Photo 8-7
Tuktoyaktuk Community Meeting, January 14, 2010

The Tuktoyaktuk community meeting began with elder Persis Gruben speaking directly to the community members to express her views on the Project. She expressed her support for the Project and the preferred 2009 Route. She highlighted a number of reasons including increased safety, cheaper costs for Tuktoyaktuk residents, increased opportunities for the youth, and being able to travel year-round.

Tuktoyaktuk residents expressed general satisfaction that the Project Team had employed all reasonable mitigation measures to address the concerns of the community members. Residents of Tuktoyaktuk and Inuvik were generally pleased with the Project's efforts to keep the proposed Highway alignment beyond the 1 km setback (with one minor encroachment of less than 2 km) in accordance with ILA recommendations and the latest version of the Husky Lakes Management Plan. They also expressed a general confidence in the ability of the Inuvialuit co-management bodies and other agencies to protect their interests in relation to future implementation of the Highway project.

Inuvik residents generally indicated great interest in seeing the Highway project move forward. Those who attended the meeting raised no objections to the proposed 2009 Route. However, it must be noted that a few of the community members continued to favour the Upland Route. Participants stated a preference for the Upland route spoke from two perspectives. One perspective was that the Upland route would be several kilometres farther from Husky Lakes than the 2009 Route and with that separation, it might have less of an effect on Husky Lakes. The other perspective preferred the Upland route because it would be a bigger project, it would employ more people, it might take longer to build, and it would require more borrow material.

The technical, economic, construction and maintenance advantages of the 2009 Route were discussed and were generally accepted as a clear rationale for presenting the 2009 Route for funding and regulatory screening. Without opposition or major concerns about the 2009 Route, the discussion turned to land use issues, environmental protection, Husky Lakes access, the regulatory review process, and management planning. Those present at the meeting expressed a strong interest in seeing an efficient regulatory process, encouraging one another to identify any concerns or possible issues now, rather than at the 'last minute', so as to avoid delaying approvals.

8.3 CONSULTATIONS OUTCOME

Inuvik and Tuktoyaktuk residents identified a long-held community sentiment that a year-round connection between Inuvik and Tuktoyaktuk will be beneficial to people from both communities, would provide construction and maintenance jobs, and would create business and employment opportunities between the communities. Residents expressed an urgency to build the Highway now because it sounds like the right time to apply for and obtain the funding. They also stated that local workers are available to construct the Highway now because there is currently very little other industrial activity.

The results of the consultation meetings (see summary in Appendix A) and subsequent discussions have been integrated into the Partners' decision-making process and the overall project design. The desire and interests brought forward by the communities, and additional information that they provided, has been integrated into the project plan and the preparation of the Project Description Report.

9.0 ENVIRONMENTAL OVERVIEW

The following sections provide a brief description of the biophysical conditions and resources existing in the Inuvik to Tuktoyaktuk Peninsula area. This background information is subsequently considered in Section 10.0 of this Project Description Report to identify potential environmental effects and proposed mitigation measures to avoid or minimize negative effects.

9.1 CLIMATE

Climate data from two meteorological stations operated by Environment Canada, Tuktoyaktuk-A and Inuvik-A are used for the discussion of climate for the Inuvik/ Tuktoyaktuk area. Inuvik climate normals between 1971-2000 and 1976–2005 are summarized in Tables 9.1-1 and 9.1-2, respectively. Tuktoyaktuk climate normals between 1971-2000 and 1978 – 2007 are summarized in Tables 9.1-3 and 9.1-4, respectively.

9.1.1 Air Temperature

For both locations the climate is characterized by long, cold winters followed by short summers.

The Inuvik climate normals for the periods of (1971–2000), and (1975–2006), are summarized in Tables 9.1-1 and 9.1-2, respectively. July is the warmest month with a daily average of 14.1˚C. The lowest average daily winter temperatures occur in February and the two sets of climate normals indicate that these temperatures have increased over time from -26.9˚C (1971-2000) to -26.0˚C (1976-2005). The average annual temperature has also increased from -8.8˚C (1971-2000) to -8.3˚C (1978-2007).

The Tuktoyaktuk A climate normals for the periods of (1971-2000), and (1978-2007) are summarized in Tables 9.1-3 and 9.1-4, respectively. July is again the warmest month with a daily average of 11.0˚C. This is 2.1˚C cooler than equivalent Inuvik temperatures. The lowest average daily winter temperatures based on the (1971-2000) climate normals occur in January. These temperatures have increased over time from -27.0˚C (1971-2000) to -26.4˚C (1978-2007). The average annual temperature has also increased from -10.6˚C (1971-2000) to -10.1˚C (1978-2007).

In general the temperature data indicate that the Tuktoyaktuk climate is 2˚C cooler than Inuvik.

Several studies have documented a slight warming of air temperatures in the Mackenzie River Delta. It is anticipated that the Canadian Arctic will continue to experience greater warming and generally higher precipitation, according to the General Circulation Model. Any changes in mean annual temperature would most certainly affect the distribution of permafrost and thermokarst processes (Lawford and Cohen, 1989). Environment Canada (1997a, 1997b) agrees with these observations.

In northern regions, warming is expected to be greatest on land, during winter. Winter precipitation and soil moisture are expected to increase over much of the North. Over the past 100 years, the average temperature of the Mackenzie Basin has risen by about 2.5°C, with the greatest warming occurring in winter and spring (Environment Canada 1997a; 997b; IOL et al. 2004).

9.1.2 Precipitation

Rainfall generally occurs throughout June through September; while snowfall generally occurs from September through May (Tables 9.1-1 through 9.1-4).

The mean annual total precipitation measured at Tuktoyaktuk has decreased from 167.9 mm (1971-2000) to 165.6 mm (1978-2007). The proportion of rainfall to precipitation has increased from 44.8% (1971-2000) to 46.4% (1978-2007). There has been an increase in the mean annual total snowfall recorded from 95.2 cm (1971-2000) to 104.1 cm (1978-2007). This indicates that slightly greater winter precipitation (snowfall) is occurring over time.

The mean annual total precipitation measured at Inuvik has decreased from 248.4 mm (1971-2000) to 237.9 mm (1976-2005). The proportion of rainfall to precipitation has increased from 47.0% (1971-2000) to 48.0% (1976-2005). There has been a decrease in the mean annual total snowfall recorded from 169.9 cm (1971-2000) to 158.2 cm (1976-2005). This indicates that slightly less winter precipitation (snowfall) is occurring over time.

On an average annual basis Inuvik receives 67% more precipitation that Tuktoyaktuk.

9.1.3 Wind Speed and Direction

The mean annual maximum hourly wind speed at Inuvik between 1971 and 2000 was 54 km/hr, with winds generally from the east. The period with the lowest maximum hourly wind speeds (46 km/hr) occur during April through July. During this period the winds shift direction from east to northeast. The period with the highest maximum hourly wind speed occurs from December to March, (>60 km/hr) typically blowing from the east.

The mean annual maximum hourly wind speed at Tuktoyaktuk between 1971 and 2000 was 72 km/hr, with winds generally from the west. The period with the lowest maximum hourly wind speeds (61 km/hr) occur during March through June where the winds shift direction from west to northeast. The period with the highest maximum hourly wind speeds (85 km/hr) occurs from December to February, typically from the west.

Tuktoyaktuk is located close to the Beaufort Sea and its topography and vegetation leave it less sheltered and more susceptible to greater wind speeds than other communities further inland, such as Inuvik. This is reflected in the average annual winds of 72 km/hr for Tuktoyaktuk compared to Inuvik where the average is 54 km/hr.

TABLE 9.1-1: CLIMATE DATA, INUVIK A STATION, NWT (1971-2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-27.6	-26.9	-23.2	-12.8	0.2	11.3	14.2	11.0	3.7	-8.2	-21.0	-25.7	-8.8
Standard Deviation	4.8	4.7	3.7	4.0	3.0	1.6	1.8	2.0	2.2	2.7	4.8	3.4	1.9
Daily Maximum (˚C)	-23.2	-22.0	-17.5	-7.1	5.0	17.3	19.8	16.1	7.8	-4.8	-16.8	-21.3	-3.9
Daily Minimum (˚C)	-31.9	-31.7	-28.8	-18.4	-4.7	5.3	8.5	5.9	-0.4	-11.6	-25.1	-30.1	-13.6
Extreme Maximum (˚C)	5.4	5.2	6.1	13.8	25.0	32.8	32.8	32.5	26.2	15.0	10.6	5.0	
Extreme Minimum (˚C)	-54.4	-49.4	-47.6	-46.1	-26.6	-5.1	-2.2	-5.9	-20.1	-32.9	-42.8	-47.2	
Precipitation:													
Rainfall (mm)	0.1	0.0	0.0	0.0	6.1	20.2	32.9	37.5	18.7	1.3	0.0	0.0	117.0
Snowfall (cm)	17.4	15.0	14.6	13.5	13.1	1.9	0.3	2.4	10.7	34.9	23.7	20.4	167.9
Precipitation (mm)	13.8	11.6	11.0	10.5	17.0	22.1	33.2	39.9	28.0	28.0	17.8	15.7	248.4
Average Snow Depth (cm)	46	54	57	54	20	0	0	0	0	11	29	39	
Median Snow Depth (cm)	47	54	57	55	19	0	0	0	0	10	29	39	
Snow Depth at Month-end (cm)	51	56	59	41	1	0	0	0	2	23	34	42	51
Extreme Daily Rainfall (mm)	1.8	0.2	0.8	.04	19.3	19.1	41.0	**33.0**	22.9	13.2	0.8	0.4	
Extreme Daily Snowfall (cm)	11.4	13.7	13.0	17.8	24.9	10.2	4.8	22.6	12.2	**44.2**	22.0	18.6	
Extreme Daily Precipitation (mm)	10.4	13.7	10.8	17.8	24.2	19.3	41.0	**42.9**	30.7	29.2	16.9	15.8	
Extreme Snow Depth (cm)	89	97	96	99	**87**	8	3	5	16	81	79	81	
Wind:													
Maximum Hourly Speed (km/hr)	65	56	61	46	47	46	46	56	50	56	56	64	54
Direction of Maximum Hourly Speed	E	E	E	E	NE	NE	NE	E	E	E	E	E	E

Source: Environnent Canada 2009. INUVIK A Station; Location: 68°18' N, 133°28.8' W; Elevation: 68.3 m. Climate Station ID: 2202570

