the likelihood of wildlife-vehicle collisions.

Mortality of birds might result from the destruction or abandonment of nest sites. Because most construction activities will occur during winter, few, if any nests will be destroyed by site clearing. However, as indicated previously, sensory disturbance during project operations might affect individuals during the nesting season. Disturbances at facility sites and all-weather roads, especially those not associated with normal day-to-day operational activities (which birds might habituate to), might cause birds to abandon nearby nests, resulting in egg mortality through predation or exposure. These disturbances are expected to occur infrequently and in localized areas, resulting in the loss of few, if any, nests during project operations.

Increased access along winter roads could facilitate hunting of upland game birds, while access along all-weather roads might increase hunting of waterfowl. Upland game birds and waterfowl are widely dispersed in the SSA and additional hunting along roads will not affect regional populations. In addition, all-weather roads

provide limited access in the SSA, and do not traverse wetland areas that are important for nesting waterfowl.

Vegetation clearing during construction might result in mortality of over-wintering amphibians. In addition, individuals crossing cleared rights-of-way might be more susceptible to predation. Minimizing clearing in upland forests, which are frequently used by over-wintering amphibians, as well as maintaining cover on the pipeline right-of-way, will reduce mortality.

Summary of Primary Mitigation Strategies – Wildlife

Table 8-21 provides a summary of the primary mitigation strategies related to potential effects on wildlife.

Table 8-21: Mitigation Strategies for Wildlife

Potential Effect	Primary Mitigation Strategies
General effects on wildlife during project activities	<ul style="list-style-type: none"> • Assign a wildlife monitor during construction. Monitors will be hired from local communities wherever practical. • Maintain contact with renewable resource councils, the Canadian Wildlife Service and the Department of Resources, Wildlife and Economic Development (now ENR) to advise of incidents involving wildlife. • Follow waste management plan and hazardous materials management plan.
Direct habitat loss because of vegetation clearing	<ul style="list-style-type: none"> • Conduct pre-construction surveys to identify critical habitat, nests or dens where practical. Protect these areas by using appropriate timing and buffers to limit disturbance and reduce the probability of accidentally clearing critical habitat. • Limit project activities near important habitats and wildlife features, such as active nest sites, dens and mineral licks, to periods when wildlife activity is at its lowest, where practical. • Reduce disturbances immediately next to watercourses where appropriate. • Limit grubbing to the ditchline and areas to be graded. • Reduce disturbance to riparian vegetation communities, where practical. • Compact snow or ice on winter roads to a minimum thickness of 10 cm, unless otherwise authorized by applicable authorities.
Indirect habitat loss because of sensory disturbance	<ul style="list-style-type: none"> • Where practical, avoid clearing and construction during sensitive periods for wildlife, such as bird breeding season, early in the denning period for bears, or during the calving season for ungulates. • Project activities within 500 m of a raptor nest during nesting season will be avoided, where practical. • Follow aircraft flight guidelines such as flight corridors and minimum altitudes, except for aerial pipeline patrols. • Follow GNWT Wildlife Harassment Regulations.

Table 8-21: Mitigation Strategies for Wildlife (cont'd)

Potential Effect	Primary Mitigation Strategies
Increased mortality because of altered human and predator access	<ul style="list-style-type: none"> • Reclaim roads when they are no longer required for construction or operations. • Prohibit recreational use of project roads and rights-of-way by project staff while on the job site. • Use existing access instead of new access, where practical. • Place barriers, such as large berms, rolled back slash or rock piles across the right-of-way at key entrance points to limit access. • Prohibit intentional destruction of wildlife unless authorized or required for safety reasons. • Clearly post and enforce speed limits on project roads.
Change of wildlife movement patterns because of physical barriers	<ul style="list-style-type: none"> • Maintain travel areas between sections of strung pipe to facilitate wildlife movements. Fill pipeline trenches as soon as practical following pipeline installation. • Excavation of borrow sites and development of access roads will be followed as closely as practical by reclamation activities. • Access corridors should avoid paralleling potential animal movement corridors, such as riparian areas, where practical. • Reduce amount of time welded pipe sits on skids and place as close to the ground as practical or at sufficient height to allow wildlife movement underneath. • Include breaks when stringing pipe along or across wildlife paths. • Keep the length and duration of open trenches short enough to allow wildlife movement, particularly during migration. • Ensure that gaps are left in the spoil piles, if piles are to be left for an extended period of time. Trench plugs will also be installed if trench is left open for an extended period of time. • Ensure adequate water movement at watercourse crossing locations, as required.
Change of wildlife movement patterns due to attraction to facilities or right-of-way	<ul style="list-style-type: none"> • Consider fencing at locations where wildlife needs to be restricted from particular areas for safety and conservation reasons. • Follow a waste management plan to ensure garbage is properly handled.
Disruption of movement or mortality of barren-ground and woodland caribou as a result of project activities	<ul style="list-style-type: none"> • Ensure that pipeline rights-of-way and heavily traveled roads are separated by more than 100 m, where practical. • Limit project activities in key barren-ground caribou winter range between October and January to limit interaction with caribou, to the extent practical.
Disruption of movement or mortality of moose as a result of project activities	<ul style="list-style-type: none"> • Limit disturbance to riparian vegetation communities. • Maintain buffer zones between access roads and other infrastructure sites and riparian zones associated with watercourses, lakes or wetlands, except where waterbodies need to be crossed by a road right-of-way or as otherwise authorized.

Table 8-21: Mitigation Strategies for Wildlife (cont'd)

Potential Effect	Primary Mitigation Strategies
Disruption of movement or mortality of grizzly bear as a result of project activities	<ul style="list-style-type: none"> • Follow the waste management plan for garbage handling. • Develop protocols for managing potential bear–human interaction, including measures to deter bears from camps and other facilities that are consistent with Safety in Bear Country: A Reference Manual (Resources, Wildlife and Economic Development). • Consult territorial and federal wildlife agencies and local hunters and trappers to determine the location of known den sites. • Conduct den surveys during the appropriate time of the year before beginning construction. Avoid construction activities near active dens, to the extent practical.
Disruption of movement of marten and lynx as a result of project activities	<ul style="list-style-type: none"> • Barriers, such as large berms, rolled back slash or rock piles might be placed across the right-of-way at key entrance points to control access.
Disruption of movement or unplanned mortality of beaver as a result of project activities	<ul style="list-style-type: none"> • Limit disturbance to drainages by designing appropriate drainage control measures and maintain a buffer zone where practical between wetland features and rights-of-way. • Review with local trappers, at least one month before the start of construction, all identified beaver dams to be removed to facilitate construction. Trappers will be given the opportunity to trap out the affected beaver colonies before construction. • Implement measures to reduce the probability of accidental spills.
Disruption of movement, destruction of nesting habitat or mortality of birds as a result of project activities	<ul style="list-style-type: none"> • Conduct pre-construction surveys to locate nest sites, especially for species at risk (such as peregrine falcon). Protect these areas by using appropriate timing and buffers to limit disturbance and reduce the probability of accidentally clearing important habitat. • Project activities within 500 m of a raptor nest during the nesting season will be avoided, where practical. • Trees used by cavity nesting species, and trees with raptor stick nests located during construction will not be felled, where possible. • Reduce the volume, duration and frequency of noise producing activities, where practical. • Conduct potentially disturbing activities when most birds are absent (that is, from October to April), where practical. • When migratory birds are present, conduct discretionary activities to occur outside the most sensitive periods unless otherwise authorized. • Follow aircraft flight guidelines for flight corridors and minimum altitudes, especially near sensitive areas and bird concentrations.
Disruption of movement or mortality of amphibians as a result of project activities	<ul style="list-style-type: none"> • Limit disturbance to waterbodies and associated riparian areas. • Implement measures to reduce the probability of accidental spills.

Hydrology

This description addresses the potential effects on hydrology in the SSA and summarizes the primary mitigation strategies to reduce these effects.

Summary of Effects

Potential effects of the project on hydrology in the SSA might include:

- changes in local surface water drainage characteristics
- increased sediment concentrations in surface water
- changes in channel morphology, including changes in channel geometry, shape and conveyance capacity

Changes in Local Surface Water Drainage Characteristics

Construction and operation of the project could lead to changes in runoff amounts and drainage patterns from land disturbance and potential changes in the ground's thermal regime because of frost heave and thaw settlement. Changes in water levels and velocities could also occur because of flow obstruction, water withdrawal and disposal, and land subsidence.

The land disturbance and compacted surfaces associated with the pipeline corridor and infrastructure will be less permeable than natural surfaces. This could result in higher volumes of water runoff from these areas than would occur under natural conditions. Site drainage will be provided so that runoff is routed in an appropriate manner into the surrounding area. Changes in the rate of runoff associated with the project will be confined to the immediate area of project developments and are expected to be low ($<0.001 \text{ m}^3/\text{s}$ change).

The land disturbance associated with the pipeline and infrastructure could interrupt existing overland drainage patterns. A disrupted drainage route could lead to a change in drainage pattern in and in the immediate vicinity of the development area. Crowning and notching the pipeline ditch backfill will reduce the redirection and routing of surface water flow along the pipeline right-of-way. This is intended to maintain natural drainage patterns and reduce the runoff from the upper part of a watershed that might enter a receiving watercourse at a more concentrated location than under natural conditions. Changes in local drainage patterns could also occur at facilities because of land disturbance. Site drainage will be provided so that runoff is routed toward the natural receiving body and so that changes in drainage patterns more removed will not be detectable from natural changes. No detectable change in drainage pattern is expected beyond 50 m from a given disturbance footprint in the SSA.

Because the gas in parts of the pipeline will be at below-zero temperatures, if it is installed in unfrozen soil, a frozen zone, or frost bulb, could develop around the pipe. The frost bulb, under certain conditions, will create frost heave which could raise the ground surface. This could interrupt overland drainage paths, create ponding areas and result in changes in the local drainage pattern. In the SSA, portions of the pipeline system will be susceptible to frost heave as a greater percentage of the ground is unfrozen. Segments of the pipeline could be subject to heave, depending on the temperature and soil conditions of the specific section and its location along the pipeline relative to the compressor stations. The effect of frost heave is to lift the pipeline in susceptible areas, potentially creating a linear obstruction to cross-pipeline sheet flow. Water could pond on the upstream side of the right-of-way and could be directed along the corridor route. The effects of frost heave might be partially reduced by notching the pipeline right-of-way and by scheduled inspection and maintenance to identify and address any local drainage issues related to frost heave over the pipe.

Changes in the timing and amount of runoff might occur because of snow and ice volume used to construct winter roads. The amount and location of changes would depend on the water volumes, water sources, road lengths and local topography. Most of the melt is expected to occur at the same time as general spring breakup or melt. As a result, the increase in runoff generated by winter road melt is expected to be small compared with total snowmelt in a basin. In addition, the landscape is relatively flat and spring conditions are characterized by overland flow in ill-defined waterways.

The development of the pipeline corridor and infrastructure could change the thermal isolation and heating of surface soils. This could result in limited and localized melting of permafrost and thaw settlement, which could affect local topography and overland drainage patterns. The pipeline will be monitored during operations to ensure any effects are identified early and drainage will be re-established where problematic and when conditions are appropriate.

Water withdrawals or disposal could affect water volumes, and hence water levels and velocities, in source or receiving waterbodies. Water supply and disposal will be required during construction for camps, winter roads, horizontal directional drilling watercourses, and pressure testing. The effects on water levels in large waterbodies are a function of withdrawal rate and background flow conditions. Since regulatory requirements regarding water withdrawal and disposal will be met, effects on water levels are not expected to be detectable over the long term.

Increased Sediment Concentrations

Construction and operation of the project could alter the flow of overland runoff or instream flow. These alterations could affect the sediment regime of watersheds and watercourses through land disturbance, bed and bank disturbance and frost bulb formation.

Land disturbance associated with construction and operations of the pipeline and infrastructure sites might result in higher sediment runoff compared with natural conditions. The eroded material from a disturbed surface will only result in increased basin sediment yield or suspended solids concentrations if the eroded material enters the watercourse system. Implementation of appropriate sediment control measures will prevent a large amount of this sediment from entering a waterbody.

The disturbance of watercourse beds and banks during construction of access road and pipeline watercourse crossings and barge landings has the potential to increase erosion, entrainment and sedimentation and affect sediment concentration. Sediment concentrations could be affected by bed and bank disturbance associated with watercourse crossing construction. Crossing construction methods have been selected to reduce the potential for sediment entrainment and transport.

Frost bulb formation at pipeline watercourse crossings along the pipeline might also result in changes in sediment concentration because of flow obstruction, as discussed earlier. Potential re-direction of local flow patterns could result in erosion and increased sediment concentrations. Deep burial or insulation of the pipeline at selected crossings will be sufficient to reduce the effect of frost bulb formation, and prevent flow obstruction in most cases.

Changes in Channel Morphology

Changes in channel morphology refer to the adjustment of channel shape in response to water flow and sediment conveyance. Morphologic change occurs continuously. Changes in channel morphology could result if there are long-term and sustained changes in channel hydraulics, that is, flow, depth and velocity, and river ice, or sediment supply.

Changes in runoff amount could change channel hydraulics, that is, flow, depth and velocity and river ice, which directly affect the sediment transport capacity of a channel. Existing channel regimes have evolved and adjusted over time in response to runoff and sediment production that vary over their respective long-term ranges. Therefore, if the project results in small changes in runoff amount, sediment production or both, that are not distinguishable from the natural regional changes, no variability in channel morphology beyond those expected naturally would occur.

Disturbance associated with pipeline installation could result in weakened banks and an unconsolidated substrate. During operations, erosion as a result of water flow could increase in disturbed areas and result in increases in sediment supply and concentrations. However, the development of erosion-prone areas will be limited by implementing suitable design approaches and construction practices. In general, the effect of the project on channel morphology is expected to be limited and localized. Locating pipeline and road watercourse crossings at stable sites

increases the likelihood that banks will be successfully stabilized and that the existing watercourse morphology will continue to evolve naturally.

Summary of Primary Mitigation Strategies – Hydrology

Table 8-22 provides a summary of the primary mitigation strategies related to potential effects on hydrology.

Table 8-22: Proposed Mitigation Strategies for Effects on Hydrology

Potential Effect	Primary Mitigation Strategies
Creation of flow obstructions and disruption of natural drainage patterns	<ul style="list-style-type: none"> • Install drainage ditches around facility sites, where required. • Incorporate drainage culverts and bridges in all-weather roads, as required. • Re-establish drainage where it might be blocked and ponding occurs along the right-of-way and roads, where problematic and when conditions are appropriate. • Install drainage controls in areas of substantive groundwater flow encountered during ditching before the ditch is backfilled. • Crown gas pipeline and NGL pipeline ditches and place breaks at intervals to maintain natural flow paths. • Set back facilities and developed areas from waterbodies, or provide protection from flooding according to regulatory requirements. • Ensure adequate cross drainage occurs in corduroy that is left in place, as required. Geotextile might be used to limit depth of corduroy. Install temporary erosion-control structures before spring breakup. • Place select fill directly on the vegetated surface for all-weather access roads and pads used in the nonfrozen season and located on thaw-unstable terrain. • Reclaim the pipeline right-of-way so that natural drainage patterns are not blocked. Remove culverts and bridges to re-establish drainage ways, and install physical erosion-control structures when all-weather roads are reclaimed. • Reclaim developed areas for natural drainage, where appropriate.
Increased runoff amounts	<ul style="list-style-type: none"> • Implement drainage, erosion and sediment controls such as grading and ditching to direct runoff through silt fences, sediment traps, vegetation, berms or isolation areas, as appropriate for the location. Monitor effectiveness of controls through routine inspection. • Install long-term erosion-control structures in slopes and watercourse banks, where required.
Change in water level and velocity related to frost bulb formation	<ul style="list-style-type: none"> • Increase burial depth of pipeline or use insulation at Active I and Active II Channel crossings that are susceptible to frost heave or frost bulb growth where fall spawning or overwintering habitat is present.

Table 8-22: Proposed Mitigation Strategies for Effects on Hydrology (cont'd)

Potential Effect	Primary Mitigation Strategies
Increased sediment concentration from bed and bank disturbance	<ul style="list-style-type: none"> • Reduce disturbances near watercourse banks and conduct clearing on the watercourse banks in an environmentally responsible manner. • Use clear span bridges or culverts on all-weather roads to cross Active I watercourses. • Install long-term erosion-control structures on slopes and watercourse banks where required. • Reduce disturbance immediately next to watercourse banks, where practical. • Reclaim disturbed areas to reduce sediment transport • When horizontal directional drilling is used as a crossing technique, maintain an undisturbed buffer zone at the edge of the watercourse. • Reclaim bed, banks and approach slopes of the watercourse to stable conditions, grades and contours. • Develop and implement site-specific Erosion and Sediment Control Plans where required. • Reduce the amount and duration of in-water activities.
Increased sediment concentrations from land disturbance during construction	<ul style="list-style-type: none"> • Locate construction activities away from waterbodies, where practical and according to regulatory requirements. • Implement drainage, erosion and sediment controls such as grading and ditching to direct runoff through silt fences, vegetation, berms or isolation areas, as appropriate for the location. Monitor effectiveness of controls through routine inspection. • Locate borrow sites away from waterbodies, where practical. • Set back facilities and developed areas from waterbodies. • Reclaim sites on completion of their use. • Reseed disturbed sites where needed.
Increased sediment concentration from frost bulb formation	<ul style="list-style-type: none"> • Increase burial depth of pipeline or use insulation at Active I and Active II Channel crossings that are susceptible to frost heave or frost bulb growth where fall spawning or overwintering habitat is present.

Groundwater

This description addresses the potential effects on groundwater in the SSA and a summary of the primary mitigation strategies to reduce these effects.

Summary of Effects

Potential effects of the project on groundwater in the SSA might include:

- obstruction of groundwater flow

- change in recharge and discharge of groundwater
- change in groundwater quality

Obstruction of Groundwater Flow

The pipeline, could affect shallow groundwater flow by blocking existing flow paths. A blockage usually results in upslope ponding and a change in the shallow groundwater flow direction. Deflection of shallow groundwater flow and water ponding could occur in areas where the pipeline crosses a sidehill slope of permeable granular materials, such as alluvial fans, kames and eskers. Icings could form where deflection occurs in the active layer.

Construction activities located upgradient of a spring discharge could intercept groundwater flow and divert a part of this flow into the ditch. Installing subdrains or other appropriate measures in areas where groundwater flow is encountered during ditching, is expected to be sufficient to:

- enable groundwater flow to continue
- prevent any substantial change in groundwater flow patterns that could otherwise result in the interruption or substantial reduction of spring flow

Effects related to redirection of groundwater flow upgradient of discharge areas could persist into the far future. Effects could occur during construction and, in areas where the pipeline is removed, during decommissioning and abandonment.

Because gas in parts of the pipeline will be below 0° C, a frost bulb might be created in areas of unfrozen ground. The frost bulb could form a barrier to downgradient movement of groundwater and in some cases, this obstruction could be sufficient to force groundwater to the surface. Icing buildups are an indication of flow obstruction. Where moderate groundwater flow passes through a confined area of high permeability underneath a watercourse, the pipeline, with or without a frost bulb, might be a sufficient barrier to subsurface water movement and could result in the same effects. Deep burial or insulation of the pipeline at selected crossings will be sufficient to reduce the effect of frost bulb formation, thus preventing icings or substantial groundwater blockage.

Watercourse crossings where mitigation is not applied and some cross-slope areas could experience effects as a result of frost bulb formation. Monitoring for frost bulb development in other areas will enable an appropriate engineering response to manage effects as necessary.

Change in Recharge and Discharge of Groundwater

Recharge and discharge areas are locations where water enters or leaves the groundwater system. Effects on recharge areas might occur through extracting borrow material from borrow sites, which are often important recharge areas.

Removing borrow material from borrow sites might alter local groundwater flow. Most of the borrow sites are on ground that is higher than the surrounding terrain and the borrow material usually has greater permeability than the surrounding material. In areas of permafrost, the active layer is thicker than at locations where finer materials are found at the surface. Rain and runoff infiltrate unfrozen borrow material, where the water will be stored before being released into the groundwater flow system. These sites are locations of recharge for local groundwater flow systems. Seasonal springs or seeps might be present at the edges of the borrow sites. Changes in surface water flow patterns and quantities might be caused by land disturbance, surface water withdrawals and other activities. These changes might alter the recharge of surface water into the groundwater system and result in changes in groundwater quantity and flow patterns. Sufficient permeable surface area will be maintained at borrow sites to ensure recharge, as necessary.

Effects through the recharge and discharge pattern pathway in the study area could occur in areas of groundwater discharge. Ditching and other subsurface activities near groundwater discharge areas might divert or block groundwater flow or require dewatering during construction. The route selection process has been successful in avoiding most of these areas.

Specific potential groundwater discharge effects resulting from project activities include the following:

- In locations downslope and close to perennial springs, construction could temporarily divert spring flow. Ditch dewatering might be required and upslope ponding is possible. Some means of channelling spring outflow might be necessary in some places.
- In locations upslope and close to perennial springs, construction activities could affect spring outflow. If pipeline ditching encounters the spring's source aquifer, an inadvertent diversion of spring flow into the pipeline ditch is possible. The likelihood of this occurring will decrease as the elevation difference between the pipeline location and the point of spring outflow increases.
- Groundwater or surface water could flow into the pipeline ditch in locations where the pipeline route crosses fault zones. Effects would be restricted to areas where the bedrock surface is near the ground surface.
- On glacially formed eskers, some borrow sites might form areas of groundwater storage. The active layer could be thicker beneath these features or under areas of ponded water at their base. Dewatering borrow site areas might be required during construction. This could temporarily alter local groundwater flow.

Change in Groundwater Quality

Small spills that might occur during normal construction from sources such as ruptured hydraulic lines, operations and decommissioning activities, have the potential to affect groundwater quality in wetland areas where the water table is near or above the ground surface. Management practices will reduce the potential for spills and leaks, and any spillage will be cleaned up in compliance with the project's contingency and emergency response plans (see [Section 11](#)). Therefore effects will be very localized and very limited.

Groundwater quality is affected by changes in the flow path along which the groundwater moves. Because groundwater makes contact with different geological materials, changes occur in the chemical interactions between the groundwater and the aquifer sediments or rocks. These changes might result in alterations to groundwater quality. Since no changes in groundwater flow paths are expected, there should be no project effects from this on groundwater quality.

The construction of project components, runoff from facilities, and activities related to all-weather roads and other infrastructure might increase the amount of sediment in surface water runoff and mobilize sediment into aquifers. Fine sediment particles, mainly silt-sized, might be transported by water and become lodged in the pore spaces of the aquifer material, thereby reducing the aquifer's storage capacity and ability to transmit water. Sedimentation is most likely to occur where disturbance is located in or near areas of high water table or near shallow, highly permeable materials, such as sands and gravels, and fractured or karstic bedrock. Construction activities at borrow sites are the most likely pathway by which sedimentation of an aquifer could potentially occur. Screening and crushing activities produce sediment that might be carried directly into the ground and underlying aquifers by runoff or precipitation.

Mitigation measures to control the release of sediment into surface water combined with trapping sediment in surface water runoff, via vegetation and deposition on the land surface, are sufficient to render the possibility of groundwater sedimentation from most project disturbances remote.

Summary of Primary Mitigation Strategies – Groundwater

[Table 8-23](#) provides a summary of the potential effects of project activities on groundwater and potential mitigation of those effects on groundwater.

Table 8-23: Mitigation Strategies for Groundwater

Potential Effect	Primary Mitigation Strategy
Obstruction of groundwater flow related to blockage from pipeline construction	<ul style="list-style-type: none"> • Install drainage controls in areas of substantive groundwater flow encountered during ditching, before the ditch is backfilled. • Crown gas and NGL pipeline ditches, and place breaks at intervals to maintain natural flow paths.
Obstruction of groundwater flow related to frost bulbs during construction and operations	<ul style="list-style-type: none"> • Increase burial depth of pipeline or use insulation at Active I and Active II Channel crossings that are susceptible to frost heave or frost bulb growth where fall spawning or overwintering habitat is present.
Change in recharge and discharge related to surface water recharge from facility construction and operation	<ul style="list-style-type: none"> • Install drainage ditches around compressor stations, where required. • Install culverts or bridges where all-weather access roads cross a defined watercourse, where required. • Stabilize any ford crossings at low points along access roads. • Ensure adequate cross drainage occurs in the corduroy that is left in place. Use geotextile to limit the depth of corduroy on the reclaimed right-of-way if necessary. • Re-establish drainage where it is blocked and where ponding occurs along the right-of-way and roads, where problematic and when conditions are appropriate.
Change in natural recharge from development of borrow sites	<ul style="list-style-type: none"> • Maintain sufficient permeable surface area at borrow sites to ensure recharge, as necessary.
Change in areas of discharge related to construction activities	<ul style="list-style-type: none"> • Monitor, by aerial inspection, visual changes in location or extent of groundwater discharge areas.
Change in groundwater discharge and quality from construction activities	<ul style="list-style-type: none"> • Monitor thaw settlement and frost heave, pond formation and drainage, and erosion at selected sites.
Increased sedimentation from development of borrow sites	<ul style="list-style-type: none"> • Implement drainage, erosion and sediment controls such as grading and ditching to direct runoff through silt fences, sediment traps, vegetation, berms or isolation areas, as appropriate for the location. Monitor effectiveness of controls through routine inspection.
Change in groundwater quality from spills and leaks during construction and operations	<ul style="list-style-type: none"> • Implement management practices, contingency plans, and emergency response plans to prevent and address leaks and spills.

Water Quality

This description addresses the potential effects on water quality in the SSA and summarizes the primary mitigation strategies to reduce these effects.

Summary of Effects

Potential effects of the project on water quality in the SSA might include:

- acid deposition
- wastewater releases from camps and pressure testing
- leaks and spills
- suspended sediment inputs

Acid Deposition

The Little Chicago facility site and Norman Wells compressor station will be the primary source of emissions of acid-forming substances, such as oxides of nitrogen (NO_x) and sulphur dioxide (SO₂), in the SSA. These emissions might cause an increased rate of acid deposition compared with background rates and might affect pH in acid-sensitive lakes. Although most lakes with available data in the acid deposition study area are not sensitive to acid deposition, a few are moderately to highly sensitive.

In the SSA, modelled acid deposition rates resulting from the two compressor stations were found to be low. Therefore, based on available information, no effects on lake water quality as a result of acid deposition are predicted.

Wastewater Releases

Most wastewater, including domestic wastewater and pressure test water, will be generated during construction. Smaller amounts of domestic wastewater will be generated during operations.

During construction and operations, domestic wastewater will be generated from camps used to house the project workforce. Construction camps will be temporary, possibly with some being required into the early part of the operations phase.

Pressure testing refers to the testing of pipelines to detect leaks. This testing will occur during construction. Water used for pressure testing will be withdrawn from nearby surface waters and regulatory criteria for discharge water quality will be met.

All project wastewater will be handled and disposed of in a manner that reduces or eliminates potential effects on the environment. Regulatory requirements, including those defined in site water licences, will be met and all water will be treated as necessary before being released.

Leaks and Spills

Small spills of some substances, including fuel, oil and grease, might reach waterbodies if intercepted by surface runoff or if they enter groundwater.

Implementation of management practices, contingency plans, mitigation measures and emergency response plans will reduce the potential of these substances to reach receiving waterbodies via surface runoff or groundwater. Therefore, adverse effects from spills or leaks are not expected.

In the unlikely event of a large spill, appropriate provisions in the emergency response and spill contingency plan will be implemented (see Section 11).

Suspended Sediment Inputs

Suspended sediment inputs to waterbodies could result from land disturbance, frost bulb formation and disturbance of watercourse bottom and bank sediments by dredging and during pipeline construction at watercourse crossings. This discussion is concerned with water quality changes caused by increases in concentrations of sediment-associated parameters and release of chemicals from suspended sediments that have been added to waterbodies, rather than with the effect of sediment addition.

Land disturbance could result in increased sediment levels in runoff. Land disturbance will occur during construction activities, clearing of the pipeline right-of-way, borrow site development and use, gravel pad use during operations and decommissioning activities, such as removal of camps. These increases in sediment levels might result in increased concentrations of sediment-associated water quality parameters, such as nutrients and metals, when measured as total concentrations. However, changes in water quality will be localized and limited by the following:

- Mitigation measures applied during project-related activities that could generate sediment will reduce sediment inputs from construction and operations.
- Sediment releases are expected to occur over short periods, during and immediately following rain events and during spring breakup.
- Project-related activities will not cause release of sediments from areas that could have elevated levels of chemicals associated with human activities. Implementation of mitigation measures for leaks and spills will ensure that runoff and suspended sediment does not contain chemicals from human sources.
- Under the conditions expected during sediment releases, water quality parameters associated with particulate material would remain attached to suspended sediments and would ultimately settle out in depositional areas downstream of the point of input.

Frost bulbs that result in frost heave might cause seasonal sediment releases. If frost heave raises a watercourse substratum, erosion of the raised area could introduce sediments to watercourse water. Alternatively, if groundwater or surface water flow is blocked in a small watercourse, ponding and sediment deposition could occur upstream of the crossing. Spring runoff could then mobilize the deposited sediments. Enhanced runoff from ice formed upstream of the crossing might cause erosion and subsequent sediment input to watercourse

water. Deep burial or insulation of the pipeline at selected crossings will be sufficient to reduce the effect of frost bulb formation, and prevent flow obstruction.

Watercourse bottom and bank sediments might need to be dredged at new and existing barge landings to facilitate landing installation, to allow barge access and as part of routine maintenance. Dredging might re-suspend large amounts of sediments from the disturbed bottom into the overlying water. The release of metals, nutrients and organic compounds to the water column during dredging depends on several factors including:

- concentrations of compounds in dredged sediments
- redox state
- sediment grain size and organic content
- the method of dredging and mitigation measures applied
- the area dredged and flow characteristics in the dredged waterbody
- other factors

Because of the many factors involved, it is difficult to predict the extent of chemical constituents released during dredging. Despite the potential for release of chemicals during dredging, the environmental effects of dredging and spoil disposal are expected to be localized and short term in nature. Available information suggests water quality usually returns to the background condition quickly after dredging is completed.

Watercourse crossings during pipeline or temporary access bridge construction could release suspended sediments into watercourse water. Crossing construction methods have been selected to reduce the potential for sediment entrainment and transport.

Summary of Primary Mitigation Strategies – Water Quality

Table 8-24 provides a summary of the primary mitigation strategies related to potential effects on water quality.

Table 8-24: Mitigation Strategies for Water Quality

Potential Effect	Primary Mitigation Strategy
Change in water and sediment quality from release of pressure test water and domestic wastewater from camps	<ul style="list-style-type: none"> • Release water to the watershed in a controlled manner such that the effects to the receiving waterbodies are reduced. • Meet appropriate water quality discharge criteria for quality of discharge waters. In the event this is not possible, use alternative disposal methods. • Dispose of wastewater at approved locations when wastewater cannot be appropriately treated for release to the watersheds.

Table 8-24: Mitigation Strategies for Water Quality (cont'd)

Potential Effect	Primary Mitigation Strategy
Change in water and sediment quality from potential dredging activities at barge landings	<ul style="list-style-type: none"> • Select dredging and sediment-control methods to comply with <i>Fisheries Act</i> authorization.
Change in water and sediment quality from leaks and spills	<ul style="list-style-type: none"> • Implement management practices, contingency plans and emergency response plans to prevent and address leaks and spills. • Use environmentally acceptable hydraulic fluid in hydraulic systems of machinery working in water. • For fuel tanks >4,000L, store fuel in either double-walled tanks, or single-walled tanks with secondary containment systems as required by regulations. • Set back storage sites for fuels, lubricating oils, chemicals, or other hazardous materials at least 100 m from any waterbody or protect from flooding, unless otherwise authorized. • For pipeline activities, wash, maintain and refuel vehicles at least 100 m from any waterbody, unless otherwise authorized. • Complete visual inspection to ensure clean facility and work sites.
Change in water and sediment quality from land disturbance	<ul style="list-style-type: none"> • Implement drainage, erosion and sediment controls such as grading and ditching to direct runoff through silt fences, sediment traps, vegetation, berms, or isolation areas, as appropriate for the location. Monitor effectiveness of controls through routine inspection. • Install long-term erosion-control structures on slopes and watercourse banks, where required. • Reduce disturbance immediately next to watercourse banks. • Reclaim disturbed areas to reduce sediment transport. • Maintain an undisturbed buffer at the edge of the watercourses adjacent to project sites, where practical. • Reclaim bed, banks and approach slopes of the watercourse to stable conditions, grade and contours. • Locate borrow sites away from waterbodies, where practical. • Develop and implement site-specific erosion and sediment control plans, where required.
Change in water and sediment quality from frost bulb formation	<ul style="list-style-type: none"> • Increase burial depth of pipeline or use insulation at Active I and Active II Channel crossings that are susceptible to frost heave or frost bulb growth where fall spawning or overwintering habitat is present.

Fish and Fish Habitat

This section contains a description of the potential effects on fish and fish habitat in the SSA and a summary of the primary mitigation measures to reduce these effects.

Summary of Effects

Potential effects of the project on fish and fish habitat in the SSA might include:

- effects on fish habitat of activities such as trench excavation, bank treatments, site preparation, placement of structures, fill or other materials in the near-shore areas of lakes and watercourses, or operation of heavy equipment in water
- effects on fish or fish habitat from exposure to suspended sediments that is disturbed or discharged by project-related activities, then transported in water to be deposited elsewhere
- effects of channel blockage from frost bulb formation on fish movements at pipeline crossing sites
- blockage of fish passage by access roads
- effects of water withdrawals from lakes or watercourses on overwintering and littoral habitats
- effects on fish or fish habitat because of a change in surface water flow because of higher runoff volume from project facilities
- effects of changes in water quality resulting from:
 - wastewater discharge to local waterbodies
 - accidental spills associated with pipeline and facilities construction and normal operations
- effects of in-water or near-shore detonations of explosives on fish or incubating eggs

Direct Effects on Fish and Fish Habitat

With the exception of trenchless crossings, watercourse crossing construction in the SSA will require excavation of a trench that disturbs the bed and banks of the watercourse, placement of the pipe in the trench and backfilling. These disturbances will cause localized changes in habitat at the crossing site. Direct effects on fish habitat might result from:

- changes in watercourse morphology
- changes in the watercourse bed from disturbance during trench excavation
- changes in composition and size of bed materials
- changes in bank configuration
- removal of bank vegetation

The gas and NGL pipelines will cross 262 watercourses in the SSA, ranging from small vegetated streams to large rivers. Crossing Vegetated Channels and Active II watercourses is not expected to directly affect fish habitat because these watercourses will be either dry or frozen to the bed during crossing construction. Watercourse bed and banks will be recontoured to stable conditions before flow returns in spring. Large River Crossings and Active I Channels that might have overwintering, spawning, egg incubation and rearing habitat for fall spawning species, will be crossed using either the trenchless or isolated crossing method where practical. Where there is no spawning or overwintering habitat in the area of crossing construction, Large River Crossings and Active I Channels in the SSA will be crossed using open cut methods.

Direct effects on fish habitat cannot be avoided when open cut or isolation methods are used. Habitat features present at the crossing location will be disturbed by trenching, pipe installation and backfilling. The time required for crossing construction depends on the width of the watercourse. Typically, the duration of crossing construction is three to five days, although more time is required for larger watercourses. On completion of crossing construction, disturbed materials are replaced with similar-sized substrates and the bed and banks of the watercourse are recontoured to stable conditions. Disruption of habitat will typically be short in duration and effects on fish or fish habitat are expected to be limited to individual or small groups of fish. The effects of direct habitat alteration are confined to the physical construction of the pipelines, so no effects are expected during normal operations or decommissioning and abandonment.

Temporary vehicle crossings are required for vehicles and equipment to cross a watercourse during pipeline construction. Temporary crossing structures include temporary bridges and snow and ice bridges. Direct effects on fish habitat are limited to disturbances of the banks at the approaches to the watercourse. Temporary bridges will be removed and watercourse bed and banks will be stabilized before spring breakup. No direct effects on fish habitat from temporary crossings are expected.

Crossing of watercourses by all-weather roads might affect habitat for spawning, rearing and overwintering at or near the road crossing. Effects will primarily occur during road crossing construction by the direct disturbance of the watercourse bed, banks or riparian areas. The effects depend on the type of habitat at the crossing site, the detailed construction plan and the crossing type selected, such as bridge or culvert installations. No adverse effects are expected during operations. Some watercourse beds and banks might be disturbed during removal of culverts and bridges. Following the implementation of mitigation measures, road crossings are not likely to adversely affect fish or fish habitat.

Effects from Exposure to Suspended Sediments

Project-related activities that might increase the amount of sediment entrained in nearby waterbodies include:

- construction of pipeline watercourse crossings
- construction, operations and decommissioning of all-weather access roads and clean up of winter roads
- runoff from various project components

Deposited sediments might modify watercourse bed conditions, thus affecting the availability and suitability of various types of fish habitat, but in particular habitat for the development of fish eggs.

Effects of Watercourse Crossing Construction on Sediment Deposition

Deposition of sediment entrained during watercourse crossing construction might adversely affect fish habitat downstream of the crossing location. The distance sediment is transported downstream is related to flow and sediment particle size. Large sediment particles settle immediately, whereas small particles are transported farther downstream. Fine particles might remain suspended indefinitely in flowing water and might not settle until they reach a lake or an area with no turbulence. The deposited sediment might clog the interstitial spaces of gravel and cobble substrates that are used as spawning, egg incubation and rearing habitat. Sediment entrained during crossing construction might also settle in pools, decreasing their depth and suitability as overwintering habitat. Effects of sediment are rarely permanent. Full recovery will occur as early as six weeks after construction, but more typically within one or two years after construction. Sediment deposited during winter construction will likely be scoured clean by the hydraulic forces of the spring freshet.

Effects of sediment deposited during crossing construction will be limited to Large River Crossings and Active I Channels. Flow during winter construction will be low, and peak TSS concentrations will decrease rapidly as particles settle quickly under less turbulent low flow conditions. Active II and Vegetated Channels will be dry or frozen to the bottom during construction and are unlikely to be affected by sediment deposition.

Effects of sediment deposition from road crossing construction are similar to those arising from pipeline watercourse crossing construction. Deposition of sediment entrained during access road crossing construction will potentially affect spawning, rearing and overwintering habitat downstream of the site. Once again, the effects depend on the type of habitat at or downstream of the site, the crossing type selected, such as bridge or culvert installations, and the construction methods

used. Construction of clear span bridges will cause minimal sediment input, and the placement of a culvert will cause inputs of larger amounts of sediment. Site-specific design for all-weather road crossing construction will consider drainage patterns and erosion control to reduce sediment input to watercourses.

The quantity of sediment entrained during access road crossing construction is typically lower than the amount resuspended during construction of pipeline watercourse crossings. Inputs of sediment could occur through operations while all-weather roads are being used. Mitigation through design criteria and by revegetating banks will reduce effects following construction.

Effects of Surface Runoff on Sediment Deposition

Land disturbance caused by construction and operation of the pipeline and other project components on previously unaltered terrain might result in higher sediment runoff compared with natural conditions. However, sediment yield or suspended sediment entrainment and deposition will only increase if the material enters a waterbody. The changes in basin sediment yield depend on the sediment source, and on the transport of sediment to the receiving waterbody, that is on surface runoff characteristics and capacity, distance to watercourse, drainage density, drainage slope and basin size. Mitigation measures will reduce the amount of sediment that could enter a waterbody.

Effects of Erosion on Sediment Deposition

Erosion is one way in which sediments might be entrained in runoff and deposited in a waterbody. Potential causes of erosion are:

- bank disturbance during all-weather access road and pipeline crossing construction
- uncontrolled runoff from facilities, infrastructure sites or borrow sites
- scouring at barge landing sites
- waves generated by barge and truck traffic

Erosion from disturbed or unstable banks or disturbed substrates at pipeline watercourse crossings might increase sediment loads and affect habitats downstream of the crossing. Crossings of Large River, Active I and Active II Channels with steep approach slopes are most susceptible to incidental erosion. Sediment inputs from erosion along the right-of-way and banks of the watercourse will decline during operations, once previously disturbed areas begin to revegetate. Because most watercourses will be frozen during construction, most sediment input will occur during the spring freshet when suspended sediment concentrations are already naturally high and many watercourses are already subject to scour. Watercourses with stabilized banks will clear up shortly after breakup and are unlikely to contribute further sediment loading thereafter.

Site-specific erosion and sediment control plans for construction and operations will reduce erosion because of bank disturbance and limit input of sediment into watercourses. Mitigation measures to maintain bank stability and revegetation of approach slopes will limit inputs of sediment from bank erosion. Regularly monitoring erosion-prone slopes and repairing eroded areas as required will also limit erosion and limit sediment reaching the waterbody. Because mitigation measures will control erosion and prevent sediment from reaching waterbodies, the effects of sedimentation from erosion at watercourse crossings are expected to be limited.

Development of infrastructure sites changes runoff coefficients. Runoff discharge and velocity will be greater in areas where vegetation has been removed and the land surface graded. Increased rates of surface runoff increase the potential for erosion. Locating sites away from waterbodies and implementing measures to intercept flow or to dissipate flow velocity will prevent erosion at pipeline facilities and infrastructure sites. Because erosion control will avoid sediment inputs, because of erosion from runoff at facilities, infrastructure sites or borrow sites are expected to be less than the effects of sedimentation from instream work during crossing construction.

A barge landing might divert the flow of a watercourse along its shoreline and cause localized erosion and scouring. There could be some localized redistribution of sediment in the immediate vicinity of the barge landing. However, sediment concentration increases from barge landing scouring and erosion will be small compared with natural sediment levels in the Mackenzie River.

The wake from vessels creates waves that might affect shorelines. As well, heavy trucks driving on winter roads create under-ice waves that also potentially increase bank or shoreline erosion. The amplitude of these waves compared with natural conditions is not considered large enough to affect shoreline or bank erosion.

Effects of Potential Dredging on Sediment Deposition

Dredging might be required at barge landing sites to facilitate installation of spud barges and barge access. Fish habitat near the site might be affected by deposition of entrained sediment. However, the amount of dredging, if any, for barge landing construction and operation is expected to be minor because most of the barge landings are at existing sites, although some are not currently in use.

Effects of Channel Blockage from Frost Bulb Formation

Subzero operating temperatures of segments of the gas pipelines can cause groundwater flowing below the watercourse bed to freeze around the circumference of the pipe, forming a frost bulb. The diameter of the frost bulb will grow over time until equilibrium between freezing and melting is reached.

The part of the frost bulb below the pipe will remain all year during operations, whereas the part of the frost bulb above the pipe will be subject to a seasonal freeze-thaw cycle. The size of the frost bulb and the resulting magnitude of effects on groundwater and watercourse flow are site-specific and influenced by:

- surface water flow
- groundwater flow
- substrate particle size
- pipe temperature
- soil temperature
- burial depth of the pipe

Blockage of flow during winter in watercourses that normally have flowing surface water beneath the ice might cause a reduction of habitat at and downstream of the crossing location. Reduction or interruption of flow might affect overwintering habitat and spawning and nursery habitat. A frost bulb could also partially or completely block the watercourse under certain conditions, impeding or completely blocking fish movement upstream, such as for spawning, or between overwintering habitats.

Small Active I and large Active II Channels will have the highest risk of complete flow blockage by frost bulbs in winter because of the shallower depth of flow and narrower watercourse width.

Insulating the pipe or burying it deeper at watercourse crossings will ensure that a thaw zone persists beneath the watercourse bed in Active I or Active II Channels susceptible to large frost bulb growth. This talik thaw zone will prevent frost bulbs from penetrating the channel bottom.

Although Active II Channels freeze to the bottom in winter, they might serve as migratory corridors for fish during the open-water period. Preliminary thermal simulations (Nixon 2003) predict that pipe temperatures will not delay thawing of the channel in the spring and that the frost bulb above the pipe will continue to thaw throughout the summer. Therefore, blockage or interference with spring fish movements is not expected.

The temperature of the gas in segments of the pipe through the SSA will be below freezing. This might cause Active II Channels to freeze earlier in the fall, and may partially block groundwater flow. Because Active II Channels are unlikely to provide overwintering or spawning habitat because of their intermittent flow, earlier freezing or partial groundwater blockage is not expected to affect fish movement. Fish in an Active II Channel would migrate out of the system to overwintering habitats at the onset of lower flow and colder temperatures. Excess blockage of groundwater flow may require the use of insulation or deeper burial of the pipeline at some Active II Channels.

Lack of groundwater flow in Vegetated Channels makes frost bulb formation unlikely. Because habitat features of Vegetated Channels and adjacent areas are the same, any new drainage pathways resulting from frost heave would still permit access to similar habitat features upstream. The effect of frost bulb formation on fish movement will be localized and limited to a small number of watercourses.

Blockage of Fish Passage

Fish passage might be blocked at winter road crossings of fish-bearing watercourses. Blockages result from snow and ice bridges that remain in place on winter roads or from culverts that are not adequately sized or installed to allow fish passage. Crossings will be designed for fish passage, where required. Snow and ice bridges on winter roads will either be removed before the spring freshet or will be notched to ensure flow is not disrupted. All-weather access road watercourse crossings will be either clear-span bridges or culverts that have been hydraulically designed to allow fish passage. These measures should prevent any effects on fish because of blockage of fish passage.

Effects of Water Withdrawals

Water withdrawal from local waterbodies will be necessary for industrial and domestic potable water use. Water withdrawal might affect flow and water levels in lakes and watercourses. Lower lake levels might change:

- shoreline habitat, such as littoral zones and areas with macrophyte growth
- overwintering capacity of fish-bearing lakes
- primary productivity, that is, effect on food for fish
- outlet watercourse discharge

Similarly, reduced flow might affect spawning, rearing, feeding, migration and overwintering habitats of fish-bearing watercourses, and it might affect watercourse productivity and the availability of food for fish, such as benthic invertebrates. It is assumed that waterbodies selected as sources of water for the project will have sufficient volumes, recharges and flow to ensure that water withdrawal will not adversely affect fish habitat.

Effects Because of a Change in Surface Water Flow

Placement of project components, such as camps, roads, barge landings, stock piles, airstrips and borrow sites, on previously unaltered terrain might reduce permeability and infiltration and change surface drainage patterns. These changes might cause a higher runoff coefficient, which results in higher volumes of runoff over shorter periods than would occur under natural conditions. These increased levels of runoff could affect fish or fish habitat. However, following the implementation of mitigation measures, increased runoff volumes resulting from

the project are expected to have limited and localized effects on fish or fish habitat.

Effects on Fish Health from Water Quality Changes Because of Spills

Small scale spills of some substances, such as fuel, oil, grease from accidental leaks, or spills from equipment working at infrastructure sites, along the banks or in the watercourse, if intercepted by surface runoff, have the potential to reach surface waters.

Small spills might affect fish health, including normal survival, growth, development or reproduction. Following the implementation of good environmental management practices, contingency plans and emergency response plans the potential of spills reaching receiving waterbodies will be greatly reduced, such that no adverse effects are expected.

Effects on Fish Health from Water Quality Changes Because of Wastewater Discharge

The discharge of domestic wastewater from the camps might increase the concentration of nutrients such as nitrates and phosphates in the receiving waterbodies. Increased nutrients in waterbodies that are particularly sensitive or vulnerable to changes in trophic status might cause eutrophication by enrichment of nutrients. In shallow lakes, eutrophication might result in low dissolved oxygen concentrations, which might affect fish survival, particularly in winter.

Several wastewater treatment and disposal options are being evaluated, and options will vary depending on camp size and location. Potential receiving waters for treated effluent have not yet been identified.

Effects on water quality resulting from domestic wastewater will be managed to comply with regulatory requirements. Wastewater will be treated and source waterbodies selected so the magnitude of effect on water quality will be low. The release will not cause an unacceptable change in the trophic status or exceed other water quality thresholds in the receiving waterbodies. Because the effects of domestic wastewater discharge on water quality will be mitigated, no adverse effects on fish health are predicted.