TABLE 9.1-2: CLIMATE DATA, INUVIK A STATION, NWT (1976-2005)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-26.7	-26.0	-22.8	-12.0	0.2	11.4	14.0	11.0	3.9	-7.6	-20.4	-24.9	-8.3
Standard Deviation													
Daily Maximum (˚C)	-22.5	-21.3	-17.2	-6.5	5.0	17.5	19.5	16.1	7.9	-4.3	-16.4	-20.7	-3.6
Daily Minimum (˚C)	-30.8	-30.6	-28.3	-17.6	-4.6	5.3	8.5	5.9	-0.1	-10.9	-24.4	-29.1	-13.1
Extreme Maximum (˚C)	5.4	5.2	4.7	13.8	25.0	32.8	32.8	32.5	26.2	20.9	6.9	4.3	
Extreme Minimum (˚C)	-50.0	-49.1	-47.6	-40.0	-26.6	-5.1	-1.0	-5.9	-20.1	-32.9	-42.6	-47.2	
Precipitation:													
Rainfall (mm)	0.1	0.0	0.0	0.5	6.6	19.0	31.5	35.9	19.7	0.8	0.0	0.0	114.2
Snowfall (cm)	15.4	15.1	14.4	12.2	14.1	1.9	0.2	2.5	11.5	30.2	21.9	18.9	158.2
Precipitation (mm)	13.6	12.1	11.5	9.9	17.0	20.6	32.0	38.5	28.5	23.8	16.5	14.1	237.9
Average Snow Depth (cm)													
Median Snow Depth (cm)													
Snow Depth at Month-end (cm)	50	55	58	37	0	0	0	0	2	20	32	40	
Extreme Daily Rainfall (mm)													
Extreme Daily Snowfall (cm)													
Extreme Daily Precipitation (mm)													
Extreme Snow Depth (cm)													

Source: Environment Canada, 2009. INUVIK A Station; Location: 68°18' N, 133°28.8' W; Elevation: 68.3 m. Climate Station ID : 2202570

TABLE 9.1-3: CLIMATE DATA, TUKTOYAKTUK A STATION, NWT (1971-2000)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-27.0	-26.6	-25.7	-16.8	-4.8	6.0	11.0	8.9	2.8	-8.1	-21.0	-25.4	-10.6
Standard Deviation	4.5	4.6	3.5	3.0	2.6	1.6	2	1.9	1.9	2.9	4.0	3.1	
Daily Maximum (˚C)	-23.4	-22.6	-21.8	-12.2	-1.1	10.5	15.2	12.3	5.3	-5.6	-17.5	-21.8	-6.9
Daily Minimum (˚C)	-30.8	-30.8	-29.7	-21.2	-8.4	1.5	6.8	5.5	0.3	-10.9	-24.5	-29.1	-14.3
Extreme Maximum (˚C)	0.6	0.7	-0.5	4.8	20.9	28.2	29.4	27.6	20.4	11.7	2.2	0.8	
Extreme Minimum (˚C)	-48.9	-46.6	-45.5	-42.8	-28.9	-8.9	-1.7	-2.5	-12.8	-28.5	-40.1	-46.7	
Precipitation:													
Rainfall (mm)	0.2	0.0	0.0	0.0	1.3	8.1	21.4	27.2	15.6	1.2	0.1	0.3	75.2
Snowfall (cm)	10.1	10.6	6.3	8.9	5.6	1.6	0.1	1.9	8.9	19.2	12.3	9.8	95.2
Precipitation (mm)	9.8	10.2	6.2	8.6	6.8	9.7	21.5	29.1	24.2	19.9	12.2	9.6	167.8
Average Snow Depth (cm)			35	35	21	1	0	0	1	7		18	
Median Snow Depth (cm)			35	35	23	0	0	0	0	6		19	
Snow Depth at Month-end (cm)	30	35	37	32	9	0	0	0	2	11	21	21	
Extreme Daily Rainfall (mm)	2.5	0.4	0.0	0.4	4.0	11.5	19.6	**14.7**	24.2	8	1	4.8	
Extreme Daily Snowfall (cm)	8.8	9.8	6.5	7.1	9.6	7.6	1	7.4	12.8	**9.1**	15	9.4	
Extreme Daily Precipitation (mm)	7.1	9.8	6.5	7.1	10.8	11.5	19.6	**14.7**	24.2	9.1	15	9.4	
Extreme Snow Depth (cm)	61	62	72	72	**61**	45	0	0	21	26	34	49	
Wind:													
Maximum Hourly Speed (km/hr)	78	89	63	60	67	56	74	74	77	69	74	87	72
Direction of Maximum Hourly Speed	W	W	W	NE	NE	NE	W	SW	NW	W	NW	NW	W

Source: Environment Canada, 2009. TUKTOYAKTUK A Station; Location: 69°25.8' N, 133°1.8' W; Elevation: 4.6 m. Climate Station ID : 2203912

TABLE 9.1-4: CLIMATE DATA, TUKTOYAKTUK A STATION, NWT (1978-2007)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature:													
Daily Average (˚C)	-26.4	-26.8	-25.4	-16.0	-4.7	6.2	11.0	8.9	3.2	-7.3	-20.0	-24.1	-10.1
Standard Deviation													
Daily Maximum (˚C)	-22.8	-22.7	-21.3	-11.8	-1.2	10.8	15.0	12.3	5.7	-4.7	-16.5	-20.3	-6.5
Daily Minimum (˚C)	-30.1	-30.9	-29.3	-20.4	-8.2	1.6	6.9	5.5	0.7	-9.8	-23.3	-27.8	-13.8
Extreme Maximum (˚C)	0.0	0.7	-0.5	4.8	20.9	28.2	29.3	27.6	20.9	17.4	0.5	0.8	
Extreme Minimum (˚C)	-46.0	-46.6	-45.5	-39.0	-28.9	-8.9	-1.5	-2.5	-11.2	-28.5	-40.1	-42.9	
Precipitation:													
Rainfall (mm)	0.0	0.0	0.0	0.0	1.6	9.6	22.8	25.8	15.2	1.5	0.0	0.2	76.8
Snowfall (cm)	12.6	9.7	9.3	9.8	6.3	1.3	0.1	1.4	8.9	20.2	13.0	11.6	104.1
Precipitation (mm)	10.0	8.6	7.7	8.8	7.1	10.9	22.8	27.2	23.1	19.1	10.9	9.4	165.6
Average Snow Depth (cm)													
Median Snow Depth (cm)													
Snow Depth at Month-end (cm)	29	32	36	31	6	0	0	0	2	11	18	23	29
Extreme Daily Rainfall (mm)													
Extreme Daily Snowfall (cm)													
Extreme Daily Precipitation (mm)													
Extreme Snow Depth (cm)													

Source: Environment Canada, 2009. TUKTOYAKTUK A Station; Location: 69°25.8' N, 133°1.8' W; Elevation: 4.6 m. Climate Station ID : 2203912

9.1.4 Air Quality

Available air quality information for the proposed Inuvik – Tuktoyaktuk Highway corridor has been drawn primarily from the baseline air quality monitoring conducted at Parsons Lake and Inuvik during the period 2001 to 2003 for the proposed Mackenzie Gas Project (IOL et al. 2004). Table 9.1-5 summarizes background concentrations of the key indicator compounds for the Parsons Lake field area, the Storm Hills pigging facility and the Inuvik Area Facility, all of which would be located in the general vicinity of the proposed Inuvik – Tuktoyaktuk Highway corridor.

As noted, background levels of combustion products, e.g., SO_2, NO_3, CO and $PM_{2.5}$ were all low. Detectable levels of ozone (O_3) were recorded, but this was to be expected as ozone levels in northern Canada are naturally high (IOL et al. 2004).

Background levels of VOCs were also recorded but again this was to be expected as organic compounds are released naturally by vegetation and decaying plant material. Background PAI (Potential Acid Input), attributed to the long range transport of acid-forming compounds emitted by large industrial facilities elsewhere in the northern hemisphere, has and will continue to be deposited by precipitation in the region (IOL et al. 2004).

Using the available baseline air quality information, estimated Mackenzie Gas Project emissions (IOL et al. 2004), and the results of modelling, it was predicted that potential air quality effects of the Mackenzie Gas Project, based on the key indicator compounds were generally of a low magnitude, localized in extent and well below existing Northwest Territories air quality standards.

TABLE 9.1-5: BASELINE AIR CONDITIONS FOR PARSONS LAKE AND THE GATHERING PIPELINES AND ASSOCIATED FACILITIES

Parameter	Parsons Lake	Storm Hills Pigging Facility	Inuvik Area Facility
Sulphur dioxide (SO_2)[1] (ug/m^3)	0.5	0.5	0.5
Nitrogen dioxide (NO_2)[1] (ug/m^3)	0.8	0.8	0.8
Carbon monoxide (CO_2)[2] (ug/m^3)	0.0	0.0	0.0
Fine particulate matter ($PM_{2.5}$)[2] (ug/m^3)	0.0	0.0	0.0
Benzene[3] (ug/m^3)	2.6	2.6	2.6
Total BTEX[3,4] (ug/m^3)	3.7	3.7	3.7
Potential acid input[5] (keq/ha/a)	0.03	0.03	0.03
Sulphate deposition[5] (kg/ha/a)	0.96	0.96	0.96
Nitrate deposition[5] (kg/ha/a)	0.62	0.62	0.62
Ozone (O_3)[1,6] (ug/m^3)	46.5	46.5	46.5

NOTES:

1 Results based on passive monitoring from Inuvik

2 Results assumed to be zero

3 Results based on SUMMA canister data from Parsons Lake

4 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and converted to ug/m^3 assuming the molecular weight of benzene
5 Results based on wet deposition monitoring data for Snare Rapids, Northwest Territories
6 Background ozone concentrations were not selected as a key indicator, but are important in determining the quantity of NO_X emissions converted to NO_2 in the atmosphere

9.1.5 Climate Change

9.1.5.1 Background

Information collected over many years at northern climate stations, suggests that the climate in the Mackenzie Delta and the Mackenzie Valley region has been changing. Communities and other stakeholders are concerned about the potential effects of climate change on the northern environment and the economy.

Natural variability, expressed as averages over the last 30 years, shows variations in average annual temperatures of 3˚C to 6˚C. Depending on the climate model scenario used, these exceed by two to three times the average annual temperature increases obtained from the model. Nonetheless, based on observed trends and on future modeled predictions, there is a consistent and gradual warming trend. Generally model results indicate a warming trend in air temperature of up to 2.5˚C and an increase in precipitation of up to 11.8% in the 30 years between 2010 and 2039 (IOL et al. 2004).

9.1.5.2 Inuvialuit Settlement Region

Table 9.1-6 summarizes the current climatic conditions as well as past and future climate trends in the Inuvialuit Settlement Region. Expected future temperature changes will be comparable to the changes that have occurred over the last 30 years. For example, the future change in average temperature is between +1.3˚C and +2.5˚C. These values are similar to the +1.5˚C increase observed between 1971 and 2000. The current average annual temperature is -10.3˚C and the annual average winter temperature is -26.5˚C (IOL et al. 2004).

TABLE 9.1-6: CLIMATE CONDITIONS AND CHANGE IN THE INUVIALUIT SETTLEMENT REGION

Parameter	Current[1] Conditions	Trend (1971 to 2000)	Forecast Trend[2] (2010 to 2039)		
			Low	Medium	High
Average annual temperature (˚C)	-10.3	+1.5	+1.3	+1.6	+2.5
Average winter temperature[3] (˚C)	-26.5	+2.1	+1.3	+2.1	+2.2
Total precipitation[4,5] (mm)	191.0	+5.2	+2.1%	+7.4%	+11.8%

Notes:

1 Current conditions are based on 1996 to 2000 observations. Source: IOL et al. 2004
2 Trend estimates ranges from Burn (2003)
3 Winter temperatures are based on December, January and February

4 Total precipitation is presented as millimeters of equivalent rainfall.

3 Future trends are presented as percentage change from the 1961 to 1990 climate normals.

Source: IOL et al. 2004

The future trend in total precipitation in this region ranges from 2.1 to 11.8% above the 1961 to 1990 climate normals. Total precipitation in the Inuvialuit Settlement Region has increased by 5.2 mm during the past 30 years. Current annual total precipitation is 191 mm (IOL et al. 2004). Section 10.8 of this Project Description Report discusses the possible effects of climate change on the future integrity of the Highway and current approaches to the mitigation of this concern.

9.2 GEOLOGY

9.2.1 Bedrock Geology

Bedrock in the Mackenzie Delta is sedimentary, comprised of Tertiary shale and sandstone. Preglacial, glacial and postglacial deposits overlie the bedrock. Depth to bedrock in the Delta ranges from about 50 m near Inuvik to greater than 150 m near the seaward limit of the modern delta.

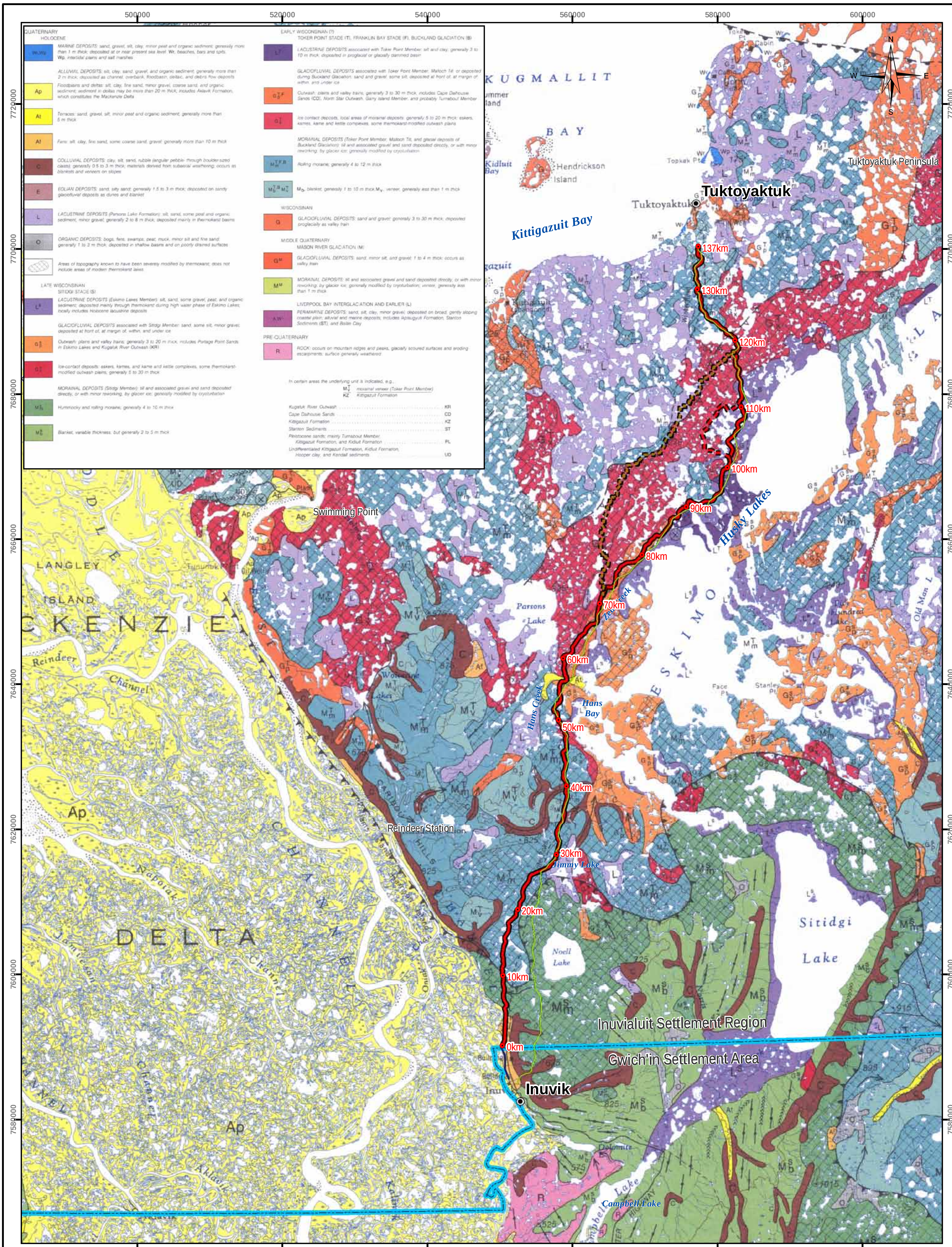
In the northern and eastern parts of the Caribou Hills, north of Inuvik and adjacent to the Parsons Lake area, Tertiary shale lies beneath glacial and post glacial deposits, and occasionally is near surface with rare exposures. The bedrock consists of weathered, poorly indurated shale, sandstone and mudstone. The bedrock in the southern part of the Caribou Hills more commonly consist of Cretaceous shale and regularly outcrops.

The proposed Highway is located within the Cenozoic Sedimentary Rock – Tertiary (IOL et al. 2004). Quaternary glacial deposits overly the Tertiary bedrock, which overlies Cretaceous strata.

9.2.2 Surficial Geology

9.2.2.1 General

Figure 9.2-1, originally generated by Rampton (1987; 1979), illustrates the the surficial geology of the Tuktoyaktuk Peninsula and general project area. The proposed alignment crosses two distinct physiographic regions between Inuvik and Tuktoyaktuk. From Inuvik to south of Husky Lakes, the alignment crosses the eastern extension of the Caribou Hills on the edge of the Anderson Plain, consisting of mostly unconsolidated materials with varying amounts of ground ice overlying relatively shallow bedrock. Much of the topographic relief is a direct reflection of the bedrock surface, but bedrock is rarely exposed. North of this area to Tuktoyaktuk, the alignments enter onto the Pleistocene Coastal Plain, consisting of thick unconsolidated sediments, moraines, ice-contact, glaciofluvial and organic lacustrine deposits (Rampton 1987; Rampton 1979). The area also contains varying quantities of ground ice and massive ice layers. Bedrock is not near surface in the Pleistocene Plain.



LEGEND

- 2009 Route
- Other Alignments Considered
- Upland Route
- PWC 1977
- Navy Road
- Gwich'in / Inuvialuit Boundary

NOTES

Base data source:
Natural Resources of Canada - gscmap-a_1647a_e_1987_mn01.jp2, Rampton (1974 and 1987)

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Surficial Geology

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:500,000
5 2.5 0 5 10 15
Kilometres

FILE NO.
V23201098_PDR-Map015-Ter-SurfGeology.mxd

PROJECT NO.	DWN	CKD	REV
V23201098	KWM	EG	0

OFFICE	DATE
EBA-VANC	January 14, 2010

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 9.2-1

Surface deposits along a more westerly Upland Route from Parsons Lake to Source 177 are primarily hummocky glacial moraine and undulating terrain studded with numerous lakes of the Pleistocene Coastlands region. The terrain is hummocky and irregular due to the ice-contact deposits, glacial depositional features, and thermokarst activity. Depressions are typically post glacial lakes, or infilled with organic-rich bogs and post glacial lacustrine silt and clay sediments. Retrogressive thaw flow slides are not uncommon along the shores and banks of lakes and streams between Parsons Lake and Tuktoyaktuk. Low and high-centre ice-wedge polygons are present in the moraine and lacustrine deposits.

9.2.2.2 Quaternary History

The Quaternary is the present geological time period, often referred to as the glacial age, and the time during which geological processes fashioned the surface of the Earth as it is known today. Quaternary events are largely responsible for the deposition of the surface materials and landforms that influence the design and construction of the Inuvik to Tuktoyaktuk Highway.

The Quaternary Period is subdivided into Pleistocene and Holocene epochs with the Holocene defined as roughly the last 10 thousand years before present. The predominant characteristics of the Quaternary period are marked climatic change, glacial advances and retreats, and the activity of other processes fuelled by climatic oscillations. Climate change is the likely cause of periods of buildup and decay of ice sheets of continental scale, resulted in transgression and regression of oceans, migration and extinction of plants and animals, etc.

9.2.2.3 Terrain

Terrain types common along the proposed route vary from relatively dry upland and hummocky conditions, to wet, ice-rich lacustrine and thick organic conditions. The unfavorable thick organic and ice-rich polygonal terrain was avoided where possible. Routing focused on traversing the most favorable terrain within the study corridor while being conscious of overall length.