Water used for the pressure testing of pipelines might be discharged to surface waters after appropriate treatment. Test water will typically be drawn from local waterbodies and might be treated with additives, such as corrosion inhibitors, glycol or methanol antifreeze, or products for leak detection. Some additives can be deleterious to fish and other aquatic organisms. The treatment and the types and amounts of additives that will be used have not been confirmed.

Any controlled discharged pressure test water will not cause unacceptable changes in trophic status or exceed other water quality thresholds in the receiving

waterbodies and will comply with regulatory requirements. Because the discharge will not affect water quality in the receiving waterbody, no effects on fish health are expected.

Effects of In-Water or Near-Shore Detonations of Explosives

Explosives might be required at selected watercourse crossings for trench excavation. Use of explosives in or near water might damage fish and other aquatic organisms. Detonation of the explosive produces a compressive shock wave followed by a rapid decay to lower than ambient pressures (Wright and Hopky 1998). This rapid change in pressure might cause the swim bladder of a fish and other organs, such as the kidney, liver and spleen of a fish to rupture or haemorrhage.

Effects of in-water detonation of explosives will be limited to fish occupying overwintering habitat in Active I Channels or Large River Channels. The area of effect is limited to the immediate crossing location. No effects on fish are expected if there is no overwintering habitat at the crossing. Active II or Vegetated Channels will not be affected. The exposure time is extremely short, that is, limited to the period of detonation.

Explosives might also be needed to develop borrow sites, though it is expected that borrow sites will be sufficiently far from fish-bearing waterbodies not to affect the fish.

Summary of Primary Mitigation Strategies – Fish and Fish Habitat

Table 8-25 provides a summary of the primary mitigation strategies related to potential effects on fish and fish habitat.

Table 8-25: Mitigation Strategies for Fish and Fish Habitat

Potential Effect	Primary Mitigation Strategies
Direct effects on fish habitat	<ul style="list-style-type: none"> • Reduce the amount and duration of in-water activities. • Locate construction activities away from waterbodies where practical and according to regulatory requirements. • Use clear span bridges or culverts on all-weather roads to cross watercourses. • Avoid spawning, rearing or overwintering habitats, unless authorized. • Where practical, implement measures to avoid harmful alteration, disruption or destruction of fish habitat resulting from the project footprint. • Select the appropriate watercourse crossing technique for the watercourse.

Table 8-25: Mitigation Strategies for Fish and Fish Habitat (cont'd)

Potential Effect	Primary Mitigation Strategies
Suspended sediments	<ul style="list-style-type: none"> • Implement erosion and sediment controls such as grading and ditching to direct runoff through silt fences, sediment traps, vegetation, berms or isolation areas as appropriate for the location. Monitor effectiveness of erosion controls through routine inspection. • Set back facilities and developed areas from waterbodies, where practical. • Install temporary erosion-control structures before spring breakup. • Install long-term erosion-control structures on slopes and stream banks, where required. • Install ditch plugs on open cut crossings of Large Rivers and Active I Channels and keep them in place if necessary until pipe installation is complete. • Reduce disturbances near watercourse banks when practical. • Reclaim, stabilize and armour banks as necessary following pipeline crossing installation. • Plan work to avoid delays between ditching, pipe installation and backfilling. • Use native backfill where spawning or overwintering habitat is present downstream, wherever practical. • Undertake watercourse crossing construction in winter, where practical, during periods of low or no flow. Summer crossing construction will take place at select locations, where necessary. • Locate borrow sites away from waterbodies where practical.
Channel blockage from frost bulb	<ul style="list-style-type: none"> • Increase burial depth of pipeline or use insulation at Active I and Active II Channel crossings that are susceptible to frost heave or frost bulb growth where fall spawning or overwintering habitat is present.
Blockage of fish passage by access roads	<ul style="list-style-type: none"> • Notch or remove ice and snow bridges before spring breakup to ensure flow is not impeded. • Design culverts or flumes on all-weather roads to provide fish passage.
Water withdrawals	<ul style="list-style-type: none"> • Source water from lakes and other waterbodies based on criteria established by the DFO Protocol dated June 2004, or as otherwise authorized. • Record the volume of water withdrawal and ensure volumes comply with regulatory requirements.

Table 8-25: Mitigation Strategies for Fish and Fish Habitat (cont'd)

Potential Effect	Primary Mitigation Strategies
Change in surface water flow	<ul style="list-style-type: none"> • Implement drainage controls such as grading and ditching to direct runoff through silt fences, sediment traps, vegetation, berms or isolation areas as appropriate for the location. • Set back facilities and developed areas from waterbodies. • Install long-term structures on slopes and watercourse banks, where required, that reduce runoff velocities. • Reduce the amount of impermeable area at facility and infrastructure sites. • Reduce disturbances near watercourse banks where practical. • Reclaim, stabilize and armour banks as necessary following pipeline crossing installation. • Develop and implement site-specific drainage and storm water management plans where required.
Wastewater discharge	<ul style="list-style-type: none"> • Release water to the watershed in a controlled manner such that the effects to the receiving waterbodies are reduced. • Ensure quality of discharge waters meets appropriate water quality discharge criteria. • Dispose of wastewater at approved locations when wastewater cannot be appropriately treated for release to the watershed.
Spills	<ul style="list-style-type: none"> • Implement management practices, contingency plans and emergency response plans to prevent and address leaks and spills. • Employ a leak-detection system. • Use environmentally acceptable hydraulic fluid in hydraulic systems of machinery working in water. • For fuel tanks > 4,000 L, store fuel in either double-walled tanks or in single-walled tanks with secondary containment systems as required by regulations. • Set back storage sites for fuels, lubricating oils, chemicals or other hazardous materials at least 100 m from any body of water or protect from flooding, unless otherwise authorized. • For pipeline activities, wash, maintain and refuel vehicles at least 100 m from any waterbody unless otherwise authorized.
Use of explosives	<ul style="list-style-type: none"> • Follow the <i>Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters</i> (Wright and Hopky 1998) if in-water use of explosives is required.

TITLE	Application for Land Use Permits for Land within the Municipal Boundaries of Norman Wells, Fort Good Hope and Tulita
SECTION	8: Environmental and Resource Effects
SUBJECT	3: Human Environment

INTRODUCTION

This subject contains a description for socio-economics, traditional culture, non-traditional land and resource use, protected areas and heritage resources aspects of the human environment in the SSA and is presented under the following headings:

- People and the Economy
- Infrastructure and Community Services
- Individual, Family and Community Wellness
- Traditional Culture
- Non-Traditional Land and Resource Use
- Protected Areas
- Heritage Resources

The purpose of the human environment section is threefold:

- to present the relevant and currently available information on the recent historic background and existing circumstances of the communities and people that might be affected by the project
- to identify and address the human environment effects of the project on the communities and region
- to identify measures to mitigate any potentially adverse effects

The first part of the human environment section describes the baseline for the study area, that is, existing conditions in the communities and region that might be affected by construction and operations. Knowledge of these conditions is essential to understanding how communities in the study area might experience project effects. This is followed by an analysis of the relevant indicators and descriptions of the various project human environment effects, after general mitigation measures have been applied.

Changes the project will induce in baseline conditions will generate both adverse and positive effects. The effects of a project-induced substantial increase in income are an example. The extra income might be saved, invested or spent by individuals to improve their standard of living and family well-being, or might be spent on socially disruptive or destabilizing behaviour. In addition to this element

of individual choice, the overall importance of many potential effects depends on the attitudes and perceptions of affected communities, groups and individuals.

Complicating the process further is the combined effects of many project components on one component of the human environment. In fact, most human environment effects are, by nature, combined effects, because causality is not often clear enough to determine which component or activity results in what effect.

Because of the combined effects, and the complex and dynamic nature of human environment effects, that is, individual attitude and choice, the challenge continues beyond assessment to mitigation, or perhaps more appropriately, management, measures. The analysis assumes both an existing best practice management framework, and proposed new or enhanced mitigation measures. These are integrated with various project plans, agreements and programs relating to human environment issues and effects, such as:

- benefits plans relating to Canada
- benefits and access agreements with First Nations
- the proposed agreements between Imperial and the GNWT

The nature, scope and magnitude of many expected project-related human environment effects, will require management plans and programs addressing these effects to have a coordinated and collaborative response from:

- the project
- Aboriginal, territorial and federal government agencies
- affected communities and individuals

Most human environment effects are expressed as marginal changes in levels of existing conditions that involve many issues directly influenced by individual, community and government decisions and that are linked to public service delivery. As a result, these human environment effects cannot be managed by project proponent decisions and actions alone, and are presented in a manner that reflects the shared responsibility focus of the mitigation measures.

For each subject area, mitigation measures are presented that reflect the complex and inter-related causes of effects and the requirement for shared responsibility in addressing them. The mitigation measures show the interfaces among parties where choices and decisions can be made to:

- share responsibility
- show the need for cooperative management among regulators, communities and affected people
- identify specific actions that could be taken

The results of these management actions are expressed as residual effects in the Assessment and Management part of the human environment subject.

HUMAN ENVIRONMENT SETTING

This topic contains a description of the setting for socio-economics, traditional culture, non-traditional land and resource use, protected areas and heritage resources aspects of the human environment in the SSA. It provides information on the communities of Colville Lake, Deline, Fort Good Hope, Norman Wells and Tulita. The regional trends reflected in this topic generally apply to the SSA communities, although some community-specific effects are also addressed.

People and the Economy

The SSA is divided up into three districts that include four predominantly Aboriginal communities, and one predominantly non-Aboriginal community.

- Fort Good Hope and Colville Lake are located in the K'ahsho Got'ine District.
- Tulita and the predominantly non-Aboriginal community of Norman Wells are located in the Tulita District.
- Déline is located in the Déline District.

The 2003 estimated population of the SSA communities was 2,504, including 797 in Norman Wells (Table 8-26). Census counts between 1991 and 2001 show increases for the Aboriginal communities of Colville Lake and Tulita.

Table 8-26: Census Counts and Population Estimates for the Sahtu Communities

Location	Census Population Numbers ^a				Growth 1991–2001 (%)	2003 Estimated Population (No.)
	1986 (No.)	1991 (No.)	1996 (No.)	2001 (No.)		
Northwest Territories	33,830	36,405	35,370	37,360	3	41,872
SSA total	2,105	2,224	2,598	2,330	5	2,504
Norman Wells	627	627	798	666	6	797
Fort Good Hope	562	602	644	549	-9	540
Déline	532	551	616	536	-2	551
Tulita	332	375	450	473	26	489
Colville Lake	52	69	90	102	48	127

NOTE:

^aEstimates are calculated by the GNWT Bureau of Statistics by allocating the demographic components of growth, down to a community level, using information from a variety of sources.

SOURCE: GNWT Bureau of Statistics (2003b, 2004)

Census data for 2001, which indicates that more than 90% of the populations of Fort Good Hope, Déline, Tulita and Colville Lake were Aboriginal (mostly Dene). In Norman Wells, 29% of the population was Aboriginal, mostly Dene and Métis (Table 8-27).

Table 8-27: Ethnicity in the Sahtu Communities (2001 Census Count)

Location	Total Population (No.)	Non-Aboriginal (%)	Aboriginal (%)	Aboriginal Components (Total = 100%) ^a				
				Inuit (%)	Dene (%)	Métis (%)	Multiple ^b (%)	Other Aboriginal ^b (%)
Northwest Territories	37,360	50	50	21	57	19	1	2
Norman Wells	665	71	29	18	42	40	-	-
Fort Good Hope	550	7	92	0	91	9	2	-
Déline	540	8	92	0	96	3	-	2
Tulita	475	7	93	2	81	16	-	-
Colville Lake	100	10	90	0	100	-	-	-

NOTES:
^aNot all percentages add up to 100% due to rounding.
^bA hyphen indicates values held confidential because of small size and random rounding.

SOURCE: GNWT Bureau of Statistics (2003c)

The data in Table 8-28 on labour force activity shows that both the male and female participation rates in the SSA increased between 1991 and 2001, by 4% for males and 7% for females. Male and female employment rates increased between 1991 and 2001 in the Sahtu Aboriginal communities. Although the female employment rates increased in Norman Wells by 9% during this period, the male rates fell by 8%. The unemployment rates of both males and females in the SSA fell by 5% between 1991 and 2001, driven primarily by declines in Fort Good Hope and Tulita.

Table 8-28: Participation, Employment and Unemployment by Gender in the Shtu Communities

Location ^b	Gender	1991 ^a				2001				Difference (2001 minus 1991)		
		Pop. ^c (No.)	Part. ^d (%)	Empl. ^e (%)	Unempl. ^f (%)	Pop. ^c (No.)	Part. ^d (%)	Empl. ^e (%)	Unempl. ^f (%)	Part. ^d (%)	Empl. ^e (%)	Unempl. ^f (%)
Northwest Territories	Male	13,540	83	73	12	13,810	80	72	10	-3	-1	-2
	Female	12,145	73	65	10	13,130	74	67	8	1	2	-2
NWT Aboriginal communities total ^g	Male	2,425	73	54	27	2,470	66	52	23	-7	-2	-4
	Female	2,010	59	46	22	2,225	58	48	17	-1	2	-5
SSA total	Male	625	72	60	19	830	76	66	14	4	6	-5
	Female	535	59	48	16	705	66	58	11	7	10	-5
SSA Aboriginal communities total	Male	385	62	46	28	575	69	57	18	7	11	-10
	Female	325	50	38	20	520	58	48	15	8	10	-5
Norman Wells	Male	240	94	92	4	255	92	84	8	-2	-8	4
	Female	210	79	71	9	230	85	80	5	6	9	-4
Fort Good Hope	Male	195	64	51	24	205	71	63	14	7	12	-10
	Female	180	50	33	28	180	64	53	13	14	20	-15
D�line	Male	195	54	41	24	180	67	44	29	13	3	5
	Female	170	47	41	12	175	51	43	11	4	2	-1
Tulita	Male	125	68	48	35	155	64	58	15	-4	10	-20
	Female	120	54	46	23	135	56	48	13	2	2	-10
Colville Lake	Male	25	80	40	50	35	86	86	0	46	46	-50
	Female	20	50	0	0	30	67	50	50	17	50	50

NOTES:

^aBecause census data is independently randomly rounded (all numbers end in a 5 or 0), totals may not add to 100, especially in small communities.

^bStatistics for very small communities are uncertain and should be considered with caution.

^cPop. – population

^dPart. – participation rate, which is the percentage of population, aged 15 years and older in the labour force

^eEmpl. – employment rate, which is the percentage of population, aged 15 years and older employed during the week before the survey

^fUnempl. – unemployment rate, which is the percentage of the labour force that was unemployed during the week before the survey

^gAll project area communities in the Northwest Territories except Inuvik, Norman Wells, Fort Simpson, Yellowknife, Hay River and Enterprise

SOURCE: Statistics Canada (1991, 2001)

[Table 8-29](#) presents 1991 and 2001 occupational groupings for the total labour force, males and females in the SSA. In 2001 in the SSA, trades and transport, sales and service, and management and business occupations were well represented. Between 1991 and 2001, the proportions in management and business, science, government service, sales and service, and primary industry occupations increased, but the proportion in clerical, and trades and transport occupations declined. During the same time, the percentages of males increased in management and business, government service, science, and trades and transport occupations. The occupational distribution in the SSA was similar to that in the Northwest Territories in 2001, except for the higher proportion in trades and transport occupations in the SSA.

There were two main changes between 1991 and 2001 in occupations in the Aboriginal communities:

- a decline from 25% to 7% among females in clerical occupations
- an increase from 8% to 29% among females in management and business occupations

According to the GNWT Bureau of Statistics definition, the potential labour supply is composed of people of working age who are unemployed and those not participating in the labour force who do want a job, less those who, because of disability, age, illiteracy, or lack of education, skills or training could be considered unemployable. [Table 8-30](#) shows data for 1999, indicating that the potential labour supply was 32% of the working-age population in the SSA Aboriginal communities. The profile of this potential labour supply indicated that 71% need training. In Norman Wells, the potential labour supply was only 10% of the working-age population.

Table 8-29: Labour Force by Standard Occupational Categories in the SSA Communities

Occupation ^{a,b}	Gender	Northwest Territories		SSA Total		SSA Aboriginal Communities		Norman Wells		Fort Good Hope		Déline		Tulita		Colville Lake	
		1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
Labour force, 15+ years	Total (No.)	20,070	20,785	975	1,125	585	695	390	430	215	260	190	210	155	180	25	45
	Male (No.)	11,225	11,115	560	635	335	395	225	240	125	145	105	120	85	105	20	25
	Female (No.)	8,850	9,670	410	480	245	290	165	190	90	110	80	90	65	75	10	15
All occupations	Total (No.)	19,675	20,425	970	1,110	575	685	395	425	215	260	180	200	155	180	25	45
	Male (No.)	11,030	10,935	565	615	335	385	230	230	125	145	105	115	90	100	15	25
	Female (No.)	8,645	9,490	405	490	240	295	165	195	90	110	75	85	65	80	10	20
Management, business, finance and administration occupations	Total (%)	18	21	13	19	9	17	20	22	7	17	14	15	6	17	0	22
	Male (%)	19	19	15	18	9	14	24	24	12	17	14	17	0	10	0	0
	Female (%)	16	24	11	30	8	29	15	31	0	27	13	18	15	25	0	100
Clerical occupations	Total (%)	17	9	12	6	10	5	15	7	9	4	11	8	13	6	0	0
	Male (%)	6	3	2	2	0	0	4	4	0	0	0	0	0	0	0	0
	Female (%)	32	16	27	9	25	7	30	13	22	0	27	12	31	13	0	0
Natural and applied sciences, and related occupations	Total (%)	4	7	3	6	2	3	5	12	0	4	6	0	0	6	0	0
	Male (%)	6	11	5	9	3	3	9	20	0	0	10	0	0	10	0	0
	Female (%)	1	3	0	4	0	3	0	5	0	9	0	0	0	0	0	0

Table 8-29: Labour Force by Standard Occupational Categories in the SSA Communities (cont'd)

Occupation ^{a,b}	Gender	Northwest Territories		SSA Total		SSA Aboriginal Communities		Norman Wells		Fort Good Hope		Déline		Tulita		Colville Lake	
		1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
Health occupations	Total (%)	3	4	2	3	2	3	3	2	0	4	0	0	6	6	0	0
	Male (%)	1	1	0	2	0	3	0	0	0	0	0	0	0	0	0	40
Social services, education, government service and religious occupations	Female (%)	6	7	5	2	4	0	6	5	0	0	0	0	15	0	0	0
	Total (%)	9	12	10	13	15	15	3	8	14	15	19	15	6	14	40	22
Art, culture, recreation and sport occupations	Male (%)	6	7	2	8	3	9	0	7	8	10	0	9	0	10	0	0
	Female (%)	14	17	21	20	31	27	6	10	22	27	47	29	15	19	100	50
Sales and service occupations	Total (%)	2	2	2	3	3	3	0	2	5	4	6	0	0	6	0	0
	Male (%)	2	2	2	3	3	5	0	0	0	7	10	9	0	0	0	0
Trades, transport and equipment operators, and related occupations	Female (%)	2	3	2	2	4	3	0	0	11	0	0	0	0	13	0	0
	Total (%)	18	22	18	21	17	22	18	20	23	23	14	23	16	19	0	22
Trades, transport and equipment operators, and related occupations	Male (%)	15	18	9	11	9	13	9	9	8	17	10	13	11	10	0	0
	Female (%)	23	27	30	33	29	32	30	33	44	36	20	35	23	31	0	0
Trades, transport and equipment operators, and related occupations	Total (%)	16	17	25	23	24	25	25	20	19	21	25	28	35	28	0	22
	Male (%)	27	30	37	41	39	44	35	35	32	38	43	48	50	50	0	40
Trades, transport and equipment operators, and related occupations	Female (%)	2	2	7	2	4	0	12	5	0	0	0	0	15	0	0	0

Table 8-29: Labour Force by Standard Occupational Categories in the SSA Communities (cont'd)

Occupation ^{a,b}	Gender	Northwest Territories		SSA Total		SSA Aboriginal Communities		Norman Wells		Fort Good Hope		Déline		Tulita		Colville Lake	
		1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
Occupations unique to the primary industry	Total (%)	5	4	5	7	5	9	5	4	9	10	0	5	8	0	22	
	Male (%)	8	8	9	11	9	14	9	7	16	17	0	9	11	0	40	
	Female (%)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Occupations unique to the processing, manufacturing and utilities industries	Total (%)	4	1	2	3	2	3	3	4	5	0	0	10	0	0	0	
	Male (%)	7	2	4	2	3	0	4	4	8	0	0	0	0	0	0	
	Female (%)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Occupations not classified elsewhere	Total (%)	3	0	4	0	3	0	4	0	5	0	0	0	6	0	0	
	Male (%)	4	0	6	0	6	0	7	0	8	0	0	0	11	0	0	
	Female (%)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

NOTES:^aNumber and percentage of population, aged 15 years and older^bBecause census data is independently randomly rounded (all numbers end in a 5 or 0), totals may not add to 100, especially in small communities.

SOURCE: Statistics Canada (1991, 2001), prepared by GNWT Bureau of Statistics

Table 8-30: Profile of the Working-Age Population in the Sahtu Communities (1999)

Profile Category	NWT Aboriginal Communities ^a	SSA Total	Norman Wells	Sahtu Aboriginal Communities Total	Fort Good Hope	Déline	Tulita	Colville Lake ^b
Population 15+ (No.)	5,821	1,917	651	1,266	471	422	307	66
Potential labour supply (No.)	1,797	476	67	409	151	161	78	17
Potential labour supply ^c (%)	31	25	10	32	32	38	25	26
Need training ^d (%)	53	68	46	71	72	76	74	-
Would do rotational work ^d (%)	73	74	46	78	84	81	80	-
Male ^d (%)	60	56	43	58	53	63	68	-
Aboriginal ^d (%)	94	88	61	93	97	94	100	-
Less than high school education ^d (%)	68	67	54	68	72	74	65	-
NOTES:								
^a All project area communities in the Northwest Territories, except Inuvik, Norman Wells, Fort Simpson, Yellowknife, Hay River and Enterprise								
^b A hyphen indicates numbers too small or cannot be released								
^c Percentage of population, aged 15 years and older								
^d Percentage of potential labour force								
SOURCE: Calculated from GNWT Bureau of Statistics (1999)								

Table 8-31 shows that in the SSA Aboriginal communities, average employment income dropped between 1996 and 1999, then increased between 1999 and 2001 to almost \$24,000 per year. This was in contrast to the strong growth in average employment income in Norman Wells, reaching over \$51,000 in 2001. The average number of monthly income support beneficiaries in all SSA communities declined markedly between 1996 and 2003, reflecting changes in government policy that introduced more stringent income support criteria (GNWT Education, Culture and Employment [ECE] regional superintendent 2002, personal communication).

Table 8-31: Employment Income and Income Support Beneficiaries in the Sahtu Communities

Location	Employment Income ^a			No. of Income Support Beneficiaries ^b			
	1996 ^c (\$)	1999 ^c (\$)	2001 ^c (\$)	1996 ^c	1999 ^c	2001 ^c	2003 ^c
Northwest Territories	33,748	35,450	38,497	102	86	59	51
NWT Aboriginal communities ^d	22,228	23,551	26,135	-	-	-	90
SSA total	30,990	30,980	33,885	135	105	53	46
Norman Wells	44,121	47,428	51,338	17	18	11	10
SSA Aboriginal communities total	23,204	21,386	23,817	-	-	-	62
Fort Good Hope	19,419	20,469	24,197	177	136	61	61
Déline	20,756	21,388	24,819	236	135	103	96
Tulita	19,659	22,716	22,086	119	159	69	29
Colville Lake	-	-	-	219	114	57	-
NOTES:							
^a Dollar amounts not adjusted for inflation							
^b Average monthly number of recipients and dependents, calculated based on population estimates for 1996 to 2002, prepared by GNWT Bureau of Statistics							
^c A hyphen indicates data not available, or held confidential because of low frequencies							
^d All project area communities in the Northwest Territories, except Inuvik, Norman Wells, Fort Simpson, Yellowknife, Hay River and Enterprise							
SOURCE: GNWT Bureau of Statistics (2002a, 2003d)							

The cost of living in the SSA was between 50 and 65% higher than in Edmonton in 2000. However, in Colville Lake, it was 110% higher in 1997. In the SSA, food prices were 60 to 73% higher than Yellowknife prices in 2001 and in Colville Lake was 113% higher in 1997 (GNWT Bureau of Statistics 2004).