As one would suspect, various types of surficial materials occur along the proposed Inuvik to Tuktoyaktuk Highway. The surficial geology along the proposed route/alignment has been generalized into four distinctive landforms (terrain types); morainal, glaciofluvial outwash, lacustrine and alluvial/colluvial deposits. The route corridor contains many seasonal watercourses, wet lowlands, peatlands and lakes, many of which are remnants of glacial outwash channels.

Through the remainder of the Holocene Period, periglacial processes resulted in the mechanical breakdown of materials and contributed to gravity transport of both glacial soils and products of periglacial grinding. Thin alluvial soil deposits formed along watercourses, and pond (lacustrine) deposits have accumulated in shallow depressions. Thicker organic deposits have formed on poorly drained floodplains and low, flat areas.

The following provides a summary of each terrain type based upon field investigations and mapping by Rampton (1987). The generalized terrain types are presented in Table 9.2-1. This classification is based on observations during the field investigation, a review of orthophotographs and LIDAR topographic surveys along the route, and surficial geology mapping by others of the study area. The majority of the route traverses Terrain Types 1 and 2, with Terrain Types 3 and 4 comprising the remainder of the route.

TABLE 9.2-1: TERRAIN TYPES ALONG THE PROPOSED ALIGNMENT

Terrain Type	Terrain Description	Approximate Percent Distribution Along Proposed Alignment
1	Morainal Deposits – deposited directly, or with minor reworking, by glacier ice; generally modified by cryoturbation. (relatively dry, stable, upland tills, overlain by a thin organic cover)	40
2	Glaciofluvial Outwash and Ice-Contact Deposits – deposited at front of, at margin of, within, and under glacier ice. (kame and kettle complexes and thermokarst modified plains, dry to wet, overlain by a thin to moderate organic cover)	35
3	Lacustrine Deposits – deposited in proglacial or glacially dammed basis, during high water phases of Husky Lakes, in thermokarst basins and recent lacustrine deposits. (wet, silt and clay, fine sand and organic sediments, moderate organic cover)	20
4	Alluvial/ Colluvial Deposits – deposited channel, floodplain, deltaic, and debris flow deposits, along ancient channels, present-day streams and steep slopes.	5

Terrain Unit 1

Morainal Deposits also known as “till” consisting of well-compacted to non-compacted material that is non-stratified and contains a heterogeneous, variable mixture of particle sizes, often in a matrix of sand, silt and clay; deposited by direct glacial action. Morainal deposits are generally moderately-well-drained, relatively ice-poor within the active layer, and smooth to rolling topography, with little surface expression of ice-rich permafrost conditions. However, morainal deposits can also include wet till and till with ice-rich permafrost features indicative of more thermally sensitive terrain; these less favorable conditions were avoided where possible.

Terrain Unit 2

Glacial Outwash and Ice-Contact Deposits dominate the middle section of the route. Materials in these depositional environments are usually interbedded mixes of sand and gravel with some silt. They have been transported away from a glacier by a stream of meltwater and deposited as a floodplain along a preexisting valley bottom or broadcast over a preexisting plain, or have been deposited in ridges, terraces and hummocky terrain along glacial ice contacts. The ground ice contents of these deposits vary greatly and are usually dependent on topographic location. Crests of prominent ridges and hummocks are typically well-drained and ice free to depths of 2 m to 5 m. Below this depth the till is generally icy with ice lenses, and massive ice is common at depth. The deposits are moderately susceptible to thermokarst activity with signs of subsidence and ground ice slumping and gullying. Local drainage patterns tend to be deranged, draining to local ponds. The potential of these deposits as borrow material is limited by ice content. Typically the high crests and hummocks yield useful material.

Ice-contact deposits are often hummocky and irregular, characteristic of the kettle lake and thermokarst terrain. Drainage in most instances is good over the irregular terrain, however imperfect to poorly drained outwash materials are found where groundwater seepage is pronounced. Textures are quite variable and range from silt to subrounded gravels. There is generally a low ice content in the near surface (active layer), but ice content increases with depth and massive ice can be encountered. These deposits represent essentially the only source of useful borrow material on the Pleistocene Plain.

Terrain Unit 3

Lacustrine deposits include wet silt, clay and fine sand, pond/lake bottom sediment deposits that occur in low-lying wet lowland terrain and old lakebeds. They are defined as sediments that have settled from suspension, and occasionally by underwater gravity flows in bodies of standing fresh water. In general, this terrain is poorly drained with standing water, overlain by moderate to thick organic over. Permafrost is present under this terrain unit, except adjacent to large waterbodies.

Lacustrine deposits are generally found in low-lying areas and depressed topography where slopes are nearly flat. Such deposits are present along the entire shoreline of Husky Lakes and in the coastal lowlands of the Pleistocene Plain. Because of the fine textured nature of these sediments, combined with imperfectly to poorly drained conditions, these sediments are ice-rich and highly susceptible to compaction and rutting.

Terrain Unit 4

Post-glacial alluvial and colluvial deposits are materials transported and deposited by streams and gravity. Fluvial deposits are found along many of the watercourses while colluvial materials are indicative of instability on steeper slopes as noted along the Hans River valley where thick sediments have slumped into the valley. Alluvial sediments are commonly moderately to well sorted and display stratification. Colluvial materials are unsorted, derived from surficial deposits that have moved downslope because of gravity-induced movement.

From an engineering perspective, many of the alluvial deposits represent potential aggregate sources, such as those identified along the north terrace of Hans Creek. These sediments are generally well drained, however, where drainage is poor or where groundwater springs are noted, care must be taken not to impact these areas as they will be prone to disturbance.

9.2.3 Permafrost Conditions

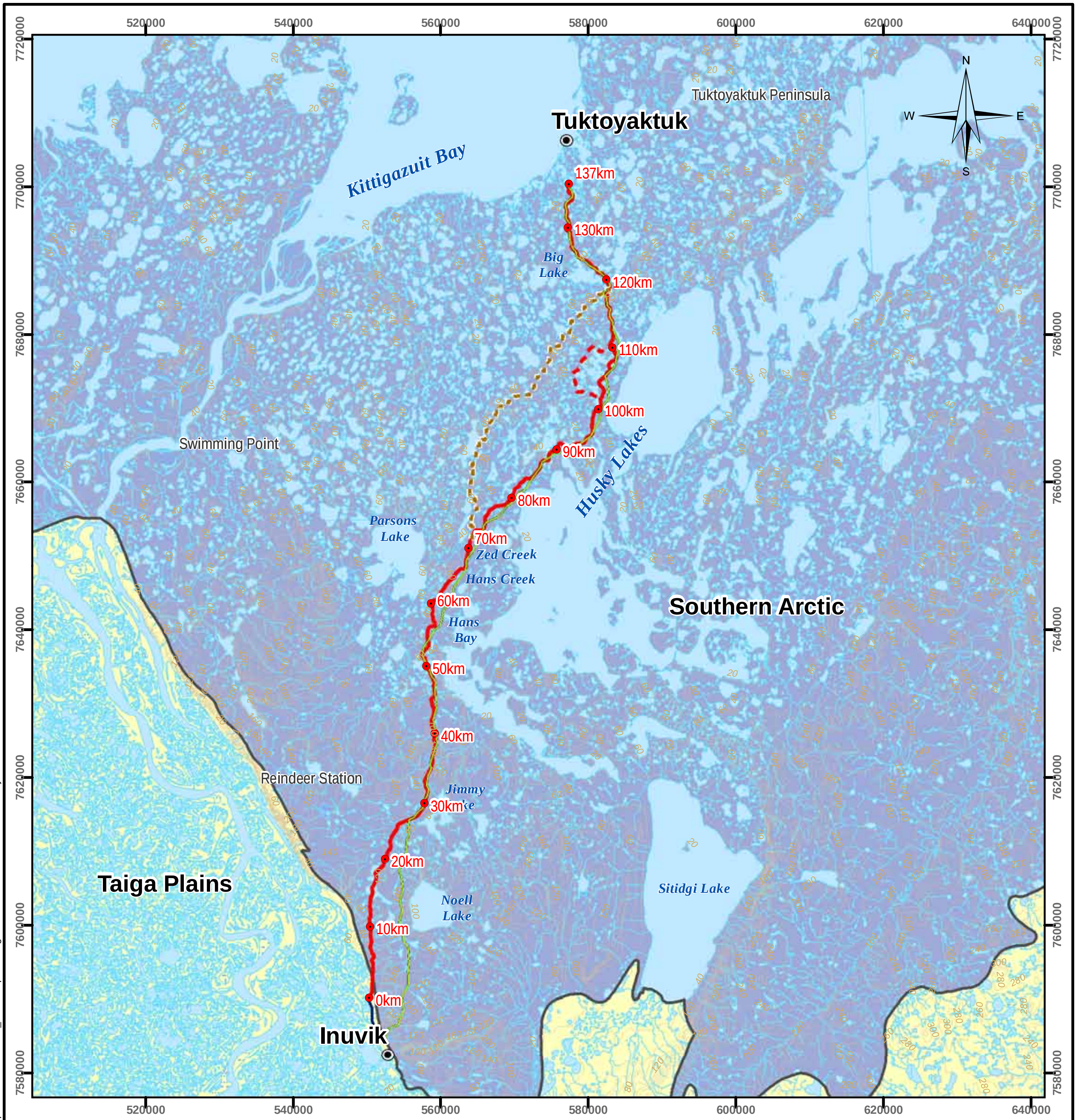
The Inuvik to Tuktoyaktuk corridor is located entirely within the zone of continuous permafrost (NRC 2007). Ground temperatures are within the range of minus 2˚C to 5˚C. Permafrost is defined as any rock or soil material that has remained below 0˚C continuously for two or more years, without consideration of material type, ground ice distribution, or thermal stability. The two-year minimum stipulation is meant to exclude from the definition the overlying ground surface layer which freezes every winter and thaws every summer (called the "active layer" or "seasonal frost"). The thickness of the active layer in the Project area is typically between 0.6 m and 0.8 m, but varies from less than 0.5 m to greater than 2.0 m on elevated, organic-free slopes. The underlying permafrost is typically a few hundred metres thick, but depends on various factors including proximity to lakes, slope, aspect, and many other site-specific conditions.