Physical Infrastructure and Community Services

This topic describes physical infrastructure and community services in the SSA.

Norman Wells serves as the transportation hub for the SSA, with daily scheduled air service to Inuvik and population centres to the south. From this centre, scheduled air services fan out to all the smaller Sahtu communities, including Colville Lake ([Table 8-32](#)).

Table 8-32: Transportation Infrastructure in the Sahtu Communities (2001)

Mode of Transportation	Norman Wells	Fort Good Hope	Déline	Tulita	Colville Lake ^{a,b}
Road					
Road access	Winter road	Winter road	Winter road	Winter road	Winter road
Highway	Winter road	Winter road	Déline Winter Road (off Highway No. 1)	Winter road	Colville Lake Winter Road (off Highway No. 1)
Typical opening and closing dates (1997–2000), winter roads	January 11 to March 16	January 6 to March 16	January 28 to March 16	Late January to March 16	-
Rail					
Rail access	None	None	None	None	None
Water^{c,d}					
Marine resupply deliveries per week	8	4	None	4	None
Ownership of facility	2 by GNWT 1 by Imperial Oil	T	N/A	T	N/A
Resupply facility classification	1 private (Imperial Oil facility) 2 Class A	B	N/A	C	N/A
Small boating facilities	Community use facility, beach landing	Beach landing only	Wharf, beach landing, private docks	Public landing, beach landings	Beach landing, community and private docks
Air^e					
Runway length	1,829 m	914 m	762 m	914 m	823 m
Runway surface	Asphalt	Gravel	Gravel	Gravel	Gravel and sand
Owner	GNWT	GNWT	GNWT	GNWT	GNWT
Critical aircraft (largest aircraft able to use runway)	B737	Twin Otter	Twin Otter	Twin Otter	Twin Otter

**Table 8-32: Transportation Infrastructure in the Sahtu Communities (2001)
(cont'd)**

Mode of Transportation	Norman Wells	Fort Good Hope	Déline	Tulita	Colville Lake ^{a,b}
Air^a (cont'd)					
Weather and communication aids	FSS	CARS	CARS	CARS	AWOS
Navigational aids	DME, NDB	DME, NDB	NDB	NDB	None
<p>NOTES:</p> <p>^aA hyphen indicates data not available</p> <p>^bN/A – not applicable</p> <p>^cWater Transportation is designated by the following letters:</p> <ul style="list-style-type: none"> • T – facility owned by federal government • P – privately owned <p>^dWater Facility Resupply Classification:</p> <ul style="list-style-type: none"> • A – >10,000 t cargo and fuel in and out per year, protected access at all water levels, secure moorage for loading and unloading, access for heavy equipment, secure marshalling and storage site. • B – 2,000–10,000 t cargo and fuel in and out per year, secure moorage at all water levels, access 4 hours/day, access for heavy equipment, secure marshalling and storage site. • C – <2,000 t cargo and fuel in and out per year, access for loading and unloading 4 hours/day, access available for heavy equipment, secure marshalling and storage site. <p>^eAir Transportation is designated by the following letters:</p> <ul style="list-style-type: none"> • AWOS – automated weather observation station • CARS – community airport radio station • DME – distance measuring equipment • FSS – flight service station • NDB – nondirectional beacon 					
SOURCE: GNWT Transportation (1995, 2000, 2001)					

Norman Wells has river-based marine resupply, but the only highway connections to the north or south are via the winter road. Thus, truck-based resupply is possible only during the winter from southern destinations. All of the small Sahtu communities have winter road connections with Norman Wells and thus with southern centres as well, permitting winter resupply. Riverside locations make summer marine resupply possible for Fort Good Hope and Tulita (GNWT Transportation 1995, 2000, 2001).

Water delivery and liquid or solid waste disposal services are available in the Sahtu communities. Norman Wells is the only community with infrastructure to deliver water or dispose liquid waste via pipes (50% of the community). With the exception of Colville Lake, whose residents still harvest water with a bucket or blocks of ice and use honey buckets or outhouses, the other Aboriginal communities have their water and liquid wastes trucked (GNWT Municipal and Community Affairs personnel 2002, personal communication). Diesel-fuelled generators provide power in all the communities and the main heating fuel is P-50 fuel oil. However, central areas of Norman Wells also use locally supplied natural

gas (Northwest Territories Power Commission 2002; GNWT Municipal and Community Affairs 2001; GNWT Municipal and Community Affairs personnel 2002, personal communication).

With the exception of Colville Lake, all of the SSA communities have television, radio, and newspaper and mail deliveries three to five times per week. Colville Lake has a courtesy bag that arrives from Fort Good Hope. Public internet access is available in Fort Good Hope, Déline and Tulita, while public connections are available in Norman Wells. No internet connection is available in Colville Lake (GNWT Resources, Wildlife and Economic Development [RWED, now ENR] 1999; Northwestel personnel 2001, personal communication; GNWT Municipal and Community Affairs personnel 2002, personal communication).

Table 8-33 shows that 20% of housing in the Sahtu communities needed major repairs in 2001. The situations in Colville Lake and Norman Wells were better than in the Northwest Territories as a whole. The community with the highest percentage of housing needing major repairs was Fort Good Hope, at 35%.

Table 8-33: Housing and Repairs Needed in the Sahtu Communities (2001)

Location	Total Houses (No.)	Needs Regular Maintenance ^{a,d} (%)	Needs Minor Repairs ^{b,d} (%)	Needs Major Repairs ^{c,d} (%)
Northwest Territories	12,565	52	32	16
SSA total	735	50	30	20
Norman Wells	270	63	24	11
Fort Good Hope	155	29	35	35
Déline	150	50	33	23
Tulita	130	46	31	23
Colville Lake	30	50	33	0

NOTES:
^aRegular maintenance refers to such conditions as requiring painting or furnace cleaning.
^bMinor repairs refers to such conditions as missing or loose floor tiles, brick or shingles, or to defective steps, railing or siding.
^cMajor repairs refers to such conditions as defective plumbing or electrical wiring, or requiring structural repairs to walls, floors or ceilings.
^dNot all percentages add up to 100% due to rounding.

SOURCE: Statistics Canada (2003)

In 2004, Norman Wells and Fort Good Hope have had serious housing shortages. The senior administrative officer for Norman Wells reported in April 2004 that the housing situation was quite strained and there were no vacancies in town that they were aware of (CBC 2004). A severe shortage was also reported as a major concern in Fort Good Hope in September 2002, when 110 people aged 18 to 26 years were actively looking for housing, according to personnel at the local

housing authority (Fort Good Hope economic development officer 2002, personal communication). Even though the statistics would seem to indicate there was a population decrease in the community of Fort Good Hope over the last few years, continued exploration activity in the Colville Lake area and the poor physical state of the houses in the community have led to housing shortages. Conversely, housing conditions in Tulita were better.

The number of people living in SSA households is declining. Conditions in the community had improved in 2002 because people were having smaller families, and people with large families could be accommodated in the larger units (Tulita housing coordinator 2002, personal communication).

Individual, Family and Community Wellness

This section describes the project area in terms of the concept of community wellness. Community wellness refers to the physical, emotional, social and economic well-being of all components of a community, including individuals and families as a functioning whole.

Community Well-Being and Delivery of Social Services

Alcohol abuse is reported by RCMP and social service personnel to be a factor in most of the problems they deal with. The hospitalization data in [Figure 8-4](#) indicates that although Norman Wells experienced generally declining rates, rates have fluctuated in Tulita, Fort Good Hope, Déline and Colville Lake.

Fort Good Hope, Déline and Tulita have similar patterns of alcohol offence rates, which generally fell within the same timeframe, 1998 to 2001. However, rates increased in 1999 in Fort Good Hope and in 1998 in Tulita (RCMP G Division 2002, RCMP local detachments 2002). The increased incomes from 2003–2004 winter exploration work in the Fort Good Hope and Colville Lake areas have led to increased substance abuse and other associated social problems (Sahtu Region Health and Social Services Authority [SRHSSA] chief executive officer 2004, personal communication). Substance abuse by teenagers in the SSA is also reported to be unusually high (Fort Good Hope RCMP officer 2002, personal communication).

According to the statistics, the spousal assault rates per 1,000 people in the SSA declined. The rate in Fort Good Hope tended to fluctuate but is explained as variations in policing practices (RCMP local detachments 2002). Nurses in Norman Wells reported in the fall of 2002 that there had been an increase in domestic violence there that is not reflected in the statistics because people are reluctant to call the police or to report it (Norman Wells GNWT HSS nurses 2002, personal communication). There is also a lack of family violence shelters in the SSA. The shelters in Inuvik and Hay River accommodate those able to reach either one from the Sahtu communities. Social workers in Tulita felt that the lack

of shelters and treatment centres in the SSA was a problem requiring immediate attention (Tulita GNWT HSS personnel 2002, personal communication).

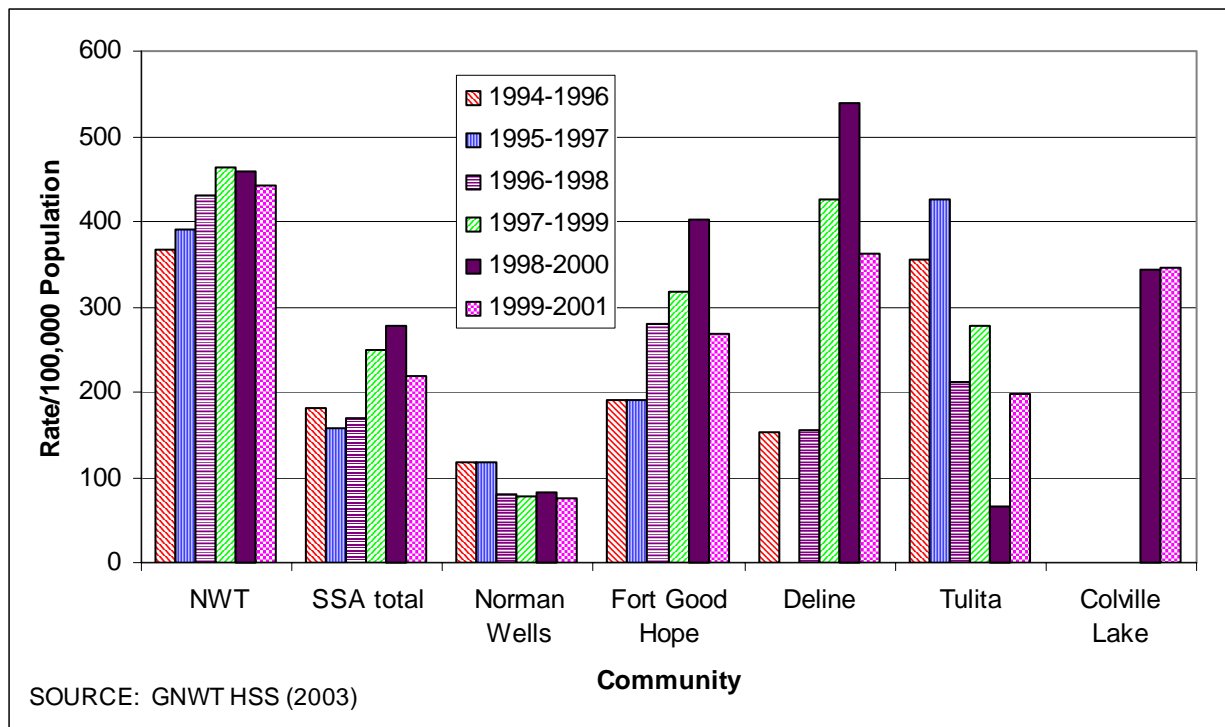


Figure 8-4: Hospitalizations for Alcohol-Related Illnesses in the Sahtu Communities

The rates of children taken into care are seen as indicative of family dysfunction. These rates have fluctuated in the SSA and SSA Aboriginal communities between 1995–1996 and 2002–2003.

Young Offenders Act offence rates have fluctuated in the SSA communities between 1997 and 2002, with the highest rates generally found in Fort Good Hope. Overall the rates have tended to increase over the five-year period (Figure 8-5).

Violent crime and property crime rates for the Aboriginal Sahtu communities were higher than those for the Northwest Territories as a whole. The Norman Wells rates were consistently below the Northwest Territories rates. The rates in the other communities fluctuated between 1997 and 2001 for both violent and property crimes (GNWT Bureau of Statistics 2003a).

The executive director of the Northwest Territories Seniors’ Society reported that Elder abuse is an issue in the Northwest Territories (2002, personal communication). A toll-free hotline received over 800 calls during 2001 from all over the Northwest Territories, reporting abuse and other seniors’ problems.

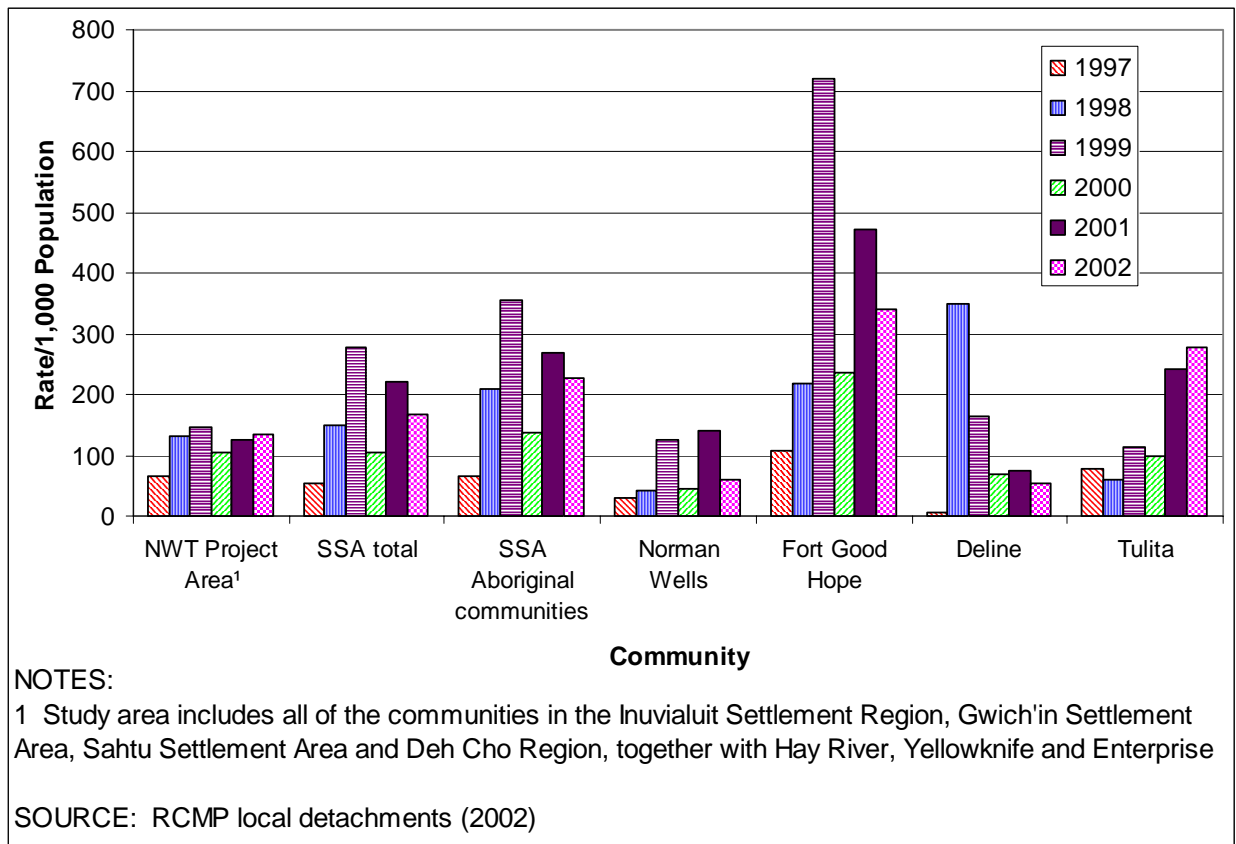


Figure 8-5: Young Offenders Act Offences in the Sahtu Communities

Health Conditions and Health Care Services

Among the health concerns in the North are smoking, sexually transmitted infections (STIs), high rates of accidental and suicidal deaths, babies with fetal alcohol syndrome/fetal alcohol effects (FAS/FAE) and increased rates of diabetes.

Smoking, whether directly inhaled or second-hand, is recognized as being a major cause of illness and death. In 1999, in all of the Aboriginal communities, about 60% of adults, 18 or more years of age, smoked. Only Norman Wells had a lower rate, 42% (GNWT Bureau of Statistics 1999, 2003b). The Northwest Territories Workers' Compensation Board banned smoking in all work places on May 1, 2004, and many municipalities had restricted smoking ordinances before this legislation.

Available data for physician treatment of respiratory illnesses in the SSA were consistently less than half the territorial rates. These rates declined in all Sahtu communities, as in the Northwest Territories, in the late 1990s through the early 2000s. Colville Lake was the exception, where rates began increasing in 1998–2000 (GNWT HSS 2003).

Three-year average rates for STIs for both sexes and all ages in the SSA communities were, for the most part, higher than the Northwest Territories rate. Since 1997–1999, rates in SSA began to increase and were almost double the Northwest Territories average in 2000–2002 (see Figure 8-6). There was a three-fold increase in the rates for both sexes and all ages during this period. Norman Wells and Colville Lake experienced consistently lower rates during this time period.

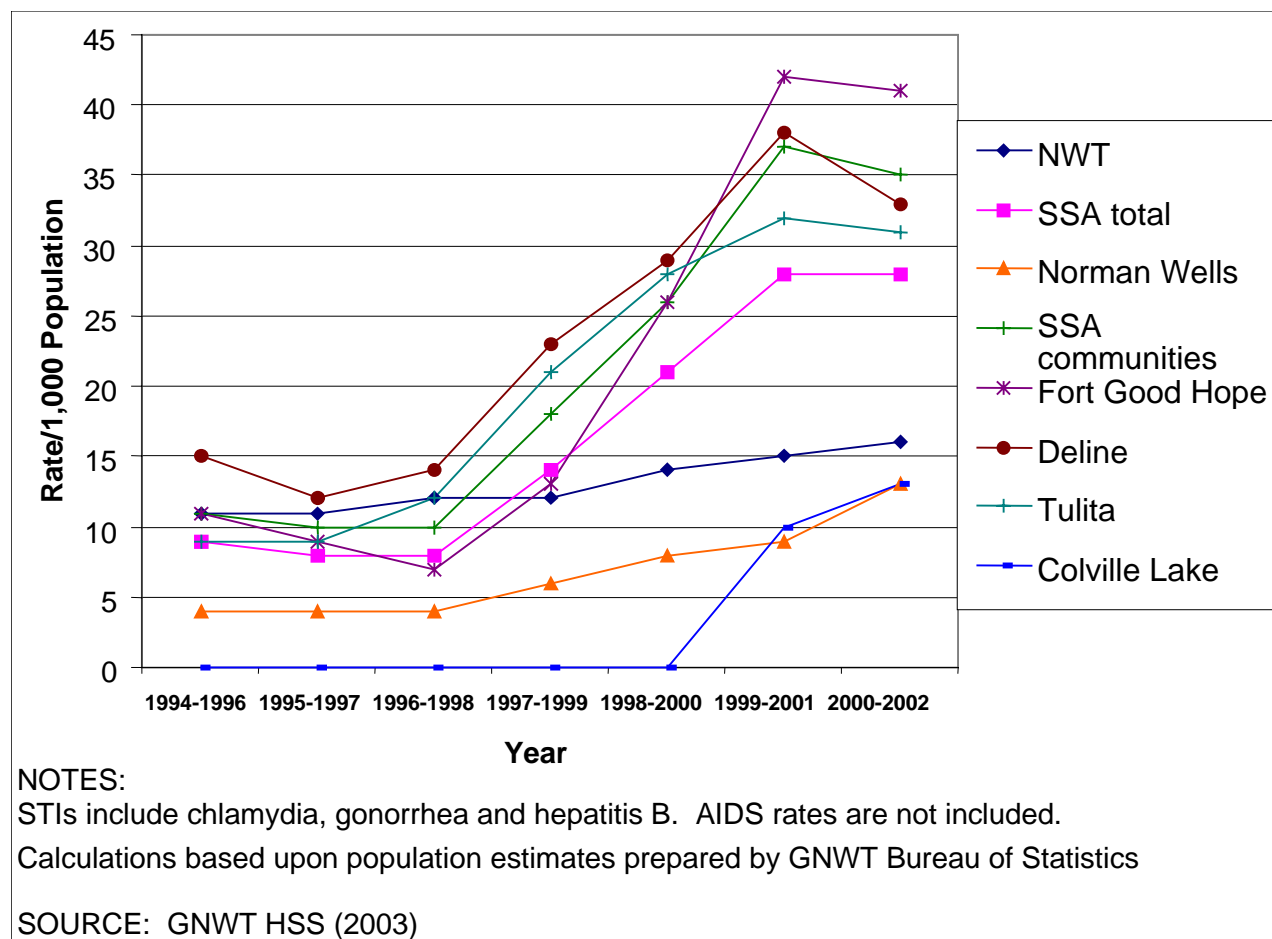


Figure 8-6: Sexually Transmitted Infections in the Sahtu Communities

An inevitable consequence of alcohol abuse among females is the substantial and possibly growing number of babies with FAS/FAE. There are currently no statistics on FAS/FAE babies in the Northwest Territories.

The SSA has the lowest rate of accidental deaths as a percentage of total deaths among the project area regions. The 1994–1998 average for the Sahtu communities was 11% – only half of the Northwest Territories rate of 20%. Only in Colville Lake was the rate high, at 40%.

Between 1994 and 1998, the average number of suicides per year for the five Sahtu communities was 22 per 100,000, compared to the Northwest Territories rate of 12 per 100,000 (GNWT Bureau of Statistics 2003a; Statistics Canada 1996). Suicide is a major and growing concern in the Northwest Territories, both because the incidence of suicide is so high relative to the rest of Canada, and because so many are teenage suicides.

Data since the late 1990s shows that the rates of mental disorders treated by physicians in the SSA communities generally increased until 1997–1999, and then decreased until 2000–2002. However, in Tulita and Colville Lake, the rate increased in 2000–2002. The decline in the Sahtu Aboriginal communities was not as marked as it was in Norman Wells.

Healthcare services for Sahtu communities are served by the Sahtu Region Health and Social Services Authority (SRHSSA). The new authority chief executive officer is developing an integrated service delivery approach to deal with the health and social services issues in the SSA. Presently four of the Sahtu communities have health centres, and Colville Lake has a health station. All five of the communities have access to social services. Hospital care is provided to the SSA by the hospital in Inuvik, with access provided by a readily accessible med-evac airplane.

Social services are available to the SSA communities, and typically include child protection and foster care, income support, mental health, and addictions counselling. There are no family violence shelters in the SSA, so individuals requiring this service need to travel to Inuvik or Hay River. Other services that are not available from the IRHSSA may be sought in Yellowknife or outside the Northwest Territories, upon referral of IRHSSA staff.

Public Safety and Protection Services

There are RCMP detachments in Norman Wells, Fort Good Hope, Déline and Tulita. The Fort Good Hope RCMP detachment consists of four officers. It is responsible for policing Colville Lake.

With the exception of Colville Lake, all of the Sahtu communities have volunteer firefighter units and current emergency plans (GNWT Municipal and Community Affairs 2002).

Education Attainment and Services

Education attainment in the SSA is at a lower level than in the Northwest Territories as a whole. In 2001, 55% of the SSA population aged 15 years and older were high school graduates and the percentage has changed little since 1994. In the largely non-Aboriginal community of Norman Wells, 84% were high school graduates in 2001. Between 1994 and 2001, increases occurred in the

percentages of high school graduates in Déline and Colville Lake, but not in Fort Good Hope or Tulita (GNWT Bureau of Statistics 2003c).