Permafrost is reflected in well developed patterned ground and periglacial processes. The mineral soils in the region generally have high ice content and are sensitive to disturbance. In this periglacial condition there are several forms of frozen ground that can occur. Frozen ground can contain excess ice, where the amount of water contained in the soil matrix in a frozen state is higher than would be retained in the soil in an unfrozen state. The excess ice can be found mixed (disseminated, non-visible) within the soil matrix, or can be in the form of pure ice, ice lenses or ice wedges. The presence of perennially frozen ground limits the percolation of water and promotes the accumulation of organic material. The importance of these ice inclusions is the susceptibility of these materials to melt, the resultant ground disturbance, and the suitability for use as construction material (NRCAN 2007).

9.3 VEGETATION AND SOILS

9.3.1 General

The proposed project is located predominantly within the *Southern Arctic Ecozone*, with a small portion of the highway alignment projecting into the *Taiga Plains Ecozone*, near Inuvik (Figure 9.3-1). An ecozone represents a large generalized unit at the top of the ecological hierarchy as defined by the Canada Committee on Ecological Land Classification, and is characterized by distinctive regional ecological factors, including climate, physiography, vegetation, soils, water, fauna and land use (Ecological Stratification Working Group 1996). The *Southern Arctic Ecozone* extends from the arctic coastline, south close to Inuvik. Inuvik, however, is situated on the edge of the *Taiga Plains Ecozone*. Since Inuvik is at the edge of the *Taiga Plains Ecozone* and the majority of the proposed Highway is within the *Southern Arctic Ecozone*, this ecozone will be described briefly here. The proposed Highway traverses approximately 2.5 km of the *Taiga Plains Ecozone*.



LEGEND

- 2009 Route
- Other Alignments Considered
- Upland Route
- PWC 1977
- Navy Road
- Contour
- Watercourse
- Waterbody
- Wetland

Ecozones

- Southern Arctic
- Taiga Plains

NOTES

Base data source:
NTS 1:250,000
Eco Zones: NWT WWF Data

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Ecozones

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000

5 2.5 0 5 10 15 20 25

Kilometres

FILE NO.
V23201098_PDR-Map013-Veg-EcoZn.mxd

PROJECT NO.	DWN	CKD	REV
V23201098	KWM	SM	1

OFFICE	DATE
EBA-VANC	January 14, 2010

Town of Inuvik

Northwest Territories

KIGGIAK - EBA

Figure 9.3-1

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Inuvik and the Mackenzie Delta lie within the *Taiga Plains Ecozone*. This ecozone is dominated by Canada's largest river, the Mackenzie, and its tributaries. It is characterised by an open, generally slow growing, conifer dominated forests of predominantly spruce (Photo 9.3-1). The shrub component is often well developed and includes dwarf birch, Labrador tea, and willow. Bearberry, mosses, and sedges are dominant understory species. Upland and foothill areas and southerly locales tend to be better drained, are warmer, and support mixed wood forests characterized by white and black spruce, tamarack, white birch, trembling aspen, and balsam poplar (Photo 9.3-2). The Mackenzie Valley forms one of North America's most travelled migratory corridors for waterfowl (ducks, geese, and swans) breeding along the arctic coast. The Tuktoyaktuk Peninsula lies within the *Southern Arctic Ecozone*. The topography is fairly level, rising from sea level to approximately 100 m in elevation at Granular Source 177. The Mackenzie Gas Project Environmental Impact Statement (IOL et al. 2004) describes this ecozone and corresponding vegetation in detail.

Photo 9.3-1
The northern edge of the Taiga Plains Ecozone is dominated by a slow growing spruce forest

Photo 9.3-2
Mixed wood forests occur on better drained sites such as upland and foothill areas

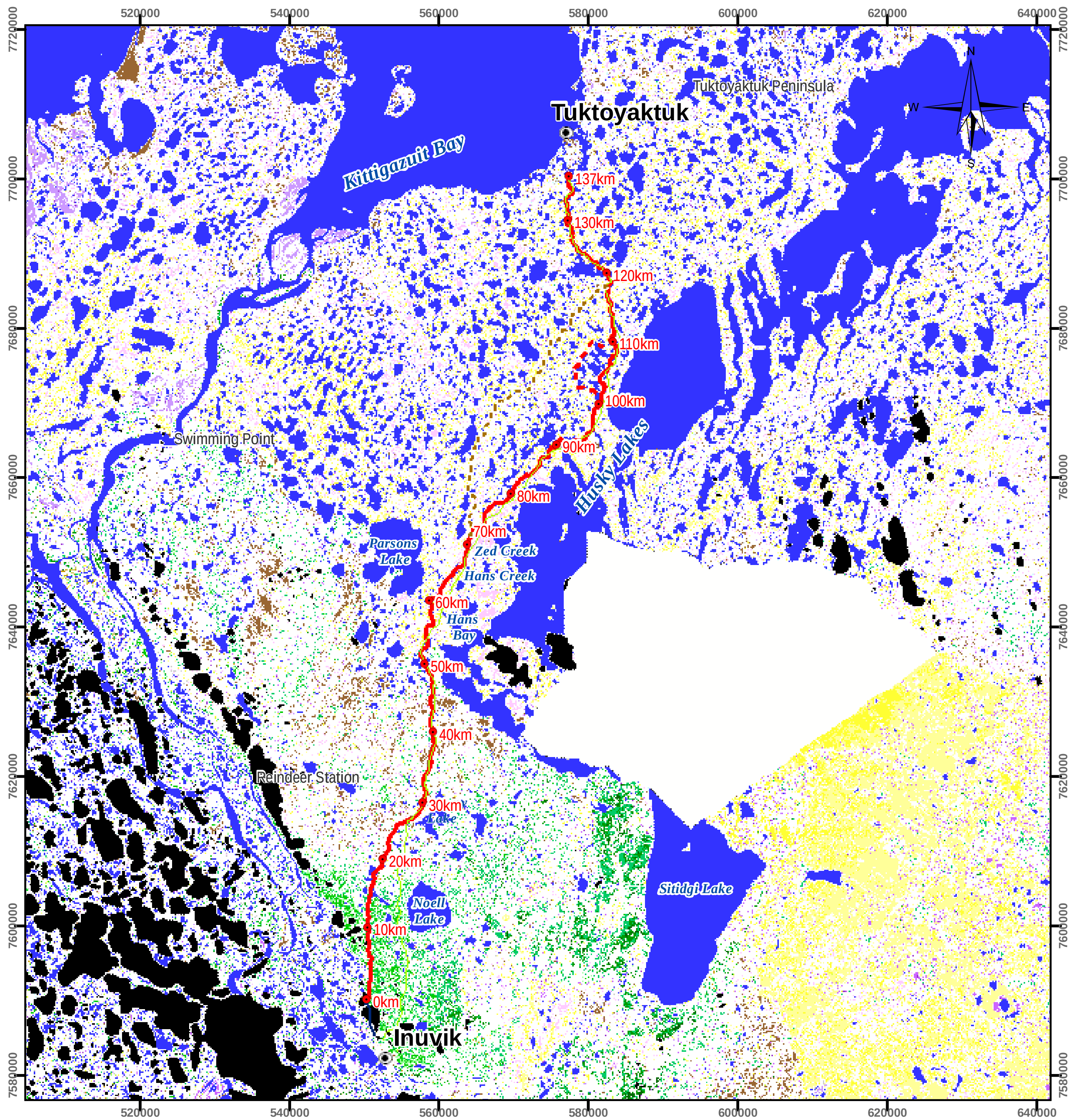
Numerous lakes, ponds, and streams are common across the Peninsula. Vegetation grows on a veneer of unfrozen organic or granular substrate overlying the permafrost. The dominant vegetation along the proposed Highway alignment is characterized by a continuous cover of shrubby tundra vegetation, consisting of dwarf birch, willow, northern Labrador tea, *Dryas* spp., and sedge tussocks (Photo 9.3-3). In wetter areas, sedges, cotton-grasses and sphagnum moss dominate high-centered and low-centered polygons. Drier areas support ericaceous shrubs. Riparian communities include wet sedge communities and taller shrubs (Photo 9.3-4).

9.3.2 Vegetation Communities

The proposed Highway occurs over a variety of terrain and plant community associations (community types) (Figure 9.3-2). The following vegetation communities are described in this section: dwarf shrub heath, upland shrub, cotton-grass tussock, high-centered polygons, low-centered polygons, riparian shrub, riparian sedge – cotton-grass, coastline shrub, coastline sedge – cotton-grass, coastline low-centered polygons, and transition forest.

Photo 9.3-3
The dominant vegetation along the proposed road alignment is characterized by shrubby tundra vegetation, consisting of dwarf birch and willow

Photo 9.3-4
Sedge and cotton-grass communities, such as this pond, provide valuable nesting habitat for waterfowl



ISSUED FOR USE

LEGEND

- 2009 Route
- Other Alignments Considered
- Upland Route
- PWC 1977
- Navy Road

No Data	Wetland-Herb	
Cloud	Herb	
Shadow	Coniferous Dense	
Water	Coniferous Open	
Snow/Ice	Coniferous Sparse	
Rock/Rubble	Broadleaf Dense	
Exposed Land	Broadleaf Open	
Bryoids	Broadleaf Sparse	
Shrub Tall	Mixedwood Dense	
Shrub Low	Mixedwood Open	
Wetland-Treed	Mixedwood Sparse	
Wetland-Shrub		

NOTES

Base data source:
Land cover: EOSD - Canadian Forest Service

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Land Cover Mapping

PROJECTION: UTM Zone 8
DATUM: NAD83

Scale: 1:750,000

5 2.5 0 5 10 15 20 25
Kilometres

FILE NO.: V23201098_PDR-Map014-Veg-Landcover.mxd

PROJECT NO.	DWN	CKD	REV
V23201098	KWM	SM	0

OFFICE: EBA-VANC
DATE: January 20, 2010

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 9.3-2

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9.3.2.1 Dwarf Shrub Heath

Dwarf shrub heath is the most common tundra community type occurring on the Tuktoyaktuk Peninsula (Photo 9.3-5) and has characteristic vegetation consisting of narrow-leaved Labrador tea and alpine bilberry. This community type is widespread throughout flat and rolling terrain, located on a variety of parent materials including glaciofluvial, morainal and colluvial materials. The soils are usually moderately to imperfectly drained, but can be poorly drained in lower landscape positions, as the shallow permafrost table controls drainage. A veneer of peat is often present over mineral deposits, but is usually thinner than 50 cm. Sites with dwarf shrub heath are usually located in crest, upper to mid-slope positions but less commonly in depressions.

Photo 9.3-5
Dwarf shrub heath is a common tundra community type occurring on Tuktoyaktuk Peninsula, and are characterized by narrow-leaved Labrador tea and alpine bilberry

Permafrost features, such as thermokarst subsidence or frost boils, are often present. Topography is undulating with slopes up to 5%. Soils are often Terric Fibric Organic Cryosols and Orthic Eutric or Dystric Turbic Cryosols. The nutrient regime in is estimated to be poor and the moisture regime ranges from mesic to hygric. The active layer depth ranges from 18 to 200 cm (IOL et al. 2004).

Dwarf shrubs make up most of the shrub and ground cover layers. Arrow-leaved coltsfoot is an indicator species for this community type. Plant species found within this community type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Green Alder	*Alnus viridis (incl A. crispa)*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Narrow-leaved Labrador Tea	*Ledum palustre ssp decumbens (L. decumbens)*
Arctic Sweet Coltsfoot	*Petasites frigidus (P. arcticus, hyperboreus, palmatus, sagittatus, and vitifolius)*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*
Red Bearberry	*Arctostaphylos rubra*
Alpine Bilberry	*Vaccinium uliginosum*

Source: GNWT ENR 2009a

Of the non-vascular plant species likely to be found in the area, common lichens are reindeer lichens and *Cetraria* spp., and peat moss is the most common bryophyte. *Peltigera* species are often associated with low cover values.

9.3.2.2 Upland Shrub

Slopes on upland areas are frequently vegetated with an upland shrub community type and have characteristic vegetation consisting of willows, *Salix glauca*. This community type typically occurs as lower and/ or taller shrubs forming a scattered to open canopy (Photo 9.3-6). Indicator species of this community type are willow, Arctic sweet coltsfoot, bistort, and lousewort.

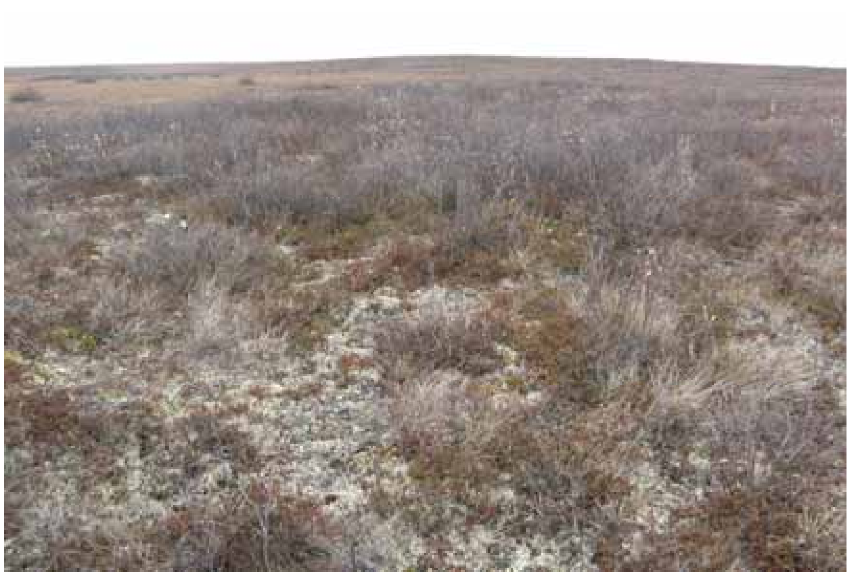


Photo 9.3-6
Upland shrub represents another common community type and is dominated by willow, *Salix glauca*

The upland shrub community type occurs on morainal or lacustrine landforms with fine silty clay and loamy texture. Most sites with upland shrub have a hygric to subhydric moisture regime with moderate to poor drainage and fairly level to gently rolling topography. Soils might be Orthic Eutric Static and Turbic Cryosols. The upland shrub community type also grows on coarse glaciofluvial sediments with coarse loamy sand to sandy loam parent material texture. At these locations, this community type is more common on the mid to lower landscape positions where drainage is restricted by permafrost. Sites with upland shrub can have thermokarst subsidence or occasional, but poorly developed, ice-wedge polygons. A veneer of peat is often present over mineral deposits, but is usually thinner than 40 cm. Sites with upland shrub have poor nutrients and a subhygric to hygric moisture regime. The active layer depth ranges from 25 to 67 cm (IOL et al. 2004).

Plant species found within this community type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Gray willow	*Salix glauca (S. cordiflora ssp callicarpea and glauca ssp stenolepsis?)*
Green Alder	*Alnus viridis (incl A. crispa)*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Red Bearberry	*Arctostaphylos rubra*
Arctic Sweet Coltsfoot	*Petasites frigidus (P. arcticus, hyperboreus, palmatus, sagittatus, and vitifolius)*
Meadow Bistort	*Bistorta plumosa (Polygonum bistorta ssp plumosum)*
Tilesius Sagebrush	*Artemisia tilesii*
Black Crowberry	*Empetrum nigrum*
Steven Meadow-sweet (*Spiraea*)	*Spiraea stevenii (S. beauverdiana)*

Source: GNWT ENR 2009a

Of the non-vascular plant species likely to be found in the area, common lichens include reindeer lichens, *Cetraria* spp. and club lichens.

9.3.2.3 Cotton-Grass Tussock

The cotton-grass tussock community type is found on lower slopes and lowlands where ground water creates hygric-subhydric soil moisture (Photo 9.3-7), particularly in the valley between the Storm Hills. The characteristic vegetation for this community type includes tussock cotton-grass.

The cotton-grass tussock community type is located mostly within fine-textured morainal and lacustrine landscapes. Drainage is usually imperfect to poor. Peat is often present as a thin veneer over mineral deposits. Sites with cotton-grass tussock can be subject to inundation or permafrost, and demonstrate features such as thermokarst subsidence and frost heave. Micro-topography is hummocky, with regional slopes less than 10%. Soils are typically either Terric Fibric or Mesic Organic Cryosols when there is more than 40 cm of organic material, or Orthic Eutric Turbic Cryosols when there is less than 40 cm of organic material at the surface. The nutrient regime in this community type is typically considered to be poor with a moisture regime ranging from hygric to subhydric. The active layer depth ranges from 11 to 75 cm (IOL et al. 2004).

Photo 9.3-7
Cotton-grass tussock communities are found on lower slopes and lowlands where ground water creates hygric to subhydric soil conditions

Sheathed cotton-grass is the dominant species in this community type. It forms dense tussocks along with two sedges, *Carex lugens* and *C. consimilis.* In between the tussocks, sphagnum species thrive, whereas shrub species are less prominent because of the high moisture levels. Cloudberry is also found in the ground cover. Species potentially found within this community type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Tussock Cotton-grass	*Eriophorum vaginatum*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Narrow-leaved Labrador Tea	*Ledum palustre ssp decumbens (L. decumbens)*
Bigelow's Sedge	*Carex bigelowii (C. consimilis, C. lugens, C. cyclocarpa, C. yukonensis, C. anguillata)*
Diamond-leaved Willow	*Salix planifolia (incl Salix tyrrellii)*
Black Crowberry	*Empetrum nigrum*
Cloudberry	*Rubus chamaemorus*

Source: GNWT ENR 2009a

Of the non-vascular plant species likely to be found in the area, *Cladonia* and *Cetraria* lichen species are sometimes present.

9.3.2.4 High-centered Polygons

High-centered polygons are found localized in depression areas and flats on the Tuktoyaktuk Peninsula, and have characteristic vegetation consisting of narrow-leaved Labrador tea and rock cranberry. They have large net-like patterns with high centers surrounded by water-filled troughs with ice bottoms (Photo 9.3-8). The centre of each polygon develops a dome of peat and is vegetated with upland species similar to the dwarf shrub heath community type.

Photo 9.3-8
High-centered polygons have large net-like patterns with high center surrounded by water-filled troughs with ice bottoms

In many high-centered polygons, a thick layer of strongly cryoturbated, mixed organic and mineral soil underlies surface peat deposits. The polygons are usually located in poorly drained areas that occupy low landscape positions such as depressions associated with thermokarst lakes or ponds, pingos, hollows or channel-like features. Sites with high-centred polygons occur in ice-rich, fine-grained soils with a silty clay loam to clay loam texture on the morainal landforms and small lacustrine basins. The organic layer on these soils is usually less than 50 cm thick. Soils are typically Terric Mesic Organic Cryosols and Orthic Dystric and Brunisolic Dystric Turbic Cryosols. The nutrient regime in areas with high-centred polygons is poor, and the moisture regime ranges from subhygric to hydric. The active layer depth ranges from 29 to 40 cm (IOL et al. 2004).

Plant species found within this community type include:

Species	Scientific Name
Narrow-leaved Labrador Tea	*Ledum palustre ssp decumbens (L. decumbens)*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*
Red Bearberry	*Arctostaphylos rubra*

Source: GNWT ENR 2009a

Of the non-vascular plant species likely to be found in the area, Reindeer lichens are prominent and *Cetraria* and club lichens also occur on most sites with high-centred polygons.

9.3.2.5 Low-centered Polygons

Low-centered polygon communities are localized in depression areas and drained lake basins on the Tuktoyaktuk Peninsula, typically adjacent to areas of standing water (Photo 9.3-9). Characteristic vegetation for this community type includes dwarf birch, diamond-leaved willow, and tussock cotton-grass. Low-centered polygons often occur adjacent to high-centered polygons and are usually similar in pattern size. The centres of the polygons are depressed, often containing pond water and covered with wetland vegetation (predominantly peat moss).

Photo 9.3-9
Low-centered polygon communities are localized in depression areas and drained lake basins on the Tuktoyaktuk Peninsula, typically adjacent to areas of standing water

The polygons are bordered by soil ridges pushed up by ice wedges that are formed in cracks and develop during freeze-thaw cycles. Surface peat deposits are typically less than 60 cm thick, and are underlain by a thick layer of strongly cryoturbated, mixed organic and mineral soil. Leatherleaf is an indicative plant of this community type; however, it has a low percent cover value, being restricted to the outer soil ridges.