Norman Wells had the highest proportion, 72%, of adults with post-secondary education, trades, technical, college or university training. The highest rate among the Aboriginal communities was in Fort Good Hope, 45%, the lowest rates were found in Tulita, 34%, and Colville Lake, 31%.

Table 8-34 shows gender differences in the levels of education attained in the Sahtu communities in 2001. In the SSA total Aboriginal communities, more males than females were high school graduates, reflected in Déline and Colville Lake, as well as in Norman Wells. However, in Fort Good Hope and Tulita, the situation was reversed. Males had post-secondary education more often than females in Déline and Tulita.

Table 8-34: Education Attainment by Gender in the Sahtu Communities (2001)

Location	Gender	High School Graduate (%) ^a	Some Post-Secondary Trades Training (%) ^a	Some College or University Education (%) ^a	Some Trades Training, College or University (%) ^a
Northwest Territories	Males	64	30	26	56
	Females	66	22	34	56
NWT Aboriginal communities total ^b	Males	43	25	11	37
	Females	44	20	18	38
SSA total	Males	55	31	16	46
	Females	54	20	28	48
SSA Aboriginal communities total	Males	43	24	11	36
	Females	41	17	20	38
Norman Wells	Males	84	45	25	71
	Females	82	27	44	71
Fort Good Hope	Males	48	30	13	43
	Females	50	31	17	47
Déline	Males	41	24	11	35
	Females	34	14	14	29
Tulita	Males	35	23	13	35
	Females	37	0	30	30

**Table 8-34: Education Attainment by Gender in the Sahtu Communities (2001)
(cont'd)**

Location	Gender	High School Graduate (%) ^a	Some Post-Secondary Trades Training (%) ^a	Some College or University Education (%) ^a	Some Trades Training, College or University (%) ^a
Colville Lake	Males	57	0	0	0
	Females	50	33	33	67
NOTES:					
^a Percentages frequently do not add up to 100 for two reasons: Statistics Canada random rounding of frequencies, and small community populations.					
^b All communities in the Northwest Territories project area except Inuvik, Norman Wells, Fort Simpson, Yellowknife, Hay River and Enterprise.					
SOURCE: GNWT Bureau of Statistics (2004)					

These education attainment indicators are influenced somewhat by the numbers of predominantly non-Aboriginal people providing services, such as teachers, nurses and RCMP, who often have graduated from high school and may have some post-secondary training. They typically comprise greater percentages of the total population in small communities, such as Colville Lake, than in larger ones, such as Déline, and thus tend to elevate rates of post-secondary education in small communities. The high percentages in Norman Wells reflects the high number of private and public sector workers that reside in the community.

However, in small communities, well-educated community members may have left the community to access better employment opportunities elsewhere. The adult educator in Fort Good Hope reported that most of their high school graduates have poor skills and need some upgrading before successfully participating in post-secondary training (Fort Good Hope adult educator 2002, personal communication). In contrast, whole families are leaving Fort Good Hope so the parents can get higher education elsewhere (Fort Good Hope principal 2002, personal communication). During 2002, 16 families moved from Fort Good Hope to Inuvik, Norman Wells, Fort Simpson and Yellowknife, almost all to pursue education.

High school dropout rates are almost impossible to calculate because of high mobility rates in and out of the Northwest Territories, and between different areas within the territory. Leaving school before graduation is a concern throughout the Northwest Territories. Stay-in-school initiatives and access to higher levels of education in Northwest Territories communities help to keep students in school and facilitate graduation.

Aurora College community learning centres in Fort Good Hope and Déline offer diploma and certificate programs and courses where there is effective demand. In recent years, the college has offered courses to train individuals to take advantage

of expected increases in petroleum industry and other industrial employment. Unfortunately, apprenticeship training is currently lagging because trainees who have finished the required apprenticeship classroom preparation often cannot find a journey person under whom to complete their training (Aurora College administrative officer 2002, personal communication).

Traditional Culture

The focus of traditional values, lore, skills and disciplines has always been on survival in the environment that is home to the Sahtu. Traditional culture thus involves:

- a language that labels things, indicating their value or importance
- a survival focus, including the knowledge, skill and discipline on which harvesting food and surviving on the land both depend

Traditional foods are recognized as important, both economically and nutritionally. In addition, traditional harvesting has immense symbolic and cultural significance to Aboriginal people, and this forms an additional strong inducement to participate in harvesting traditional foods.

Language retention is taken as an indicator of cultural retention because appreciation of traditional, deeper, spiritual relationships can only be comprehended in traditional language terms. Aboriginal languages are better adapted and more precisely suited to effective resource harvesting, although the lore, skills and disciplines can certainly be communicated in other languages.

Figure 8-7 shows the available findings from the GNWT surveys in 1993, 1998 and 2002. These surveys show that 45% of the adult population in the Sahtu Aboriginal communities, including both Aboriginal and non-Aboriginal respondents, reported having hunted or fished in 1998. The percentages for all adult residents in the Sahtu Aboriginal communities increased between 1998 and 2002, from 46% to 53%. At the same time, there was a decline in harvesting in Norman Wells, from 44% to 38%.

Information on the amount of wildlife food harvested and consumption of country food is available from the Sahtu Renewable Resource Board surveys conducted between 1998 and 2001. The data for 2001 shows the great contribution harvesting has made to the 1,800 Aboriginal residents of the SSA. For each resident, an average of 1.5 caribou, 1.7 geese, 2 ducks, almost 9 fish, and 0.13 moose were harvested in that year. Furs were obtained from almost 1,500 furbearers, excluding rabbit and hare. Some of these animals, e.g., beaver, were eaten.

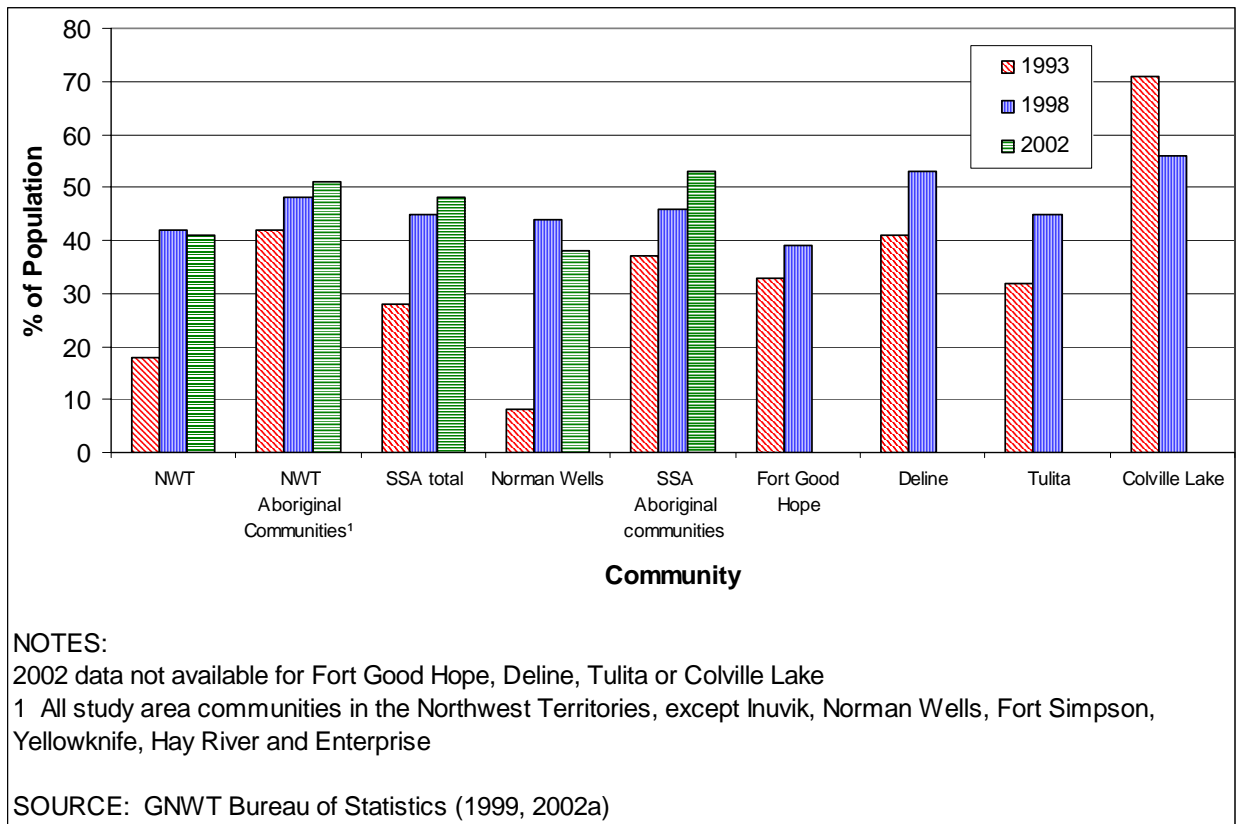


Figure 8-7: Adults Who Hunted or Fished in the Sahtu Communities

The harvested total edible weights of mammals, birds and fish by Sahtu Dene and Métis for 1999 and 2001 yielded a total of 222,064 kg, or about 124 kg per person for the Dene, and 162,016, or about 90 kg per person for the Métis. The monetary value of this SSA wildlife harvest was calculated based on the cost of replacing the edible weight with store-bought beef, chicken and fish. According to these calculations, the total replacement costs for the edible SSA wildlife harvests were \$3,208,775 for 1999 and \$2,320,686 for 2001.

The 2001 Sahtu harvest data substantiates the survey finding that 87% of Sahtu Aboriginal community residents reported that in 2002, half or more of the food they consumed was country food. In Norman Wells, the comparable figure was 31% (GNWT Bureau of Statistics 2002a, 2002b; Sahtu Renewable Resource Board 2001).

GNWT data documenting trapping activity by Sahtu trappers indicates that the percentage of males aged 25 to 59 years who trapped fell from 82% to 26% between 1987 and 1993 (GNWT RWED 1987, 1993, 1999, 2002). The greatest involvement was in the small and isolated community of Colville Lake, where almost every year 90% or more of males aged 25 to 59 years were trappers. In

contrast, only 4% of males in Norman Wells were trappers in 1987, and this declined to 1% in 2002.

Between 1987 and 1993, average income per trapper in the Northwest Territories Aboriginal communities as a whole declined sharply, to a maximum of one third of the 1987 average (not adjusted for inflation). For the Sahtu Aboriginal communities, the data shows a decline from about \$4,100 per trapper in 1987 to about \$1,600 in more recent years (GNWT RWED 1987, 1993, 1999, 2002).

Between 1989 and 1999, the proportion of Sahtu adults in Aboriginal communities who reported they could speak an Aboriginal language declined from 86% to 64%. Even so, in 1999, almost two thirds were still proficient in their mother tongue. The data shows that language retention is strongest in Déline, where 93% of adults could still speak their language in 1999 (Figure 8-8).

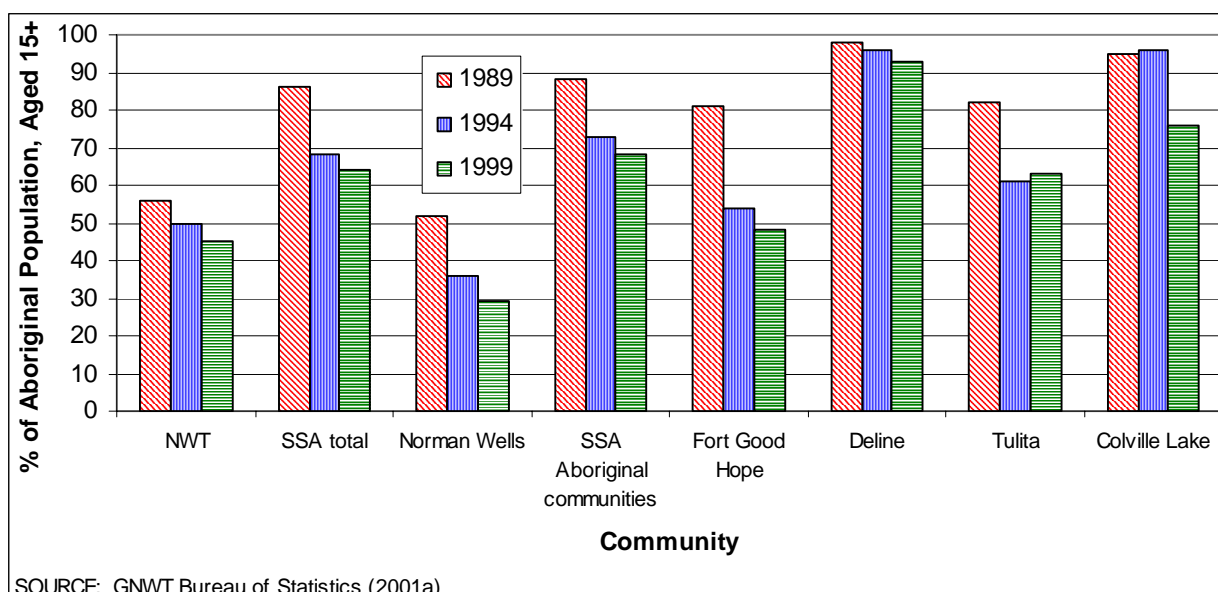


Figure 8-8: Aboriginal Language Speakers in the Sahtu Communities

Nontraditional Land and Resource Use

This topic addresses non-traditional use of land and resources within the SSA. Background information is provided on granular resources, timber resources, mineral resources, oil and gas activities, non-traditional resource harvesting, tourism and recreation, and other commercial activities.

Borrow Sources

Several borrow sites and related operations are located in the SSA part of the study area, especially near Norman Wells. A large quarry is located about 3 km

east of Norman Wells, near the town landfill site. There is also an existing gravel pit between Norman Wells and Tulita at the Little Bear River.

Timber Resources

There are no commercial export timber harvesting operations in the SSA near the study area. Timber harvesting facilities used in the past were located at Little Chicago and Grandview. Each community in the SSA has a small lumber mill to process timber for local use. Residents harvest fuel wood along winter roads throughout the SSA.

Mineral Resources

No deposits of interest have been identified near the study area in the SSA. There are several mineral claims, held by Patrician Consolidated Gold Mines Ltd., located in the study area at the southern boundary of the SSA. North of Fort Good Hope, several prospecting permits were recently issued to Diamondex Resources Ltd., DeBeers Exploration Inc. and an individual.

Oil and Gas Activities

The most prominent petroleum industry activity in the SSA part of the study area is the Norman Wells oil field, operated by Imperial Oil Resources Ventures Limited, and the associated Enbridge pipeline. In addition, several oil and gas exploratory licences are located near Norman Wells, Tulita and Colville Lake. Some significant discovery licences are also held in the Colville Lake area.

Nontraditional Resource Harvesting

Resident and nonresident sport hunting is permitted within the SSA for:

- black bear
- moose
- caribou
- muskox
- wolf
- wolverine
- small non-furbearing mammals

Game bird hunting is permitted for ptarmigan and grouse. GNWT RWED has recently established a limited-entry draw for muskox in the SSA.

There are no designated guide–outfitter areas in the study area part of the SSA. However, one outfitter, Jackson’s Arctic Circle Tours, operates out of Fort Good Hope at Manual Lake.

Only one commercial fishing licence is issued near the study area – on Lennie Lake, located on the east side of the Norman Range. There are about 12 domestic fishing licences issued to residents of Norman Wells. A domestic fishing licence allows non-aboriginal residents to fish with a net for non-commercial purposes. Some of this fishing occurs in the Mackenzie River.

Sport fishing occurs in many lakes and watercourses in the SSA and is licensed by RWED. Sport fishing is also subject to the terms and conditions set out in the Sahtu Comprehensive Land Claim.

Other Commercial Activities

The Mackenzie Highway is extended via a winter road from Wrigley to Fort Good Hope during the winter. It is a transportation corridor for trucks carrying goods to the valley communities. The Mackenzie River is an important transportation corridor for barges and other boats that deliver goods to many of the communities along its banks, on the Beaufort Sea and in other parts of the Arctic.

Tourism and Recreation

Residents use a variety of waterways in the SSA for recreational purposes. The Mackenzie River is travelled by boats for recreation by residents and to a lesser extent by non-residents. The Great Bear River is a popular canoeing destination in the summer months, mostly for residents. The winter road and the Enbridge right-of-way are used by residents and some non-residents throughout all seasons for recreational purposes, such as snowmobiling, cross-country skiing or hiking.

There are several tourism operators in the SSA. The SS Norweta tour boat travels up and down the Mackenzie River all summer. Archie Lennie of Tulita offers jet boat tours on the Mackenzie River and its tributaries, and Winter Lennie of Norman Wells offers tourism opportunities on Kelly Lake during the summer. Wilfred Jackson from Fort Good Hope has a tourist camp on Manual Lake that operates primarily in the summer.

Protected Areas

The Sahtu Preliminary Draft Land Use Plan, released in January 2003, identifies several proposed special management areas and proposed conservation areas (see [Figure 8-9](#)). The pipeline route encounters four proposed special management areas in the SSA:

- Yeltea and Manual Lakes
- Colville Lake Trail
- Lac à Jacques, Turton Lake and Sam Macrae Lake
- Mackenzie River

The right-of-way also traverses two proposed conservation areas in the SSA:

- Fort Anderson Trail
- Great Bear River

The SPDLUP notes that oil and gas exploration and development are acceptable activities in the proposed special management areas but proposes that activities are restricted or unacceptable in proposed conservation areas. Approved and proposed land use plans in other northern regions have included provisions for infrastructure corridors to accommodate linear developments.

The Willow Lake and River area, also referred to as Bracket Lake, is located just north of the Great Bear River in the pipeline corridor. This area was considered for designation as an International Biological Program site. The reserve was enlarged to include the potential highway and pipeline transportation corridor to monitor the natural recovery processes following human disturbance.

Heritage Resources

The heritage resources that have been identified within the SSA are usually situated at, or near, the ground surface and as such, are highly susceptible to any activities that result in ground disturbance. The three primary classifications of heritage resources, used by consulting archaeologists, are: palaeontological, prehistoric archaeological and historic archaeological sites. While all heritage resources must be considered, prehistoric and historic sites are of primary concern with respect to this project.

The *Mackenzie Valley Resource Management Act* (Department of Justice 2002) defines heritage resources as: archaeological or historic sites, burial sites, artefacts and other objects of heritage, cultural, or religious significance. Heritage and cultural records are also included in this definition. An archaeological artefact is defined in the Northwest Territories Archaeological Sites Regulations (GNWT 2001) as “any tangible evidence of human activity that is more than 50 years old, in respect of which an unbroken chain of possession cannot be demonstrated”. Further, an archaeological site is defined as “a site where an archaeological artefact is found”. Therefore, under these definitions, examples of heritage resources include ancient campsites, lithic scatters, traditional gathering places, trap line trails, cabins, fossils, sacred sites, graves, culturally modified landscapes and objects of literature.

Figure 8.9 has been moved to reduce file size. To view it, click on the link to the figure in the web page List of Figures for this document.

In conjunction with the previously recorded heritage resources that are near the proposed development areas the 2002 focused reconnaissance program resulted in identification of 30 heritage resources in the SSA. These included prehistoric archaeological, historic archaeological, and a wide array of cultural sites, including recent campsites, trails, cabins, deadfall traps and fishing camps. Palaeontological resources were also identified. The 2003 focused reconnaissance program resulted in the further identification of 18 heritage resources of similar natures in the SSA. Due to changes in the alignment of the corridor and other shifts in development component locations some of these sites are now located in areas that are no longer part of the proposed development area. *Recommendations on the mitigation of potential conflicts of proposed developments with these site locations will be determined on a site by site basis as the proposed pipeline alignment shifts and other proposed development areas are adjusted.*

The majority of sites were noted in areas located along river terraces, ridges, cutlines or trails and upland terrace slopes. The proposed development areas that have been investigated in the SSA consist mainly of watercourse crossings, infrastructure locations, access roads, granular resource extraction locations and other geotechnical investigation areas. Field investigations focused on the parts of these areas identified by the local assistants and the heritage resources team as having moderate to high potential for discovering heritage resources. Areas where high levels of ground disturbance were anticipated from development activity were also targets of field investigation.

HUMAN ENVIRONMENT POTENTIAL EFFECTS AND MITIGATION

The potential effects of the proposed development activities are described next for the socio-economic, traditional culture, non-traditional land and resource use. Protected areas are addressed in site-specific sections. Heritage resources effects and mitigation are explained in [Section 11](#).

The assessment of effects on most socio-economic components lacks specific guidelines and scientific thresholds as guidance. This is because of several factors, including the inability to quantitatively determine effects that are not easily defined by numbers on individuals, the economy, the communities and its services. For example, it is difficult to predict a numerical change in recreational activities, or a change in perceived enjoyment.

Therefore, qualitative methods were used to assess many, social, nontraditional land and resource use, and heritage resource effects. Input from the public participation process, professional judgement and linkages with other disciplines were used to make effect predictions in these cases.

Definitions

The following terms are used throughout this assessment of the potential effects of the development on the human environment in the SSA.

- Direction – describes the ultimate long-term trend of the effect. There are three options for direction, including adverse, neutral and positive. For components such as traditional resource harvesting, project effects can be both positive and adverse, e.g., an increase in income could be spent to support new opportunities for hunters. However, project employment might decrease time available for hunting.
 - adverse – effect is worsening or is not desirable
 - neutral – effect is not changing compared with baseline conditions and trends
 - positive – effect is improving or is desirable
- Magnitude – describes the severity or intensity of the effect. Typical measurements of magnitude indicate gains or losses in features, e.g., less accommodation available or higher demand on recreational resources, or changes in conditions, e.g., ability of policing services to keep up with demands for service. The terms no effect, low, moderate and high are used to describe magnitude. Some effects could have a range of magnitude because of subjective factors.
 - no effect – effect does not occur
 - low – effect occurs that might or might not be detectable, but is within the normal range of variability
 - moderate – clearly an effect but unlikely to pose a serious risk or represent a management challenge
 - high – effect is likely to pose a serious risk and represents a management challenge
- Geographic extent – describes the measurement of area within which an effect occurs. The terms local, regional, beyond regional and national are used to describe the geographic extent of an effect.
 - local – effect is limited to specific affected persons or communities
 - regional – effect extends to several communities in the affected region
 - beyond regional – effect extends beyond one region to include communities in more than one region of the study area, or to include commercial or industrial centres in the Northwest Territories
 - national – effect extends nationally, or beyond the communities in the study area

- Duration – refers to how long an effect occurs, or how long the recovery period of that effect will be. Recovery is defined as a return to conditions that would exist if the project had not occurred. For socio-economic effects, it is not normally practical to be more precise than short-term (construction) and long-term (operations).
- Shared responsibility for the management of effects – given the nature, scope and magnitude of potential effects and the complex inter-related causes of effects, a coordinated and collaborative management response from the project and other parties is necessary. These include measures that can be implemented by the project, either on its own accord or in cooperation with the GNWT, communities, local authorities, service providers and other third parties.

Procurement, Employment and Regional Economics

This discussion addresses procurement, employment, income and regional economic effects in the SSA.

Estimates of economic effects were determined from simulations using employment and expenditures estimates supplied by Imperial. The simulations (of direct, indirect and induced economic effects) were done using the Statistics Canada Inter-Regional Input-Output Model (I-O Model). However, because the I-O Model only produces results at the territorial or provincial level, the Northwest Territories effects were allocated to regions using data produced by Ellis Consulting Services (2004).

Capital expenditures made in the SSA for goods, services and labour will be linked to project components and activities located in the region. These include:

- two compressor stations, near Little Chicago and Norman Wells
- parts of the natural gas liquid (NGL) and gas pipelines
- granular extraction
- seven infrastructure sites, including:
 - camps
 - fuel storage
 - pipe and materials stockpiles
 - equipment storage
 - barge landings and, in some instances, airstrips

Procurement and employment opportunities in the SSA exist for qualified SSA businesses and individuals. However, given the small population base and resulting capacity limitations in the SSA, significant project-related employment and capital expenditures for goods and services are expected to occur outside the region.

Assessment and Management of Project-Specific Effects – Construction

Expenditures – Construction

The main project construction will occur over the four-year period from 2006–2007 to 2009–2010.