The polygons are usually located in poorly-drained areas that occupy low landscape positions such as depressions associated with thermokarst lakes or ponds, pingos, hollows or channel-like features. Sites with low-centred polygons occur in ice-rich, fine-grained soils with a silty clay loam to clay loam texture on the morainal landforms and small lacustrine basins. The organic layer on these soils is usually less than 50 cm thick. Soils are typically Terric Mesic Organic Cryosols and Orthic Dystric or Eutric Turbic Cryosols, and occasionally, Gleyed Turbic Cryosols. This community type is nutrient poor and has a moisture regime ranging from subhygric to hydric. The active layer depth ranges from 11 to 50 cm (IOL et al. 2004).

The drier ridges are dominated by dwarf shrub heath vegetation. Plant species found within this community type include:

Species	Scientific Name
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Diamond-leaved Willow	*Salix planifolia (incl Salix tyrrellii)*
Green Alder	*Alnus viridis (incl A. crispa)*
Tussock Cotton-grass	*Eriophorum vaginatum*
Alpine Bilberry	*Vaccinium uliginosum*
Bigelow's Sedge	*Carex bigelowii (C. consimilis, C. lugens, C. cyclocarpa, C. yukonensis, C. anguillata)*
Narrow-leaved Labrador Tea	*Ledum palustre ssp decumbens (L. decumbens)*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*
Pumpkin-fruited Sedge	*Carex rotundata*

Source: GNWT ENR 2009a

Of the non-vascular plant species likely to be found in the area, common lichen species include reindeer lichens and *Cetraria* spp.

9.3.2.6 Riparian Shrub

The riparian shrub community type is found along streams and drainage basins in the southern portion of the Highway corridor, comprising of taller shrubs such as diamond-leaved willow, Arctic dwarf birch, and green alder (Photo 9.3-10). This community type is most common on silty sand fluvial deposits associated with small streams. Topography is subdued and concave, with slopes up to 5%. Soils are usually moderately well to poorly drained, with a shallow permafrost table and water table near the surface. Seasonal or occasional flooding deposits fresh silt and fine sand layers on the surface of the soils. Soils are commonly Regosolic Static Cryosols and occur close to the active river channel. Peat can be present as a veneer over mineral deposits in the areas above the flooding zone. Sites with riparian shrub have a poor to medium nutrient regime and the moisture regime ranges from hygric to hydric. The active layer depth ranges from 18 to 90 cm (IOL et al. 2004).

Species found within this community type include:

Species	Scientific Name
Diamond-leaved Willow	*Salix planifolia (incl S. tyrrellii)*
Arctic Dwarf Birch (Dwarf Birch)	*Betula nana (B. glandulosa, Betula x eastwoodiae)*
Green Alder	*Alnus viridis (incl A. crispa)*
Water Sedge	*Carex aquatilis*
Rock Cranberry (Lingonberry)	*Vaccinium vitis-idaea*
Narrow-leaved Labrador Tea	*Ledum palustre ssp decumbens (L. decumbens)*
Marsh Cinquefoil	*Comarum palustre (Potentilla palustris)*
Cloudberry	*Rubus chamaemorus*
Black Crowberry	*Empetrum nigrum*

Source: GNWT ENR 2009a

Photo 9.3-10
Riparian shrub communities are found along streams and drainage basins in the southern portion of the Highway corridor

9.3.2.7 Riparian Sedge – Cotton-Grass

The riparian sedge – cotton-grass community type occurs on the perimeters of small lake and ponds (Photo 9.3-11), and less commonly along small streams, in the Tuktoyaktuk Peninsula. The dominant vegetation is water sedge (*Carex aquatilis*). Indicator species for this community type include water horsetail and buckbean. Peat moss is the most prominent nonvascular component.

Photo 9.3-11
Riparian sedge – cotton-grass communities occur on the perimeters of small lakes and ponds

The riparian sedge – cotton-grass community type is most common on silty sand deposits associated with the small lakes and ponds. Topography is subdued with slopes up to 5%. Soils are usually imperfectly to very poorly drained, with a shallow permafrost table. Seasonal or occasional flooding deposits fresh silt sand fine sand layers on the surface of the soils and there is little to no organic material. Soils are most commonly Regosolic Static Cryosols, Gleyed Static or Turbic Cryosols. Parent material textures typically range between silty clay loam and loam. Sites with riparian sedge – cotton-grass have a poor nutrient regime and the moisture regime ranges from subhydric to hydric. The active layer depth ranges from 15 to 45 cm (IOL et al. 2004).

Species found within this community type include:

Species	Scientific Name
Water Sedge	*Carex aquatilis*
Water Horsetail	*Equisetum fluviatile*
Bog Buckbean	*Menyanthes trifoliata*

Source: GNWT ENR 2009a

9.3.2.8 Coastline Shrub

The coastline shrub community type occurs on floodplains and levees in the Mackenzie Delta that are frequently disturbed by floods and ice scour. It has a typically tall dense shrub layer and ground cover layer. Indicator species of this community type are tufted hair grass and meadow horsetail.

The coastline shrub community type is located on fluvial deltaic deposits associated with the lower Mackenzie Delta. Topography is typically level and soils are poorly to very poorly drained. Soils are usually Regosolic Static Cryosols. Parent material is silt to silt loam. Sties with coastline shrub have a poor nutrient regime with a moisture regime of subhydric to hydric. The active layer depth ranges from 22 to 110 cm (IOL et al. 2004).

Plant species found within this community type include:

Species	Scientific Name
Gray willow	*Salix glauca (S. cordiflora ssp callicarpea and glauca ssp stenolepsis)*
Richardson Willow	*Salix richardsonii (S. lanata ssp. richardsonii)*
Dwarf Scouring-rush	*Equisetum scirpoides*
Water Sedge	*Carex aquatilis*
Narrow-leaved Cotton-grass	*Eriophorum angustifolium (incl. E. triste)*
Tufted Hair Grass	*Deschampsia cespitosa (D. caespitosa, D. glauca)*
Meadow Horsetail	*Equisetum pratense*
Ruap Indian Paintbrush	*Castilleja raupii*
Slim-stem Reed Grass	*Calamagrostis stricta (C. inexpansa, C. neglecta and C. chordorrhiza)*

Source: GNWT ENR 2009a

9.3.2.9 Coastline Sedge – Cotton-Grass

The [coastline] sedge – cotton-grass community type is widespread on wet floodplains of the Mackenzie Delta. The dominant species in the ground cover layer are water sedge (*Carex aquatilis*) and narrow-leaved cotton-grass (*Eriophorum angustifolium* (including *Eriophorum triste*)).

Topography is typically level, and soils are poorly to very poorly drained. Several soil subgroups can occur depending on the type of drainage channel and proximity to the channel. Mineral soils above the level of annual inundation are typically Orthic Regosols when permafrost is deeper than 1 m. Soils are Regosolic or Gleysolic Static Cryosols if permafrost is encountered within 1 m of the surface. Parent materials are typically fluvial with silt to loamy sand textures. Sites with coastline sedge – cotton-grass are poor in nutrients, and their moisture regime is subhydric. The active layer depth occurs at 60 cm (IOL et al. 2004).

Plant species found within this community type include:

Species	Scientific Name
Water Sedge	*Carex aquatilis*
Narrow-leaved Cotton-grass	*Eriophorum angustifolium (incl. Eriophorum triste)*

Source: GNWT ENR 2009a

9.3.2.10 Coastline Low-centered Polygons

[Coastline] low-centered polygons are abundant on the delta and coastline of the Peninsula, resembling tundra low-centered polygons. The centre of each polygon is depressed and covered with lowland vegetation such as water sedge, variegated horsetail, and narrow-leaved cotton-grass. The polygons outer ridges are dominated by upland vegetation such as Richardson's willow and [entire-leaved] mountain avens.

The nearly flat, low-lying, broad areas are composed of recent fluvial sediments. Soils are classified most commonly as Regosolic Static Cryosols, and occasionally as Gleysolic Static Cryosols. The centres of these polygons are wet, with standing shallow water during most of the thawed season. Subtle ridges that are pushed up by ice wedges formed under the through surround the middle of the low-center polygons. Flooding, either by salt water during storm surges, or by fresh water as the level of the Mackenzie River fluctuates, is common. Parent material texture is silt to loamy sand. Sites with coastline low-centred polygons have a poor to very poor nutrient regime and their moisture regime ranges from subhydric to hydric. The active layer depth ranges from 22 to 43 cm (IOL et al. 2004).

Plant species found within this community type include:

Species	Scientific Name
Richardson Willow	*Salix richardsonii (Salix lanata ssp. richardsonii)*
Water Sedge	*Carex aquatilis*
Variegated Horsetail	*Equisetum variegatum*
Narrow-leaved Cotton-grass	*Eriophorum angustifolium (incl. Eriophorum triste)*
Entire-leaved Mountain Avens	*Dryas integrifolia (incl. Dryas chamissonis, Dryas sylvatica, Dryas crenulata)*

Source: GNWT ENR 2009a

9.3.2.11 Transition Forest

Inuvik is situated at the northern edge of the *Taiga Plains Ecozone*. The surrounding forest represents the transition zone between the forests found in the *Taiga Plains Ecozone* and the tundra habitat of the *Southern Arctic Ecozone*. In the northern part of this transition zone is a mixture of stunted spruce forest spruce forest and tundra vegetation, being highly variably depending upon elevation, micro-site topography and aspect.

The forest surrounding Inuvik is predominantly spruce, but changes to mixed forest to deciduous forest and shrub along the proposed Highway alignment to the northeast as the elevation increases (Photos 9.3-12 and 9.3-13). Closer to Inuvik, along the lower slopes, shrub communities, shrub fens, bogs and riparian white spruce or willow communities can be found. In the uplands white and black spruce, tamarack, dwarf birch are more common.

Photo 9.3-12
The forest surrounding Inuvik is predominantly spruce; however, it quickly changes to deciduous forest and shrub closer to the treeline

Photo 9.3-13
At the treeline, the deciduous forest becomes dominated by shrubs

This community type is associated with moderate to steeply sloping colluvial deposits. These deposits occur as a thin veneer over morainal material. Texture of the parent material is variable because of the colluvial origin. Drainage is moderately well to imperfect with a subhygric moisture regime and a poor nutrient regime. Soils are poorly developed and are commonly Regosolic Static Cryosols (IOL et al. 2004).