About 60% of the NGL pipeline, about 40% of the gas pipeline and two of the facilities will be located in the SSA. As shown in [Table 8-35](#), this represents about \$1.7 billion, 27%, of the total project capital investment for 2006–2007 to 2009–2010.

Table 8-35: Project Capital Investment in the SSA

Indicator	2006–2007		2007–2008		2008–2009		2009–2010		Total	
	(\$M) ^a	(%) ^b	(\$M) ^a	(%) ^b	(\$M) ^a	(%) ^b	(\$M) ^a	(%) ^b	(\$M) ^a	(%) ^b
Project total investment	1,409	100	2,261	100	1,907	100	671	100	6,247	100
Spending outside the SSA	420	97	635	97	462	96	116	96	1,633	96 ^c
Spending in the SSA	13	3	23	3	21	4	4	4	61	4 ^c
SSA total ^d	433	31	657	29	483	25	121	18	1,694	27 ^d
NOTES: ^a Figures in millions of constant \$2003 ^b Numbers might not add up because of rounding. ^c Percentage of SSA portion of total investment ^d Percentage of total project investment										

The small labour supply, and the limited size and number of businesses in the region, that is, the lack of capacity of the region to undertake such a project, will require construction contractors to hire employees and purchase goods and services from outside the region. The economic activity associated with direct purchases outside the region will occur where the goods or services are produced.

It is estimated that about \$1.6 billion, or 96%, of the total SSA capital expenditures of \$1.7 billion will occur outside the SSA. The remaining \$61 million, 4%, of capital spending will occur in the SSA.

Employment and Income – Construction

Construction of the project components located in the SSA will require a large workforce and most work will take place during four winter construction seasons. Many of the required skills will not be readily available in the SSA. As a result, it

is expected that much of the required labour will be brought in from outside both the region and the Northwest Territories.

The 2002 Northwest Territories labour force indicator statistics were used to determine the size of the labour force in the SSA potentially available to the project. Labour force participation is provided, along with employment and unemployment rates. The unemployment rate includes persons actively seeking employment as well as those that *want a job* but who are not actively looking for work.

Although individuals classified as unemployed but *want a job* constitute the primary regional labour pool available for the project, there are other SSA residents who are available and qualified, and will seek project employment. These people are currently employed in SSA communities and businesses. They have not been included in the demographic modelling because there is no way of accurately predicting their numbers.

Table 8-36 shows the estimated size and composition of the regional labour market before project effects. This forecast was developed using a demographic model to estimate population change and applying the *want a job* rates from the 2002 survey results to the population projections.

Table 8-36: Estimated Labour Force in the SSA – Before Project Effects

Indicator	2006–2007	2007–2008	2008–2009	2009–2010	Average
Total population (No.)	2,661	2,784	2,806	2,779	2,757
Net migration (No.)	0	0	0	0	0
Population 15+ (No.)	1,958	2,082	2,119	2,112	2,068
Labour force (No.)	1,559	1,658	1,687	1,681	1,646
Employed (No.)	1,225	1,302	1,326	1,321	1,293
Unemployed (No.)	334	355	362	360	353
Not in labour force (No.)	399	425	432	431	422
Participation rate (%)	79.6	79.6	79.6	79.6	79.6
Employment rate (%)	62.6	62.6	62.6	62.6	62.6
Unemployment rate (%)	21.4	21.4	21.4	21.4	21.4

It is expected that during the peak winter construction season in 2007–2008, 100 persons could migrate to the SSA because of the project. However, it is assumed that half of these persons will leave the region when construction ends in 2009–2010. It is further assumed that all new in-migrants of labour-force age will be available to participate in project construction.

Some project-related in-migration was factored into the estimate on the assumption that some skilled and experienced employees in the SSA will resign their jobs and seek project-related employment. This will lead to vacancies that could be filled from within the region but also create a demand for southern employees to move north. Before project effects in 2006–2007, it is estimated that there will be 334 unemployed persons in the region. Because of in-migration and an increase in labour force participation, the number of unemployed people available during the construction period is expected to increase to an annual average of 353 people.

Table 8-37 provides a forecast of the maximum labour pool in the SSA that could be available to fill direct project jobs and jobs in other businesses that will supply goods and services to the project and its employees.

Table 8-37: Estimated Maximum Potential Labour Pool Available for Project-Related Work in the SSA

Indicator	2006–2007	2007–2008	2008–2009	2009–2010	Average
Total unemployed persons (No.)	334	355	362	360	353
Will do rotational work (%) ^a	87	90	87	86	87
Total unemployed persons adjusted for rotational work (No.)	291	320	315	308	308
NOTE: ^a Percentages have been rounded to the nearest whole number, and the adjusted number of unemployed people may not add up because of rounding.					

The annual average of 353 unemployed persons has been adjusted to reflect the number of unemployed persons who would or would not be willing to do rotational work. The willingness to do rotational work was applied to about half of the unemployed workforce that *want a job* because this condition only applies to direct project jobs, which make up about half of the total number of project-related jobs created.

It is estimated that an annual average of 308 SSA residents will be available to seek direct project construction employment, and employment in businesses that provide goods and services to the project and its workforce on a rotational basis.

An estimate of direct employment demand for the region was derived by comparing the job types and occupation requirements for each project component in the region to the expected skills of the regional labour force. Statistics Canada's I-O Model was used to estimate the total project-related demand for indirect and induced employment in the Northwest Territories. The territorial estimates were then broken down into regions using project expenditure data.

Table 8-38 shows direct, and modelled indirect and induced employment estimates in the SSA, and more realistic employment estimates that take into

consideration the constraints of the available labour pool and existing businesses in the region. The employment estimates include direct project employment, and new jobs in businesses supplying goods and services to the project and its employees.

Table 8-38: Estimated Project Employment Demand in the SSA

Indicator	Type of Demand	Number of Jobs					
		2006–2007	2007–2008	2008–2009	2009–2010	Total ^a	Average
Modelled employment demand in the SSA without labour supply constraints	Direct	74	366	265	15	719	180
	Indirect	113	222	207	42	584	146
	Induced	37	63	56	11	166	42
	Total	223	651	527	68	1,469	367
Estimated employment demand in the SSA with labour supply adjustments	Direct	74	209	213	15	511	128
	Indirect	45	42	43	42	171	43
	Induced	22	21	21	11	76	19
	Total	141	272	277	68	758	190

NOTE:
^aNumbers might not add up because of rounding.

It is estimated that with no limits to the size of the available labour force or business capacity, the project will generate an average annual demand of 367 jobs for residents of the SSA during construction. However, when the available labour force is taken into account, the average annual demand for jobs in the SSA decreases to 190. This means that all qualified SSA residents who *want a job* should be able to find project-related employment.

Project-related employment will lead to a rise in household income in the region, as shown in [Table 8-39](#).

Table 8-39: Estimated Project-Related Labour Income in the SSA

Type of Demand	2006–2007 (\$M) ^a	2007–2008 (\$M) ^a	2008–2009 (\$M) ^a	2009–2010 (\$M) ^a	Total (\$M) ^{a,b}	Average (\$M) ^a
Direct	3	11	11	1	27	7
Indirect	2	3	3	2	11	3
Induced	1	1	1	0	3	1
Total ^b	7	15	15	4	41	10

NOTES:
^aFigures in millions of constant \$2003
^bNumbers might not add up because of rounding.

It is estimated that project construction will generate \$41 million in labour income in the region throughout construction. This will be comprised of \$27 million in direct project-related income, and another \$14 million earned by employees producing goods and services for the project and its employees.

Table 8-40 summarizes the effects of project-related employment on the regional labour market during construction. It is estimated that project-related employment will generate a demand for a potential maximum annual average of 190 jobs over the construction period. The increase in demand applies to the available portion of the SSA labour force.

Table 8-40: Estimated Project Effects on the Labour Market in the SSA

Indicator	2006–2007	2007–2008	2008–2009	2009–2010	Average
Total population (No.)	2,661	2,784	2,806	2,779	2,757
Net migration (No.)	0	100	0	-50	13
Population 15+ (No.)	1,958	2,082	2,119	2,112	2,068
Labour force (No.)	1,559	1,658	1,687	1,681	1,646
Employed (No.)	1,366	1,575	1,603	1,389	1,483
Other employed (No.)	1,225	1,302	1,326	1,321	1,293
Project employment (No.)	141	272	277	68	190
Unemployed (No.)	193	83	84	292	163
Not in labour force (No.)	399	425	432	431	422
Participation rate (%)	79.6	79.6	79.6	79.6	79.6
Employment rate (%)	69.7	75.6	75.6	65.8	71.7
Unemployment rate (%)	12.4	5.0	5.0	17.4	9.9

It is estimated that the labour force participation rate in the region will remain constant at 79.6% during construction. Project-related jobs could increase the employment rate from an average of 62.6% in 2002 to 71.7% in the SSA during construction, and the unemployment rate will decrease from an average of 21.4% in 2002 to 9.9% during the same period. For the years 2007–2008 and 2008–2009, a constraint was imposed where the unemployment rate was not allowed to fall below 5%, as this rate was considered to be full employment. There is also a noticeable increase in the unemployment rate in 2009–2010 to 17.4%, but this is an incomplete representation of the labour market situation in that year because although construction activity is complete, the project has not come to an end. It will be entering the next phase, which includes (the much smaller) start-up and ongoing operations employment, not reflected in this table.

Mitigation Measures – Construction

The mitigation measures targeting potential southern in-migrants, based on common practices for influencing population movements associated with large development projects, will seek to convince the in-migrants that there will be few employment opportunities that can be accessed only in the Northwest Territories. This will involve the following procedures or actions:

- Southern workers will be hired for project-related positions in selected cities, from contractor lists and by media advertising for positions in the Northwest Territories. Hiring in the North will be restricted to Aboriginal and other northerners, that is Northwest Territories, Nunavut and Yukon residents that meet the definition of a northern resident.
- Human Resources Skills Development Canada (HRSDC) offices will be asked to publicize this restriction. They will also provide the message that the only direct project hiring in the North will be of qualified people that have lived in the North for at least one year and have a medical card for the Northwest Territories. This message will also be publicized through television and radio news programs, and newspaper advertisements.

To build business capacity, and optimize project-related procurement and expenditures within the SSA, a procurement plan is being developed. The procurement plan will demonstrate that Imperial is committed to using Aboriginal, other northern and other Canadian suppliers of goods and services if they are:

- able to meet or exceed specified safety, environmental, technical and quality standards, and project timing requirements
- internationally cost competitive at the place and time where the goods or services are required

Recognizing that the construction and operations will primarily occur in the Northwest Territories, Imperial will give preference to qualified, competitive Aboriginal and other northern businesses for certain goods and services. In some instances, Aboriginal or other northern businesses might be invited to bid first.

In order to accomplish this, Imperial will:

- provide full and fair opportunity for Aboriginal and other northern businesses to participate in business opportunities
- comply with relevant land claims settlements, and benefits and access agreements

- foster development of Aboriginal and northern business and human capacity that provides long-term benefits to Imperial, such as meeting long-term sustained demand for goods and services
- ensure that suppliers of goods and services meet Imperial's commitments to use Aboriginal and northern businesses

To build capacity and optimize employment of Aboriginal and other residents in the Northwest Territories, a program and principles, where applicable, have been provided. The program and principles address education, training and employment. To develop Aboriginal and other northern workers for, and employ them in, positions associated with construction and operations, Imperial is committed to the following:

- Aboriginal and other northerners who are qualified, or who take the steps necessary to become qualified for work on the project, will be provided with the opportunity to work during the construction phase, consistent with:
 - relevant land claims settlement agreements
 - benefits and access agreements
 - provisions of applicable human rights legislation
 - the *Canadian Charter of Rights and Freedoms*
 - the *Canada Oil and Gas Operations Act*
- recognizing the role and responsibilities of governments, and cooperating with governments as they carry out their responsibilities
- early identification and communication of project employment opportunities
- taking a leadership role in the Pipeline Operations Training Committee (POTC), an initiative to develop and implement a system for the early identification of, and education and training for, potential trades and technical workers for pipeline operations and production operations for the three anchor fields (In 2004, the POTC initiative formed a key component for the NWT oil and gas sector's successful application to HRSDC under the Aboriginal Skills Employment Program (ASEP). ASEP supports training programs intended to provide early development for workers and potential workers for the construction phase of the project. The specific training courses will be planned on an annual basis.)
- emphasize preferential employment of qualified Aboriginal and other northern residents during all phases of the project
- promote Aboriginal and other northern worker participation in a range of skilled, unskilled, technical and professional job classifications, and provide opportunities for advancement on the basis of qualifications and performance

- provide ongoing support for Aboriginal and other northern hires that recognizes cultural differences at the worksites and in camps
- provide a workplace where all individuals are treated in a fair, equitable and respectful manner while working on the project

Successful implementation of the plan will require project leadership by way of a employment and training coordination function, and the partnership, cooperation, support and involvement of:

- Aboriginal organizations
- northern communities
- education and training institutions
- relevant territorial and federal government agencies
- industry organizations
- contractors
- unions
- workers

Residual Effects – Construction

With timely implementation of the previously described mitigation measures, business and labour force capacity in the region will expand. There will be capital expenditures and project-related procurement in the region that could represent up to 27% of total project capital expenditures in the Northwest Territories (see [Table 8-40](#), shown previously). In addition, labour force participation and employment rates will increase because it is assumed that more people will be drawn into the labour force as a result of the project.

The duration of capital expenditures, procurement and employment effects will be most noticeable during the winter construction season of 2007–2008, and positive and high in magnitude during the four-year construction period. The increase in capacity among regional businesses and the labour force is expected to continue well beyond construction.

Assessment and Management of Project-Specific Effects – Operations

The assessment of project-specific operations effects includes an evaluation of direct, indirect and induced employment and labour income in the region. Both employment and labour income will be generated because of project operations, and ongoing capital and drilling activities scheduled over the life of the project.

Employment and Income – Operations

Norman Wells, the designated base for ongoing operations and maintenance of the natural gas pipeline and related facilities, is located in the SSA, along with portions of the NGL and gas pipelines and two compressor stations.

As shown in [Table 8- 41](#), annual average direct employment associated with operations and maintenance of the pipelines and associated facilities will range from 24 to 32 jobs annually, and average 27 jobs from 2009 to 2030.

Table 8-41: Annual Average Direct, Indirect, Induced and Total Employment in the SSA

Type of Demand	Number of Jobs				
	2009–2015	2016–2020	2021–2025	2026–2030	Annual Average
Direct	32	24	24	24	27
Indirect	6	8	8	8	7
Induced	3	4	4	4	4
Total ^a	42	36	36	36	38
NOTE: ^a Numbers might not add up because of rounding.					

Total employment in the SSA during operations, including direct as well as spin-off indirect and induced employment, will range from 36 to 42 jobs annually, with an annual average of 38 jobs from 2009 to 2030. Residents of the region are expected to fill some of these positions. However, because of the knowledge, experience and skills required for many of the positions, some will be filled by people from outside the region and the Northwest Territories.

To help build labour force capacity in the region, technical and trades training programs will be developed and delivered to regional residents by Aurora College in association with the communities, GNWT and Imperial, before and during project operations. With implementation of these training programs, regional participation in direct project operations employment opportunities is expected to increase throughout the life of the project.

[Table 8-42](#) presents the estimated labour income associated with the direct, indirect and induced labour income related to the project in the SSA. It is estimated that annual average direct labour income will be just under \$3 million from 2009 to 2030. During the same period, annual total direct, indirect and induced labour income generated in the region will average just over \$3 million.

Table 8-42: Annual Average Direct, Indirect and Induced Labour Income in the SSA

Type of Demand	2009–2015 (\$M) ^a	2016–2020 (\$M) ^a	2021–2025 (\$M) ^a	2026–2030 (\$M) ^a	Annual Average (\$M) ^a
Direct	3.2	2.4	2.4	2.4	2.7
Indirect	0.3	0.4	0.4	0.4	0.4
Induced	0.1	0.2	0.2	0.2	0.2
Total ^b	3.7	3.0	3.0	3.0	3.2

NOTES:
^aFigures are millions of constant \$2003.
^bNumbers might not add up because of rounding.

Residual Effects – Operations

With timely and ongoing implementation of the mitigation measures described previously, business and labour force capacity in the region will expand. There will be ongoing operations and maintenance expenditures, and also ongoing capital expenditures, and project-related procurement in the region and elsewhere in the Northwest Territories. In some cases this will create long-term spin-off jobs, e.g., maintenance services, in the region, and even though the effects will be positive, they will be low in magnitude.

Demography

This discussion addresses potential project effects on demography and population mobility in the SSA.

Assessment and Management of Project-Specific Effects – Construction

There will be many project-induced employment and business opportunities in the SSA, as there will be in all regions crossed by the project. However, interest in employment might well be driven by the closeness of project facilities and activities to Fort Good Hope and Norman Wells – both with 1,350-person camps, equipment and fuel storage, pipe stockpile, and barge-landing sites nearby – and Tulita – with equipment and fuel storage, pipe stockpile, barge-landing, and contractor staging and marshalling sites nearby. There will be a great deal of construction activity, including compressor station facilities and the NGL and natural gas pipelines in the Norman Wells area.

The project sites and related activities in the SSA are not expected to attract substantial migration from outside or inside the Northwest Territories because the SSA communities are accessible only by air or by winter road from Wrigley. However, this will be less true of migration within the SSA. Specifically, some Colville Lake and Déline residents, particularly those who earlier lived in Fort

Good Hope or possibly Norman Wells, might be attracted back by employment or the excitement of the unusual activity. Again, recruiting and hiring will be available in every community.

Mitigation Measures – Construction

Mitigation measures to discourage potential migration to Fort Good Hope, Norman Wells and Tulita from other communities within the SSA and from other regions of the Northwest Territories will emphasize that the prospects of project-related employment will be as good in their home communities. This will involve the following actions:

- Imperial representatives will continue to visit every community in the development area to describe the employment opportunities available, and the terms and conditions of employment.
- Imperial or community representatives will interview interested individuals, and document qualifications and interests in relevant databases. Interested parties will be able to provide new or updated information for the databases.
- Imperial or community representatives will provide database information to project contractors.
- Recruitment procedures for northern residents will be described in English and Aboriginal language news programs, and the dates when project representatives are scheduled to visit the individual communities will be advertised in advance.
- Transportation to and from the point of hire on a rotational work schedule will be provided, as will accommodation at job sites.

Residual Effects – Construction

A sizeable part of the project activity in the SSA will be in the vicinity of Norman Wells and Fort Good Hope. It will not be possible to eliminate all population movement and project effects, if they occur, are expected to be adverse. Some non-Aboriginal Norman Wells residents might advise their relatives of remunerative job opportunities, possibly offering temporary accommodation as well.

It is estimated that the population of Norman Wells could increase by a maximum of 100 people in the peak activity year of 2007. It is further estimated that 60 of these people will be single adults. Accordingly, the project could induce a high-magnitude increase in the population of Norman Wells during construction. However, in Fort Good Hope, the effects on the local populations should be no more than moderate. The effects are expected to be adverse, short-term and local

in extent. Effects on the populations in other SSA communities will likely be low in magnitude.

Operations Phase Effects

As only about 10% of the operations and maintenance jobs created during operations will relate to the activities of the Norman Wells operations centre, only a minor population increase is expected in Norman Wells, the regional administrative, commercial and industrial centre for the SSA. Regional business opportunities could also stimulate some population growth, through in-migration, to fill indirect and induced jobs.

It is expected that the population of Norman Wells will transition from the 100-person peak construction increase to a level of about 40 people more than pre-project levels. It is important to note that these effects do not include normal growth that could occur because of factors other than the project.

The long-term, stable contribution of these levels of population effects to the local economy and community should be easily accommodated in the time frames available, and should require no mitigation and represent no residual adverse effect during the operations phase. In fact this long-term population increase is expected to have a net positive effect.

Physical Infrastructure and Community Services – Transportation Infrastructure and Use

This description addresses potential project effects on transportation infrastructure and its use in the SSA.

Assessment and Management of Project-Specific Effects – Construction

Norman Wells is the focal point for marine and air traffic in the SSA. To a lesser extent, it is also a centre for winter road transport. Although it has no all-weather road, it does have a winter road connection to the south via Wrigley, and to the north and east via Fort Good Hope and Colville Lake. Virtually all passengers and most of the freight arriving from outside this region stop in Norman Wells, whether it or a small outlying community is the final destination. A clear exception is freight being barged directly to Tulita or Fort Good Hope. Therefore, although several smaller communities might experience increased use and effects on their airstrip operations, Norman Wells airport operations will be most noticeably affected.

Most project freight will be moved by barge. Perishable foods for the construction camps will be flown in, and other foods and camp supplies not delivered by barge will be trucked in via winter road. The result will be an increase in traffic on the

winter road to Norman Wells, but not enough to threaten transportation services to, or motor vehicle safety for, other SSA communities.

An important issue that Imperial is aware of is the increase in the number of vehicles in the Colville Lake area because of increased gas exploration, and that some of the trucks were not being driven in a safe and courteous manner. Because there will be increased traffic on the winter road, there will be some increase in needed road maintenance. It has been suggested during community consultations that discussions with the RCMP should start now to develop an emergency preparedness plan for transportation incidents, in order to increase the coordination of road and safety maintenance efforts among the GNWT, Imperial and Sahtu communities. This increase in road and safety maintenance will likely be to the economic benefit of some people in Tulita, Norman Wells, Fort Good Hope and Colville Lake.

Mitigation Measures – Construction

The various measures that should be implemented by the project, the Department of Transportation (DOT) and local communities, are detailed below.

All effects related to transportation are manageable, provided that:

- there is adequate and timely planning
- needed human and financial resources are available

Joint planning, information sharing, cooperation and coordination by Imperial, project transportation and logistics functions, local communities, and DOT will be necessary for effective planning to reduce project effects on transportation. These efforts must focus on the steps to be taken, development of effective protocols and procedures, and the resources required to implement them.

Agreements between Imperial, the GNWT and the federal government, and between Imperial and the applicable communities will be negotiated and will include provisions for project use of seasonal roads. The agreements will consider:

- coordination of road maintenance activities, which will recognize:
 - the timing of winter road maintenance
 - installing and maintaining ice roads and bridges
 - access restrictions
 - coordination of road upgrading where required
- using bypass roads in the communities of Norman Wells, Tulita and Fort Good Hope

Other general mitigation measures will include:

- continuing discussions with barge service providers to provide them with ample lead time to ensure sufficient capacity to meet community requirements and project demands
- continuing discussions with air transportation providers to give them ample lead time so that northern carriers can potentially expand their aircraft inventories to meet existing community requirements and project demands
- coordinating with the GNWT and other responsible authorities to provide construction-related air and barge traffic demand projections, including provisions for assessing the need for, and completing, upgrading and improving of, regional and municipal airports, airstrips and barge landings
- posting and enforcing speed limits for project vehicles on project access roads, and having project vehicles adhere to speed limits on public winter ice roads
- using pilot vehicles when transporting oversized truck loads (on winter ice roads), where appropriate
- observing road bans before winter freezeup and during spring breakup, unless otherwise approved
- developing plans for truck traffic routes, as required
- providing bus transportation of construction workers, where required
- sharing information about new borrow sites in the region with DOT and local communities for negotiation of post-project use of, and responsibility for, those sites

Residual Effects – Construction

As indicated, without carefully planned mitigation, project effects on air travel, air and barge freight services, and travel on winter roads in the region could negatively affect SSA residents. However, these adverse effects are preventable.

Positive effects on air transportation infrastructure in Norman Wells, i.e., early resurfacing of the runways and installation of an instrument landing system, and Fort Good Hope, i.e., an upgraded and extended airstrip that can accommodate larger aircraft service, could also be attributed to the project. The effects on road and marine modes of traffic in the region are expected to be adverse. The effects, both positive and adverse, will be moderate but will be within the normal range of variability and detectable only during the construction phase.

Operations Phase Effects

Road, marine and air transport traffic, which will increase during construction, will decline dramatically once construction is complete. Exploratory drilling by other operators is expected to continue in the Colville Lake area. The two compressor stations in the SSA will be staffed during the start-up and stabilization period, and then will become remote operations regularly visited by crews using helicopters or an all-weather road.

Pipeline monitoring and maintenance will be managed out of a base in Norman Wells, utilizing air and ground surveillance. Operations effects on transportation in the SSA will be very similar to the pre-construction years. The project could also result in some increase in transportation capacity. Thus, there will be no need for additional mitigation beyond local and winter road maintenance, and dust suppression as needed. There will be no residual adverse effects in the SSA during operations.

Physical Infrastructure and Community Services – Energy and Utilities

This description addresses potential project effects on energy and utilities infrastructure and their use in the SSA.

Assessment and Management of Project-Specific Effects – Construction

There will be several construction camps in the SSA ranging in capacity from 30 to over 1,350 persons. All larger camps, with the possible exception of those located close to communities, will be self sufficient in terms of power, water supply, water treatment, sewage and solid waste treatment and disposal, and communications capabilities. In instances where a camp is located near a community, the project and the community could enter into an arrangement whereby the project is permitted to use community infrastructure. Such arrangements will only be made if both parties stand to benefit, and the capacity of the infrastructure to meet current and future community needs is not compromised. Some of the small camps will haul wastes to approved sites or facilities.

The project should have no adverse effects on nontransport community infrastructure, that is utilities, energy sources or communications facilities, in Norman Wells or any of the other SSA communities. All SSA communities have sufficient relevant capacities to provide for any foreseeable demands created by the projected level of in-migrants or transients the project might attract to the SSA.

Mitigation Measures – Construction

Assuming the camps are self sufficient regarding physical infrastructure, energy supply and utilities, they will have no effect on the SSA communities. Similarly, if the project enters into a mutually beneficial arrangement for camp use of SSA Community infrastructure, there should be no adverse effects on the community.

Residual Effects – Construction

As there will be no adverse effects on the nontransport infrastructure in any SSA community, there will be no residual.

Operations Phase Effects

There will be no need for mitigation of project effects and no residual effects during the operations phase in the SSA.

Physical Infrastructure and Community Services – Housing

This description addresses project effects on housing in the SSA.

Assessment and Management of Project-Specific Effects – Construction

It is expected that some SSA migrants might be attracted from their outlying home communities to Norman Wells and possibly Fort Good Hope because of their closeness to associated project activities. Some might be drawn by interest in employment opportunities and because they have relatives who can provide accommodation. This is especially true in Norman Wells.

Ellis Consulting (2002) projected the need for a cumulative total of about five additional dwellings in Norman Wells by the end of 2006, and about seven additional dwellings by the end of 2009.

Temporary accommodations exist in Norman Wells, but they fill up during the winter months. Although, housing in Norman Wells is in short supply, in 2000, only 11% of the housing was in need of major repair. In Fort Good Hope, housing is limited and about one third needed major repairs in 2000. Any sizeable number of in-migrants, even those moving in with relatives for the short term, could have adverse effects on housing in either community. These effects will be greater in Norman Wells, where most of the non-Aboriginal and some SSA migrants likely will be attracted. However, an expansion of both permanent housing units and temporary accommodation is also expected to occur by that time.

Mitigation Measures – Construction

The mitigation measures for minimizing the project-related migration that will elevate housing demand were described in the Demography topic. Additionally, self-contained camps will be provided for all project construction activities in the SSA. The camps will be sized to accommodate peak direct workforce and others indirectly involved in the project, such as project managers, inspectors, environmental monitors, consultants and regulators, to minimize demands in the SSA communities.

Additionally, to increase the housing supply, the GNWT could:

- initiate or provide incentives for major housing repairs needed to ensure that the existing housing shortage is not exacerbated by increased deterioration, causing some occupied housing to become unliveable
- initiate or provide incentives for needed repairs to abandoned housing, where feasible, to make it liveable again, therefore expanding the supply of available housing
- provide tax or other incentives to prompt construction of new housing in communities where there is limited housing

It is expected that if the project is approved, some owners of short-term rental housing may be eager to upgrade and expand their accommodations in anticipation of project-induced demand.

Residual Effects – Construction

It will not be possible to eliminate all population movement, and project effects on temporary and permanent housing in some SSA communities could be adverse.

If the predicted in-migration level is achieved and if all of these persons were to be housed in permanent accommodation, as many as 40 additional housing units would be required in Norman Wells. This is outside the range of demand projected in the Ellis Consulting study, and therefore the Norman Wells housing and accommodation market will need to make a substantial capacity adjustment in anticipation of this short-term peak in demand. It is also likely that much of this demand would be met through use of temporary accommodation, as it is unlikely the long-term demand would justify investment in permanent housing. Effects on housing in Norman Wells are predicted to be adverse and high in magnitude during the construction phase. Effects on housing in the other SSA communities will be adverse, but low in magnitude during the same time period.

Operations Phase Effects

Most employment opportunities generated by the project will end once construction and site reclamation activities are complete. However, ongoing project operations and maintenance will create direct, indirect and induced job opportunities for northern residents. Although some rotational operations workers might be housed in camp facilities, some might be housed in Norman Wells. At the start of project operations, it is probable that southerners will fill most of the operations and maintenance positions. However, as northern trainees become qualified, it is expected that northern residents will fill most of these jobs.

As a result, there could be an incremental demand for about 16 residences in Norman Wells by 2020. The capacity of the local housing sector should be able to meet this need over that time. In fact, this ongoing demand could lessen any decline in the market related to the drop-off from construction demand effects. The resulting long-term tax base would also be a positive effect. No effects are expected in any other SSA community.

Individual, Family and Community Wellness – Community Well-Being and Delivery of Social Services

This discussion focuses on potential project effects on community well-being and delivery of social services in the SSA.

Project effects on well-being conditions will largely be influenced by:

- income levels (and related spending patterns)
- length of work separations from home
- family and community levels of stress and mistrust
- availability of alcohol
- access of southern workers to some Aboriginal communities

Assessment and Management of Project-Specific Effects – Construction

This project might affect community wellness if residents accept project-related employment, and also if there are project activities quite close to a community. Déline and Colville Lake will experience project effects on community wellness only if residents accept project-related employment, because both are far from project activities and facilities.

Norman Wells, Fort Good Hope and Tulita will have much greater exposure to the pipeline construction process. Two 1,350-person construction camps, in operation throughout most of the three-year construction period, will be located at Norman Wells and near Fort Good Hope. Camp workers will arrive and depart through the Norman Wells and Fort Good Hope airports, and there might be other

opportunities for camp-based workers to associate with local residents. These interactions might be a source of some wellness problems.

Though Tulita will be about 6 km from the site of horizontal drilling for the pipeline crossing of the Great Bear River, there will be no crossing or construction camp in the vicinity.

Insulation of all three communities from southern construction workers and their influences will be difficult. This is of little concern in Norman Wells, a predominantly southern Canadian community where 74% of the residents are non-Aboriginal, and the Aboriginal residents have had long exposure to non-Aboriginal influences. However, both Fort Good Hope and Tulita are Aboriginal communities, having only 15% (Fort Good Hope) and 10% (Tulita) non-Aboriginal, typically temporary, residents. Their Aboriginal band councils make decisions for the benefit of Aboriginal people. Many of the influences, which might be felt from a neighbouring construction camp or major river crossing operation, could be intrusive.

The project is aware of the concern that the amount of income in hand has a direct and negative effect in homes where family violence is an issue, and highlighted the need for an alcohol and drug abuse prevention strategy (participants, first Sahtu regional technical workshop, June 2003). Concerns were voiced there, and at a community meeting in Fort Good Hope in April 2003, that the closeness of camps to communities would increase the potential for drugs being brought into local communities. A camp security force and appropriate security policies were seen by some at the 2003 workshop as a way to reduce this threat.

Indications of the possible vulnerability of the Sahtu Aboriginal communities of Fort Good Hope, Tulita and Norman Wells to adverse project effects on family and community wellness are usually reflected in alcohol and violence indicators. With respect to alcohol-related hospitalizations, Fort Good Hope and Tulita ranked in the middle range and Norman Wells ranked low. Norman Wells, Fort Good Hope and Tulita all ranked in the low to middle range for alcohol offences.

Perhaps the best indicator of dysfunctional use of income might be the violence rates, because violence causes injuries and is usually associated with alcohol abuse. Norman Wells had no cases of spousal violence or children in care reported, and ranked quite low for young offenders and violent crimes. The high rate of spousal violence in Fort Good Hope should be discounted, as a result of law enforcement policy changes. The violent crime rate there was midrange in comparison with other communities, but the property crime rate was very high. All indicators for Tulita were midrange. Forecasts of project effects based on these indicator standings suggest that much of project earnings might be spent improving traditional lifestyles in Déline and Colville Lake, and likely on nontraditional lifestyles in Norman Wells and Tulita. The implications of the indicators for Fort Good Hope are less clear, reflecting its closeness to the wage

employment opportunities of Norman Wells and the more traditional lifestyle of Colville Lake. In any case, some increased earnings will be spent on alcohol, and there might be some resulting increase in adverse social effects. This increase is expected to be minor in most of the Sahtu communities, including Norman Wells, and is likely the most difficult to predict for Fort Good Hope.

Norman Wells residents are sufficiently concerned about the project effects they might experience, and what can be done to reduce these effects, to have produced a carefully written analysis and proposal entitled, *Breaking Down the Barriers, a Proposal for Community Partnership and Action* (Town of Norman Wells 2003). The proposed program will seek to address a range of problems, including effects of substance abuse on youth and appreciation of cultural diversity.

More substantial adverse effects could occur in Fort Good Hope because of potential interactions between the construction camp and the community, including increased tension, and local consumption of drugs and alcohol. This combination of increased tension and alcohol might lead to increased conflict and violence. Similar but less serious effects are possible in Tulita, again because of its closeness to the activity associated with crossing the Great Bear River.

Mitigation Measures – Construction

There are mitigation measures which Imperial can and will implement in order to manage potential adverse effects on community well-being in the communities within the SSA.

Certain mitigation measures will be implemented and will be mandatory for all workers. Imperial will:

- respect a community's right to privacy and discourage workers from entering any community that asks for privacy
- enforce policies for alcohol-and drug-free workplaces and camps, including a requirement that all contractors and sub contractors also enforce policies that meet Imperial's requirements. In addition, Imperial will establish support systems and resources for the prevention of alcohol and substance abuse
- inspect or search the luggage of workers upon arrival for each work rotation
- conduct cultural awareness training
- provide a workplace where all individuals are treated in a fair, equitable and respectful manner, specifically including issues of harassment and privacy
- conduct pre-employment safety training

- apply actions for noncompliance with camp policies, which could be up to and including dismissal

Certain mitigation measures will be offered to workers on a voluntary basis as part of on-the-job support to help improve worksite and life skills. These include:

- a program to help develop life skills and upgrade non-technical workplace effectiveness skills
- an Aboriginal worker liaison program
- a workplace mentor program
- programs on life skills guidance such as money management and the opportunity to assign part of one's wages to a savings account as a means to reduce the potential for negative lifestyle choices

Certain mitigation measures will be developed in cooperation with others and could be offered for both camp workers and members of the SSA communities. These include:

- providing, if requested, an opportunity for Aboriginal artisans to display and sell their handicrafts in the camps, reducing potential disruption caused by project workers visiting local Aboriginal communities in search of handicrafts
- encouraging and supporting efforts by the territorial government to set up community-based training programs in personal finance and money management focusing on informed consumption, savings and investment choices for increased incomes
- supporting government programs to provide assistance to families and communities of workers

The steps available to safeguard community wellness are shared responsibility among Imperial, the GNWT and local communities. Therefore, the GNWT and the local communities should do all they can to control substance abuse, and any resulting conflict and violence. The government and communities could also focus on sustaining the family relationships that might be stressed by absences associated with camp-based project employment.

The territorial government could:

- initiate community-based training programs in personal finance and money management, focusing on informed consumption, savings and investment choices for increased incomes

- ensure that all community wellness centres in the study area are adequately staffed
- implement the recommendations to improve treatment services contained in the Chalmers and Associates (2002) study of substance abuse
- plan (HSS) for the likely increase in the stresses and family conflicts often associated with employment absences, and provide additional training to HSS personnel to help them better prevent and effectively deal with these conditions
- prioritize the need for child and Elder care support in communities with a substantial number of females employed in rotational positions
- promptly act on HSS initiatives that address the frustrations, concerns and professional needs of HSS service providers in communities, to improve the morale and effectiveness of its personnel

The SSA communities could:

- enact a bylaw, if one does not already exist, that limits the amount of alcohol that can be purchased or imported per trip
- police themselves with respect to alcohol and drug use
- implement a realistic campaign to inform residents of the human and financial costs to the community of substance abuse, enlisting the whole community, and particularly the moral authority of the Elders

The mitigation measures for wellness threats might be less effective than those described for social service delivery as the measures to inhibit wellness-threatening behaviour are dependent on the decisions and actions of many individuals, whereas the social services delivery measures can be implemented administratively. However, potential project effects tending to increase family and community wellness problem rates will inevitably add to the workloads of service providers.

It is important to acknowledge that the community well-being conditions and social services delivery likely to be potentially affected by the project already represent considerable challenges to study area communities and residents. Therefore, any project-induced effects will be disruptive, unless they are prevented by implementing suitable mitigation. The most important of these responses can only be made by governments and by the communities themselves. This is considered to represent a very serious challenge, requiring a concentrated effort by all.

Residual Effects – Construction

As stated previously, increased income levels might well induce both positive and negative consequences. The community well-being benefits could include improved lifestyles, depending on the consumption, savings and investment decisions made by individuals. The risks of effects on individuals discussed in this section reflect the concerns expressed by the public and social service professionals, and the related judgment of the assessment team.

Because of the difficulties in controlling alcohol abuse, and the serious social consequences of such abuse, the best mitigation measures will only be moderately effective. As well, the stresses of long work shifts and extended work absences are inescapable for workers, and lone household management and child rearing are stressful for workers' spouses. When easy access to alcohol is added to the seriously conflicting needs of returned workers and their homebound spouses, conflict and violence might well result.

Implementing the recommended measures for social services delivery will increase the effectiveness of wellness centres in dealing with potential project effects, but an increase in the workloads of these centres is very likely. Because of their nearness to project activity sites and resulting opportunities for contacts between project workers and local residents, effects on wellness conditions in Norman Wells and Fort Good Hope are expected to be adverse and moderate in magnitude. Similar lower magnitude effects are expected in Tulita, Déline and Colville Lake, and these might be somewhat offset by beneficial effects because of the distances of the communities from pipeline facilities and activities. These effects are expected to last for the construction phase.

Effects on the delivery of social services will be adverse and moderate in Fort Good Hope and Norman Wells. However, in Déline, Tulita and Colville Lake, effects are expected to be low in magnitude. The project-induced effects on social services should last only during construction.

Operations Phase Effects

Most employment and business opportunities generated by the project will end once construction and site reclamation activities are complete. There will be about 27 pipeline operations and maintenance jobs based in SSA. However, this much-reduced level of income-generating opportunities, which will be relatively long term and stable in nature, is not expected to result in elevated wellness problem conditions. The population increase associated with this activity is expected to be modest, about 40 people, and should generate no noticeable additional demand for social service delivery. There will be no need for mitigation and no residual effects during operations.

Individual, Family and Community Wellness – Health Conditions and Health Care Services

This description focuses on project effects on health conditions and health care services in the SSA.

Assessment and Management of Project-Specific Effects – Construction

There will inevitably be important differences between the corridor communities of Norman Wells, Fort Good Hope and Tulita, and the noncorridor communities of Colville Lake and Déline in their experiences of project effects. In all communities, project effects on health conditions will typically originate with the people who take project-related employment opportunities and earn increased incomes. Both beneficial and adverse effects might result. There is also the risk of increased pressure from the workers who are traveling in close proximity to the corridor communities.

Norman Wells and the construction camps might be sites of elevated risk of disease contagion, with many local people, transients and people in the camps associating with each other, and because of increased travel between communities. Increased numbers of casual sexual encounters, perhaps in Norman Wells, might lead to increased rates of STIs. Some workers in camps might be at elevated risk of incidents.

The project recognizes the concern that construction workers might introduce a global virus into the region. It has been suggested during public consultation that every construction worker should be thoroughly screened for any infectious disease before being permitted to work in the North.

Treatment of illnesses and accidental injuries will be the responsibility of the health care facility at each camp, until the patient returns to her or his home community. Thereafter, the community health centre will have responsibility for continued treatment and dealing with any disease conditions brought into the community by returning workers. Territorial or southern hospitals will be required to deal with serious incidents or diseases that exceed the response capability of camp health care resources.

In addition, the project is aware of local concerns about project effects on increases in communicable diseases and health conditions generally, on health service delivery, and about relevant preventative measures. A related issue is that alcohol and drug abuse create dangerous situations for health care givers attending to inebriated people, and also makes it difficult for care givers to attend to the needs of others.

Alcohol consumption will likely increase during the construction phase, potentially intensifying the workloads of nurses and affecting the quality of treatment their patients receive.

Mitigation Measures – Construction

Various mitigation measures are indicated to address project-related issues with respect to the health of individuals, families and communities, and health service workloads in either camps, or with HSS or local communities.

Measures to reduce alcohol abuse, described earlier, are important because alcohol abuse is associated with violence and various forms of abuse, accidental and violent injuries, and often mental and emotional disorders. The number of HSS staff will need to be expanded to address the increased demand for their services. Imperial will work with the HSS to:

- design project health and work environment guidelines, procedures and protocols for:
 - medical alert and quarantine protocols
 - fitness for work assessments
 - assessment and care of ill or injured workers
 - camp food and waste handling and storage
- facilitate communications and cooperation among medical personnel in the camps, the HSS, environmental monitors and inspectors, and the regional health authorities
- ensure joint planning, by construction camp operators, health care personnel and hospital administrators, of the relevant steps and procedures for accessing mental health counsellors or transferring one or more patients from the camp health care facility to a hospital, if this should become necessary
- ensure construction contractors and subcontractors are bound to the guidelines, procedures and protocols developed by Imperial and HSS
- provide the HSS in Yellowknife and the regional health authorities with a comprehensive list containing the names and contact information of construction contractors, camp management and senior medical personnel

Imperial, construction contractors and camp medical staff will be provided with a comprehensive list of contacts for the HSS and the regional health authorities.

All camps will have qualified medical staff, supplies, equipment and transportation appropriate to camp size and location.

Pre-employment fitness-for-work assessments and screening protocols will be standardized and implemented for all project and contractor employees. Screening and immunizations will be appropriate for the risks identified.

The territorial government could take measures that are specifically relevant to health conditions and health services delivery in the SSA, such as:

- ensuring that all the health centres in the project area are fully staffed
- working with the project and other service delivery stakeholder representatives to develop the appropriate procedures for dealing with health crises in construction camps, and overload situations in health centres and hospitals
- promptly and fully implementing HSS initiatives that address the concerns and professional needs of GNWT health service providers in communities that are detailed in *Health and Social Services Action Plan, 2002 to 2005* (HSS, no date)

Changes in population demographics resulting from in-migration were noted previously. Therefore, the mitigation measures described previously in the Demography section are relevant, and are presumed in this discussion.

Because of the difficulties in controlling alcohol abuse, and the many health consequences of this abuse, the best mitigation measures will likely be only moderately effective. As well, the stresses of long work shifts over extended periods are inescapable for workers, and the periods of lone household management and child rearing will likely be stressful for some workers' spouses. Over-tired workers might have increased vulnerability to disease, therefore potentially exposing members of their families. Increased alcohol abuse might lead to increased numbers of snowmobile and all-terrain vehicle incidents, which can be very serious.

These mitigation measures will be less effective for individual health than will those described for health care delivery. The measures for individual health are dependent on the decisions and actions of many individuals, whereas the health care delivery measures can be implemented administratively. However, project effects could potentially increase health problem rates and will add to health care workloads.

Residual Effects – Construction

Increased income levels might well induce both positive and negative consequences. The health conditions and services likely to be affected by the project represent considerable existing challenges to SSA communities and residents. Therefore, any project effects would be incremental, unless suitable mitigation responses are implemented. Governments and the communities

themselves must undertake key mitigation measures in response to any incremental needs related to health conditions or services.

Generally, in Norman Wells and most of the other smaller communities, effects on health conditions might be adverse and moderate in magnitude. However, they are expected to be restricted to local communities and last only for the construction phase. Fort Good Hope could experience the greatest effect in the SSA (high in magnitude), but the effect will only be noticeable during the construction period.

Similarly, implementation of the measures recommended by HSS for nurses will increase the effectiveness of health centres in dealing with potential project effects on community health, but an increase in the workloads of these centres is very likely. Again, Norman Wells and most of the other smaller communities will experience adverse effects on health care services that will be moderate in magnitude. Fort Good Hope will experience the greatest effect in the SSA (high in magnitude), in turn somewhat affecting service in Colville Lake. However, the effects are expected to be restricted to local communities and last only for the construction phase.

Operations Phase Effects

Most employment opportunities generated by the project will end once construction and site reclamation activities are complete. The smaller numbers of income-generating opportunities, combined with their longer-term and stable nature, are not expected to result in negative effects on health conditions or healthcare services. As the project effects will be restricted to construction, there will be no need for mitigation and no residual effects during the operations phase.

Individual, Family and Community Wellness – Public Safety and Protection Services

This discussion focuses on potential project effects on public safety and protection services in the SSA.

Assessment and Management of Project-Specific Effects – Construction

The workloads of RCMP detachments in this area will be affected by:

- potential project effects on the SSA communities
- the size of community populations, which may be affected by limited in-migration
- the incidence of alcohol abuse

- the number of expected project camps in the area
- the numbers of officers available to deal with policing issues

Construction is expected to raise the levels of community incomes, increasing substance abuse and attracting a modest population increase in the SSA. The project is aware of the concerns voiced by participants in the first SSA regional technical workshop in June 2003 and the Sahtu regional confirmation meeting in May 2004 that there will be increased alcohol and drug abuse because of in-migration and increased income from project-related work.

Norman Wells will be the winter road, airport and barging transportation hub for the central Northwest Territories part of the pipeline, with the inevitable resulting increases in policing workload. Some temporary residents will be in town on project-related business, after which they will leave, and others will be southerners exploring business opportunities. Some of the predominantly non-Aboriginal residents might successfully encourage relatives in the south to come take advantage of local, well-paying, project-induced jobs. Easy access to Norman Wells by boat, winter road or scheduled flights from other Sahtu communities will accommodate local opportunity seekers and those attracted by the heightened activity in this regional centre. These and other temporary residents will be away from home, and from the familiar and relatively effective personal social controls of their home communities. Therefore, increased local employment and earnings in Norman Wells will likely lead to increased abuse of alcohol or drugs, thus adding to policing burdens.

Given the closeness of Fort Good Hope to a project construction camp and a compressor station site, some previous residents or relatives of locals might be attracted to this area. In Fort Good Hope, as in Norman Wells, the increased income associated with project-induced activity, and the inevitable increased availability of alcohol and drugs, might add to the workload of local police.

Mitigation Measures – Construction

The mitigation measures required to reduce project effects on the calls for RCMP services from the various communities will be somewhat different from those measures relevant to needs originating in the construction camps. In this section, the measures appropriate to dealing with the direct construction and camp effects on RCMP are detailed first. This is followed by a description of the varied measures for reducing project effects on community wellness that could add to detachment workloads.

Project transportation activities could affect RCMP workloads. Imperial will undertake the following mitigation measures to ensure that:

- safety is the highest priority for the project
- transportation equipment is regularly inspected for safety

- safety is taken into account when planning contractor delivery schedules

The project will be responsible for security at project camps and for setting policies regarding behaviour in project camps. Imperial will continue discussions with the RCMP regarding project activities and plans that could influence RCMP workloads, communications between camp management and the RCMP, and the efficiency of RCMP responses to calls for service from the camps.

The general purpose of this consultation would be to improve communication between camp management and the RCMP detachment, and forestall possible misunderstandings, to reduce the likelihood of incidents requiring police action and improve the efficiency of RCMP response to calls for service from the camp. The topics on which understandings should be reached include:

- communication procedures, including after-hours communications
- precise specifications of the reason for a call, the urgency of the call and the details relevant to how the RCMP should be prepared to respond
- indication of normal response time and best possible response time to an emergency

Incremental staffing may be needed to control increased policing workloads in communities affected by the project.

The mitigation measures that are normally effective in controlling in-migration were described previously. The effectiveness of such mitigation is important in respect to protection services, because increases in migration can increase the numbers of calls for service to which the local RCMP must respond.

Measures to reduce alcohol abuse, described above in the Health Conditions and Health Care Services section, should be taken by local communities and the GNWT. Two of the communities in the SSA have restrictions on alcohol and the liquor outlet in Norman Wells has a purchase limit. Accordingly, given the very frequent association of alcohol abuse with policing problems, an effective way to reduce project-induced overburdening of police might be to restrict alcohol availability in all the SSA communities. Band councils could inform their residents about the costs of alcohol abuse and implement controls to limit the volumes of liquor imports. Additionally, firm enforcement of the *Liquor Act*, prior to the construction phase, will also assist with overburdening police services. This would include taking into protective custody those so inebriated as to be a danger to themselves or others. Unfortunately, in Tulita and Colville Lake, there are no restrictions. In these two communities, an effective way to curtail alcohol abuse might be for the band councils to inform their residents about the costs of alcohol abuse and the control measures they, like Fort Good Hope and Déline, could impose, and to enact bylaws limiting the volume of liquor imports.

In view of the present, relative ineffectiveness of efforts to control substance abuse in the Northwest Territories, it might be expected that these problems will increase during construction. Accordingly, in order to assess the relative effectiveness of mitigation measures, and why some might be failing, it will be important to implement the proposed socio-economic monitoring program. This will enable the communities, the GNWT, contractors and protective services to cooperatively monitor relevant issues, the workloads of public safety and police services, and the effectiveness of mitigation measures. Implementing this program will provide the information and opportunity to adjust policies, programs and funding relevant to wellness issues, as necessary during construction.

Residual Effects – Construction

The important role of monitoring and the related adjustment of mitigation and management measures are key to minimizing residual effects. Policing services in Norman Wells and Fort Good Hope might experience moderate magnitude adverse project effects during construction because of temporary in-migration, elevated income levels, and tendencies toward alcohol abuse and related social problems.

Other SSA communities might also experience some increase in policing burdens, but these are expected to be low in magnitude. In all cases, the effects are expected to be restricted to individual communities and last only during construction.

Operations Phase Effects

Most employment opportunities generated by the project will end once construction and site reclamation activities are complete. The smaller numbers of income-generating opportunities, and limited population increases are not expected to result in substantial additional demand for protection service delivery. As the project effects will be restricted to construction, there will be no need for mitigation and no residual effects during the operations phase.

Individual, Family and Community Wellness – Education Attainment and Services

This discussion focuses on potential project effects on education attainment and services in the SSA.

Assessment and Management of Project-Specific Effects – Construction

An important issue that the project is aware of is that young people may drop out of school to take high-paying, short-term, construction-related jobs.

Interest in project-related employment will likely be driven by the closeness of project facilities and activities to Fort Good Hope and Norman Wells, both with neighbouring 1,350-person camps, and equipment and fuel storage, pipe stockpile and barge landing sites. This also applies to Tulita, with nearby equipment and fuel storage, pipe stockpile, a barge landing, and staging and marshalling sites. Norman Wells will also be the scene of much construction activity. The effects of all this activity might be to increase in-migration, increase adolescent school dropouts, increase school retention, or some combination of these.

The discussion of project-induced effects on population in the Demography section concludes that even with relevant mitigation measures in place, Norman Wells and Fort Good Hope might experience in-migration in excess of normal variation. Aboriginal young people with limited access to employment in Colville Lake or Déline could improve their situations by moving in with relatives in Fort Good Hope or possibly Norman Wells. Therefore, the Norman Wells and Fort Good Hope school systems might experience increased enrolment pressures.

There is currently enough surplus capacity in the Norman Wells and Fort Good Hope classrooms to accommodate any likely enrolment additions. There might be recruitment problems if additional staff is needed, or if some teachers resign to pursue project-created opportunities. However, the likelihood of this is small. Indeed, if in-migration is contained and many students drop out of school to take project-induced employment, the reverse would be the case.

It is relevant to the POTC program that the second highest proportion of Aboriginal adults with high school graduation and post-secondary training is found in the SSA Aboriginal communities, in particular in Fort Good Hope.

Mitigation Measures – Construction

Measures will be designed to counter the attractions of perceived unrestricted access to project-induced economic opportunities for older students and also the disinterest in classes often found in this age group. The measures must emphasize the interesting and remunerative employment and career opportunities which high school and relevant post-secondary training or technical and trade certification would make accessible during and after the project.

Measures could be designed by GNWT Education, Culture and Employment to make it unnecessary for young people to choose between project employment and continuing their education. This could be accomplished by:

- modification of school programming to allow for participation in the project, which may include school leaves and some credit for work experience
- collaboration between government, educational institutions and the project with regard to developing classroom and on-the-job learning equivalencies

Other measures taken by Imperial to publicize the opportunities that will come with school completion and with further training will include:

- before construction, continuing to promote awareness among residents and secondary school students in affected northern communities about construction and operations employment and career opportunities, and also the education and qualifications needed to access these opportunities
- working with school organizations, secondary schools and students to promote employment and career opportunities associated with the project, and the oil and gas and pipeline industries, while emphasizing the need to complete high school to qualify for these and other post-secondary learning, employment and career opportunities
- raising the level of understanding about oil and gas production and pipeline opportunities such that northern residents can make informed choices about employment and career opportunities

As described previously in the mitigation measures under Procurement, Employment and Regional Economic Effects, Imperial is involved in a variety of initiatives to prepare Aboriginal people, females and other northern residents for professional- and technical-level long-term employment opportunities.

Delivering a coordinated stay-in-school message must be the collective responsibility of educators, families, community leaders and Imperial. This message should inform young people of the skills required to access project employment opportunities, and the need for education and training to acquire these skills. Emphasis must also be placed on recruiting and training females for nontraditional jobs, given the:

- educational attainment of females, which is often better than the attainment of males throughout the North
- under-representation of females in most job categories related to project requirements

Imperial will request that:

- HRSDC, Aboriginal Human Resource Development Strategy Delivery Agents and training providers work with the project to develop training in basic labourer skills, construction trades, heavy equipment operation and truck driving, using local capital projects as training venues wherever possible
- education and training providers develop training programs specifically geared towards the long-term employment of females in these nontraditional occupations

- GNWT agencies (DOT MACA) and private contractors cooperate with and support hands-on experience for the trainees
- education and training providers consider training in the summer season to avoid conflict with employment opportunities during project construction months. This will also permit using instructors who might be unavailable for this training during the regular school year.

In summary, through the cooperation and support of POTC members and northern communities, the training strategy can reinforce the stay-in-school message and provide long-term, transferable employment opportunities without adversely affecting existing educational institution resources and program delivery.

Residual Effects – Construction

According to current estimates, 100 people are expected to in-migrate to Norman Wells because of project construction. Among the families included in this total could be about 10 children of school age. Despite the relatively small size of the Norman Wells population and with current levels of unused capacity in the school, this number will have a neutral effect on education attainment or services.

However, measures to discourage migration from outlying communities to centres of project activities will reduce, but not eliminate, such migration, which will likely target Norman Wells and perhaps Fort Good Hope. The effects on school facilities and services in these communities could be adverse.

Mitigation measures might also fail to deter some adolescent students from dropping out of school to seek short-term project employment, particularly in Norman Wells and Fort Good Hope. Both are near centres of project activity where there will be many opportunities. This closeness might also motivate some to stay in school and some former dropouts to return to qualify for attractive employment. Possible project effects on early school leaving are expected to be both positive and adverse, and low in magnitude in all communities except possibly Fort Good Hope, where dropout rates could be somewhat noticeable (moderate in magnitude). However, Fort Good Hope has the highest education attainment levels in the SSA.

It is likely that effects on migration and leaving school early would tend to cancel each other out in respect to effects on education facilities and services, one tending to increase and the other to decrease enrolments. In any case, the duration of these effects are expected to be limited to construction.

Operations Phase Effects

About 27 of the operations and maintenance positions will be based in the SSA. The intent is to develop training programs, and to staff the operations and maintenance positions with fully qualified northern residents in due time.

The effect of this increasing employment of local people during operations, and of other likely opportunities, will be to demonstrate the benefits of completing high school and post-secondary training. This effect will be marked in Norman Wells because there will likely be many good job prospects there, but relatively meagre opportunities for any advanced education or training. Accordingly, the effects of operations on education attainment are expected to be positive in Norman Wells, but low in magnitude during the operations phase. There will be virtually no effects on education attainment in the other Sahtu communities.

No project effects on facilities and teaching services in Norman Wells are expected because of the small population base, the low expected demands and existing unused capacity.

Traditional Culture – Traditional Harvesting and Land Use

This discussion focuses on potential project effects on traditional harvesting and land use in the SSA.

Assessment and Management of Project-Specific Effects – Construction

The project will affect traditional harvesting through effects on the availability of relevant time, the resources needed for efficient harvesting, and the motivation of Aboriginal people to do the often demanding work of harvesting.

Project demands for workers and a range of employment opportunities will exist throughout the project area. This increased employment might reduce time spent on harvesting activities. However, earnings from well-paying employment could make it possible to purchase new and better equipment, such as, snow machines, all-terrain vehicles, boats and outboard motors, to make resource harvesting more efficient and productive.

Project-induced employment could increase harvesting motivation among various types of harvesters. Those who spend some of their earnings on harvesting equipment will be eager to use their new equipment. The full-time and seasonal harvesters will be most eager to invest in upgrading their equipment, whereas the recreational harvesters will likely be interested in a broader range of expenditure options.

For many Aboriginal people, harvesting is a source of food and of cultural sustenance, and will not decrease because of wage employment. Many believe that harvesters will still find time to hunt. The desire of many to consume country foods and maintain traditional lifestyles is very strong.

However, harvesting motivation might be undercut by substantial incomes, often earned in work activities and settings more physically comfortable than those associated with harvesting. Those most vulnerable would be the full-time

harvesters who might be attracted by the number and diversity of jobs not previously available to them. Alternatively, the behaviour of non-Aboriginal supervisors or work associates and the work place culture will likely be less emotionally comfortable for most full-time harvesters than when they are out hunting. Depending on their experiences working on the project, seasonal harvesters might experience a strengthening of either their harvesting or their wage employment interests, or both.

If wage employment opportunities result in reduced traditional harvests, it will affect the 87% of Sahtu Aboriginal community households where at least half of their diet was country food in 2002, a substantial increase over the 76% rate for 1998. This level of dependence might ensure the continuing obligation and motivation of many to continue harvesting wild foods. Important, as well, is the satisfaction of the Sahtu people when eating moose meat, and their testimony to the importance of this food harvest.

Mitigation Measures – Construction

Although the project can have both facilitating and inhibiting influences on traditional harvesting, project effects could add to the slow, ongoing decline in traditional harvesting activity. Mitigation should focus on inhibiting any such tendency. Relevant efforts can be made by Imperial and the GNWT. Local communities can continue to expect and consume the traditional harvest, and encourage and reward the harvesters with praise and status.

Measures that will be undertaken by Imperial include:

- providing Aboriginal workers with flexible work schedules to accommodate traditional harvesting and other Aboriginal cultural, family and community needs, where practical, recognizing that work flexibility will be limited in the peak winter construction seasons
- supporting cultural activities and events that are consistent with Imperial's principles and practices for community involvement
- supporting community-based traditional lifestyle initiatives that promote traditional harvesting and positive relationships with communities

RWED has devoted much effort to facilitating traditional harvesting, including programs to *grubstake* trappers and send their furs to auction. It also publishes a trapper newsletter, and several well-illustrated, region-specific booklets showing how to butcher the game available in the area and how to cook the various cuts of meat. These programs and publications should be continued and potentially expanded.

Given the significance of country food gift exchanges with relatives, friends and other communities, it is important to provide opportunities for bountiful harvests through participation in harvesting activities.

Harvester compensation agreements will address actual and potential wildlife harvest loss resulting directly from project construction and operations. The specific terms and provisions of the agreements will be negotiated by Imperial with the renewable resource councils or other relevant organizations.

Residual Effects – Construction

The harvesting component of the dual economy is sufficiently flexible to permit scheduling of harvest leaves. There are expected beneficial and adverse effects on different people within the communities. Taken on balance and given that the GNWT will continue relevant programs and the project will support harvesting leaves, there will be low magnitude adverse effects on traditional harvesting in SSA aboriginal communities. All effects are expected to last only during construction.

Operations Phase Effects

Most employment and opportunities generated by the project will end once construction and site restoration activities are complete. There will be about 27 pipeline operations and maintenance positions created in the SSA. Since most of the project effects on traditional harvesting and land use are expected to occur during the construction phase, there will be no need for mitigation and no residual effects during operations phase.

Traditional Culture – Preservation of Traditional Language and Culture

This discussion focuses on potential project effects on the preservation of traditional language and culture in the SSA.

Assessment and Management of Project-Specific Effects – Construction

The project will affect language and culture preservation through effects on the time available for Aboriginal people to spend with others in their home communities. Their motivation to engage in shared activities such as communal hunting will also be important, because their language has particular relevance for these activities. Project demands for workers, and a broad range of employment opportunities, will be found throughout most of the SSA. Those responding to these opportunities will find that their time with family and home community could be substantially reduced for two or more years. Their opportunities to speak their Aboriginal language will thus be reduced.

For some, project-induced employment and the resulting interactions with non-Aboriginal fellow workers might increase their valuation of traditional language and culture. For others, these relationships with fellow workers might be valued as friendly, interesting, challenging or giving promise of access to new opportunities. Substantial project-related earnings, often in work activities and settings more physically comfortable than those associated with traditional harvesting, might sharpen this tendency.

However, there are also counterbalancing forces, including the strong influences of Elders favouring traditional ways, the support implicit in Aboriginal language taught in the schools, and also the mistrust some Aboriginal people feel from some dealings with some non-Aboriginal officials and individuals.

With 68% of SSA Aboriginal community residents able to speak North Slavey in 1999, the use of English is much less common than in most of the Northwest Territories. This is particularly true in Déline, where 93% of the population speaks its native tongue. Despite this relative strength, it is believed that existing trends and influences on language and culture preservation are erosive, and influences deriving from project employment will tend to further this process.

Although many Norman Wells residents speak an Aboriginal language, English influences are already so strong in this community that the project is expected to have little or no effect on language and culture preservation there.

Mitigation Measures – Construction

Imperial recognizes that language and culture can be strengthened when local communities esteem Elders and the way of life they advocate, and honour those who are knowledgeable in traditional language and culture.

Imperial will implement the following important initiatives:

- providing cultural awareness training to all workers on the project. (The goal will be to provide southern workers with information on traditional Sahtu culture: its values, norms and conceptions of human nature and suitable human behaviour. This training will promote appreciation and respect for Aboriginal people and their culture, and facilitate smooth, friendly interaction between Aboriginal and non-Aboriginal employees at work and in camp).
- providing flexible work schedules for northern Aboriginal workers to accommodate traditional harvesting and other Aboriginal cultural, family and community needs, where practical, recognizing that work flexibility will be limited in the peak winter construction seasons
- supporting community-based traditional lifestyle initiatives that promote traditional culture and positive relationships with communities

- supporting cultural activities and events that are consistent with Imperial's principles and practices for community involvement
- periodically providing country foods in the construction camps
- providing access to Aboriginal language reading material, and Aboriginal language radio and television broadcasts, tapes and CDs where available
- providing an opportunity for Aboriginal artisans to display and sell original handcrafts in camps, if local communities favour this (such exhibits would enable camp workers to buy a memento of their northern work experience, provide Aboriginal craft-workers with a market for their work and forestall any need for workers, wanting to buy Aboriginal handcraft, to visit a local community).

The GNWT has encouraged local school boards to provide Aboriginal language instruction in schools. Aurora College offers several courses designed to help perpetuate traditional skills and activities. These programs should be continued.

Residual Effects – Construction

The residual adverse effects on language and culture preservation might be stronger in Fort Good Hope than in the other SSA communities because Fort Good Hope is less traditional than the other Aboriginal SSA communities. Given the strength of English language influences in the Northwest Territories, the indications of decline in speakers of an Aboriginal language between 1989 and 1999, and the relatively short duration of project-induced influences, project effects are expected to be low in magnitude and undetectable from the language and culture preservation historical trend in the other SSA Aboriginal communities. The effects are expected to last only during construction. English language influences are already so strong in Norman Wells that project effects on language and culture preservation there are expected to be negligible (no effect).

Operations Phase Effects

Most employment and opportunities generated by the project will end once construction and site restoration activities are complete. There will be about 27 operations and maintenance positions based in the SSA. Since most of the project effects on traditional harvesting and land use are expected to occur during the construction phase, there will be no need for mitigation and no residual effects during operations phase.

Nontraditional Land and Resource Use

Borrow Resources

Project construction activities could block access to existing borrow operations. Project effects will only be adverse if existing operations are temporarily closed or inaccessible for community use during construction. However, because extensive borrow resources are required for the project, it is more likely that current use and access to existing operations will increase substantially. There will also be positive effects related to increased northern benefits because of expansion of the existing and development of new borrow sites.

Removal of some of the granular resources from borrow sites will be permanent. This will result in a depletion of the total amount of borrow materials presently identified in the SSA. Currently, it is estimated that the project will use about 1% of the available granular material in the SSA. Based on this, granular materials available are more than adequate to meet project needs and to allow for future granular resource needs in the region.

During the life of the project, additional borrow resources will be required periodically for maintenance and repairs. The amounts required would be less than that needed for construction of project components. Because borrow resources will continue to be removed during operations, the overall effect will increase. However, the primary effect from the project will occur during construction.

Following decommissioning of the project, borrow materials used for the project, such as facility or infrastructure pads, might be available for use by local communities.

Timber Resources

The project will have no major project effects on forestry operations as there are none occurring in the SSA. However, existing timber harvesting practices for local firewood supply or building materials could be disrupted because of restricted access to areas in and around facilities, infrastructure sites, borrow sites and the right-of-way during construction. In addition, clearing of timber along the pipeline right-of-way and project sites will result in a decrease in the available supply of firewood and construction materials for residents in the local area. However, if the project enters into an agreement with the communities, merchantable timber cleared from the site that is not required for the project will be set aside for the local communities.

During operations, there could be a positive effect for timber harvesters because of increased access to previously unavailable timber. Operations and maintenance activities could occasionally require removal of timber, which would potentially

adversely affect the available supply of timber for use by local residents and communities.

Mineral Resources

There are several mineral claims in the study area near the southern boundary of the SSA. In addition, several prospecting permits have been issued for diamond exploration north of Fort Good Hope. Imperial will inform the owners of these claims and permits about project plans, to ensure any conflicts with the project are addressed. There are no other mineral showings currently identified in the SSA.

Oil and Gas Activities

Oil and gas activities in the vicinity of the project components could be adversely affected during construction activities because of blocked or restricted access to lands with existing exploratory licences or significant discovery licences. However, it is more likely that other oil and gas operations will plan their activities around the project, and the level of oil and gas activity could be encouraged and increased because of the promise of an efficient method of moving product.

Following construction, other oil and gas-related activities could increase because of improved access. On occasion, intermittent ground operations activities could temporarily block access to lands in the immediate vicinity of the pipeline. Few of these instances are expected.

The current Norman Wells oilfield operations are not likely to be adversely affected by the project as that field is owned by Imperial Oil Resources Ventures Ltd., who will likely schedule its activities to coordinate with pipeline construction and operations. The project will have a positive effect on the Enbridge Norman Wells pipeline as it will provide additional liquids for transport in the currently underused pipeline.

Nontraditional Resource Harvesting

Restricted access to lands crossed by the pipeline or occupied by other project components could disrupt non-traditional resource harvesting at locations where construction activities are occurring. Fish and wildlife species inhabiting or migrating through the study area could also be displaced by construction activities and noise. This could lead to a decrease in harvest success and thereby affect nontraditional resource harvesters.

Following construction, non-traditional resource harvesting should return to normal in the area of most project components, except during intermittent ground operations activities that could temporarily displace wildlife or block access to lands in the immediate vicinity of the activity. At the Little Chicago facility site and Norman Wells compressor station, increased noise from machinery and

increased human activity during operations could also cause sensory disturbance to wildlife. This displacement of wildlife species could lead to a decrease in harvest success in the local area of the facilities, thereby adversely affecting resource harvesters by requiring them to hunt and fish in different areas.

Presence of the pipeline right-of-way and all-weather or winter access roads associated with the project could provide increased access to wildlife or fisheries resources, resulting in a positive effect to local resource harvesters. Although regional harvesting levels are not expected to increase because of improved access, it could result in a change in the locations where harvesting occurs.

During decommissioning of the project, there will be an increase in traffic, noise and emissions from heavy machinery. These activities could also have indirect adverse effects on resource harvesting by causing a displacement of wildlife.

During construction of the project, there is the potential that collisions with vehicles on access roads could cause some mortality to wildlife. This should not lead to a decrease in harvest success, but traffic effects of the project will be reduced by decreasing the number of vehicles that must travel on access roads (for instance by using multi-person vehicles such as buses whenever possible) and providing suitable training to project employees to encourage them to drive with caution.

If the many workers required to construct the pipeline take part in hunting or fishing in their free time, there could be effects to other resource users. The project will have hunting and fishing prohibitions in place for workers based in construction camps. However, if workers choose to hunt or fish away from the camps on their personal time before or following the rotation of their shift, the local hunting and fishing regulations will apply to them as they will to any other northern visitor.

Operations staff requirements will be much smaller than construction requirements and positions will likely be filled from the local communities over time. However, initially most operations personnel for the pipelines and facilities will be southerners based out of Norman Wells, with the exception of a few northern trainees. Minimal effect on local resource harvesting is expected during operations because operations staff will be much smaller than construction staff. Also, it is expected that in time, trained northerners will take over the operation duties from the southern workers, and most of these northerners will be community residents who already partake in resource harvesting.

Other Commercial Activities

Operation of other commercial activities, such as, transportation of supplies to communities, and business travel by residents and nonresidents, could be altered because of project traffic during construction. Barge traffic on the Mackenzie River will increase quite substantially during construction, which could result in

delays for unrelated barging traffic. It is expected that agreements will be made between the project and transportation companies to ensure nonrelated transportation services remain largely unaffected by the project. The improved access created for the project could provide an opportunity for other commercial activities to be initiated.

Tourism and Recreation

Following completion of construction activities, there could be a positive effect on recreation because of access to previously inaccessible areas along the pipeline right-of-way and other project-related clearings, like access roads, particularly north of Fort Good Hope.

Noise produced at the sites could continue to affect tourism and recreation in the area of the facilities well into the operations phase. However, it is expected that few of these activities occur in the area of the Little Chicago facility site because of its relatively remote location. In addition, recreational land users will likely not be affected by the Norman Wells facility because of its closeness to an existing industrial facility.

Mitigation Measures

Several mitigation measures for nontraditional land and resource use were assumed before assessing project effects, including:

- All necessary access and land use permits will be obtained and their conditions followed.
- Access management will be used, to the extent practical and where identified by the communities, regulatory authorities or other concerned parties, to inhibit other potential land users, that is, nontraditional hunters, timber harvesters and tourists, from using project infrastructure as a method of accessing resources that were previously inaccessible. These access controls will be left in place for operations, and decommissioning and abandonment, if needed.
- At locations directed by Imperial's representative, access management techniques could include the following:
 - rolling back slash and timber to prevent access along the pipeline right-of-way
 - installing slash berms across the pipeline right-of-way, or winter road easements
 - planting trees or shrubs at potential access points, to visually screen the pipeline right-of-way or road easements

- Hunting and fishing by workers will be prohibited while on the job site.
- Merchantable timber will be salvaged for use by the project or where agreements have been made with a community.
- Imperial will inform other nontraditional land and resource users about the pipeline route and construction schedule before beginning construction.
- Compensation will be negotiated, where required, with granular resource owners for removal of granular resources from their lands.
- A plan for abandoning infrastructure and borrow sites will be developed that will include public consultation on alternative uses for the infrastructure and the sites. Local cultural, land use and environmental principles will be incorporated in project planning and implementation decisions.
- Once a borrow site is no longer required by the project, it might be available for use by communities or abandoned and reclaimed by the project.