Plant species commonly found in the forested areas around Inuvik include:

Species	Scientific Name
White Spruce	*Picea glauca*
Dwarf Birch	*Betula glandulosa*
Prickly Rose	*Rosa acicularis*
Mountain Cranberry	*Vaccinium vitis-idaea*
Bog Bilberry	*Vaccinium uliginosum*
Black Crowberry	*Empetrum nigrum*
Narrow-leaved Labrador Tea	*Ledum decumbens*

Source: GNWT ENR 2009a

9.4 WILDLIFE

The Tuktoyaktuk Peninsula supports a wide variety of wildlife. As defined under the *Western Arctic Claim Inuvialuit Final Agreement As Amended* (1987), "wildlife" means all fauna in a wild state other than reindeer. While this distinction is recognized, the reader is advised that the Project Description Report contains information about wildlife and reindeer in the Tuktoyaktuk Peninsula and Delta area.

Approximately 23 species of terrestrial mammals potentially occur along the proposed Highway alignment (Table 9.4-1). The local and regional abundance and distribution of these species varies considerably depending on habitat availability and access to terrain suitable for various life history phases, such as calving and denning.

TABLE 9.4-1: TERRESTRIAL MAMMALS OCCURRING ALONG THE PROPOSED HIGHWAY ALIGNMENT

Common Name	Scientific Name
Masked shrew	*Sorex cinereus*
Snowshoe hare	*Lepus americanus*
Arctic hare	*Lepus sp. articus*
Arctic ground squirrel	*Spermophilus parryii*
American red squirrel	*Tamiasciurus hudsonicus*
American beaver	*Castor canadensis*
Northern red-backed vole	*Clethrionomys rutilus*
Brown lemming	*Lemmus sibiricus*

TABLE 9.4-1: TERRESTRIAL MAMMALS OCCURRING ALONG THE PROPOSED HIGHWAY ALIGNMENT

Common Name	Scientific Name
Collared lemming	*Dicrostonyx torquatus*
Muskrat	*Ondatra zibethicus*
Meadow vole	*Microtus pennsylvanicus*
Tundra vole	*Microtus oeconomus*
Wolf	*Canis lupus*
Arctic fox	*Alopex lagopus*
Red fox	*Vulpes vulpes*
Grizzly bear	*Ursus arctos*
Ermine	*Mustela erminea*
Least weasel	*Mustela nivalis*
American mink	*Mustela vison*
Wolverine	*Gulo gulo*
River otter	*Lutra canadensis*
Moose	*Alces alces*
Caribou	*Rangifer tarandus*

Approximately 137 bird species have been recorded in the region of the Mackenzie Delta and Tuktoyaktuk Peninsula. Most of these bird species are migratory; however, 17 are year round residents, 101 nest and/or moult and remain during the summer and 19 are rare transients or visitors. In addition, a further 39 species have been reported but their occurrence has not been confirmed (Martell, 1984).

9.4.1 Barren-ground Caribou / Cape Bathurst and Bluenose-West Herds

There are eight major barren-ground caribou herds within the Northwest Territories (Working Group on General Status of NWT Species 2006), each of which are identified by the location of their calving grounds (Thomas 1969; Gunn and Miller 1986). Two caribou herds occur on the Tuktoyaktuk Peninsula: the Cape Bathurst and Bluenose-West herds. The Cape Bathurst and Bluenose-West caribou herds' annual range overlaps that of the proposed Highway alignment. Caribou are highly migratory and occupy different habitats during different seasons (IOL et al. 2004).

The Cape Bathurst caribou (Photo 9.4-1) herd was identified as a distinct herd from the Bluenose-West herd using genetic and radio-telemetry studies (Nagy et al. 1999). This is the primary caribou herd that utilizes the Tuktoyaktuk Peninsula. The herd calves and summers in the Brock, Hornaday and Horton River area (Community of Tuktoyaktuk et al. 2000), while rutting occurs east of Husky Lakes (IOL et al. 2004). The herd's winter range stretches from the Tuktoyaktuk Peninsula to the Mackenzie River in the west and the Husky Lakes in the south (IOL et al. 2004; GNWT ENR 2006a).

The GNWT Department of Environment and Natural Resources reports that the caribou migration from the Parsons Lake area to Cape Bathurst typically occurs in April. Caribou have been active in the Parsons Lake area, but a notable decline has been detected in the past three to four years (GNWT ENR, pers. comm. November 20, 2008).

The Bluenose-West caribou herd marginally overlaps with the proposed Highway alignment along the northwest corner of their annual range and a few individuals can be expected to be present from October to May. The Bluenose-West herd calving grounds are located east of Tuktoyaktuk Peninsula in the western Melville Hills in Tuktut Nogait National Park, with high calving densities in the area west of the Hornaday River south to the Little Hornaday River.

The post calving range of Bluenose-West herd includes the Melville Hills from the coastal areas near Paulatuk, east to Bluenose Lake, south to the Little Hornaday River, and in the areas east of the Hornaday River. Rutting occurs in this area and as far west as the Kugaluk River and south to the Simpson and Horton lakes areas. The winter range of this herd includes the area from Eskimo Lakes and the Anderson River to the north and Colville and Great Bear lakes and Fort Good Hope to the south (Nagy and Johnson 2006).

Photo 9.4-1
Caribou were periodically seen during the aerial reconnaissance survey along the proposed road alignment. Here three bull caribou were seen grazing on sedges

The proposed road alignment is located south of the summer and fall caribou harvesting areas, sites 306C and 309C respectively (Community of Tuktoyaktuk et al. 2000). However, the proposed road corridor is located within the spring and winter caribou harvesting areas, sites 302C and 315C respectively (Figure 7.8-1; Community of Tuktoyaktuk et al. 2000). As well, the proposed road alignment occurs within the Bluenose-West Winter Range management area, site 701B (Figure 7.4-2; Community of Tuktoyaktuk et al. 2000; Community of Inuvik et al. 2000). This area provides important winter habitat for the Bluenose-West caribou herd, which are valued for subsistence harvesting year-round by Inuvialuit communities and other aboriginal communities outside the ISR (Community of Tuktoyaktuk et al. 2000; Community of Inuvik et al. 2000).

In 2005, Cape Bathurst and Bluenose-West caribou herds population estimates indicated that both herds were declining. In 2006, standard methods were used to conduct photo-census surveys on both herds to confirm population estimates obtained in 2005 and determine if herds had continued to decline. Surveys were also undertaken to estimate the number of caribou on the upper Tuktoyaktuk Peninsula. Analysis of the results provided a population estimate of approximately 18,050 for non-calf caribou for the Bluenose-West herd (Table 9.4-2; GNWT ENR 2006a). This population estimate was significantly lower than the 2005 estimate, indicating that the population of the herd had continued to decline.

The population estimate for the non-calf caribou for the Cape Bathurst herd was approximately 1,800 in 2006 (Table 9.4-2; GNWT ENR 2006b). This population estimate is significantly lower than that for 2005, indicating that this herd has also continued to decline. Researchers believe that the Cape Bathurst and Bluenose-West caribou herds continued to decline between 2005 and 2006 (Nagy and Johnson 2006).

The Cape Bathurst and Bluenose-West herds were surveyed in July 2009. In his October 2009 report to the GNWT Legislative Assembly of the NWT (Minister's Statement 9-16(4), October 21, 2009), Environment and Natural Resources Minister, Hon. Michael Miltenberger reported that the Cape Bathurst herd has remained stable at 1,800 animals and the Bluenose-West herd has remained stable at just under 18,000 animals. In light of populations decreasing elsewhere in the world, Miltenberger attributes the stability of these populations to the caribou harvesting restrictions implemented by the co-management boards in the Inuvialuit Settlement Region and the Gwich'in and Sahtu regions.

TABLE 9.4-2: CAPE BATHURST AND BLUENOSE-WEST CARIBOU HERD POPULATION ESTIMATES

Herd	Year	Population Estimate (non-calf)
Cape Bathurst Caribou	1987	14,529
	1992	17,521
	2000	10,013
	2005	2,400
	2006	1,821
Bluenose-West Caribou	1987	98,874
	1992	64,705
	2000	74,273
	2005	20,800
	2006	18,050
	2009[1]	approximately 18,000

Source: GNWT ENR 2006a, 2006b

The barren-ground caribou is ranked by GNWT Department of Environment and Natural Resources as Sensitive under the general status program (GNWT ENR 2009a), i.e. a species not at risk of extinction or extirpation, but which might require special attention or protection to prevent them from becoming at risk (Working Group on General Status of NWT Species 2006). This species is not considered to be at risk under the *Species at Risk Act* (Working Group on General Status of NWT Species 2006) or the Committee on the Status of endangered Wildlife in Canada (COSEWIC 2009).

In addition to the two herds of barren-ground caribou, a privately owned reindeer herd has historically used portions of the upper Tuktoyaktuk Peninsula and Richards Island. More recently, the herd typically summers in the Richards Island area from about April to late November and the herd is moved south to an area of Crown Land extending from north of Parsons Lake to the Jimmie and Noell lakes area for the overwintering period. The location of the reindeer grazing allotment is illustrated in Figures 7.6-1 and 12.1-1 of this Project Description Report. According to Lloyd Binder, the custodian of the herd, the current population of the herd is around 3,000 animals.

9.4.2 Woodland Caribou

Woodland caribou in the Northwest Territories are divided into two ecotypes, the boreal population and the northern mountain population. These caribou have different habitat requirements, but are otherwise the same species. The woodland caribou, boreal population, is listed by SARA as Threatened (Government of Canada 2009), and is ranked by GNWT Department of Environment and Natural Resources as Sensitive under the general status program (GNWT ENR 2009a).

Mountain caribou are found primarily in the mountainous region of the Northwest Territories from Nahanni National Park Reserve in the South to the Richardson Mountains in the north. Boreal caribou are dispersed over a large area throughout the boreal forest, occurring along the Mackenzie Valley from the Northwest Territories/Alberta border north to the Mackenzie Delta (Olsen et al. 2001), and from the eastern edge of the Mackenzie Mountains to the Canadian Shield and Great Slave Lake (Government of Canada 2009). The town of Inuvik is located on the northern edge of their distribution.

Boreal caribou are not expected to be affected by the development of the proposed Highway since Inuvik is located on the edge of their range and the highway heads away to the northeast. Furthermore, that section of proposed Highway leading into Inuvik will be constructed along an already established road, and further out, through mixed forest. Boreal caribou typically prefer mature or old growth coniferous forests associated with bogs, lakes and rivers.

9.4.3 Moose

Moose occur in the Mackenzie Delta, but their distribution is restricted to patches of suitable habitat, which occurs along the proposed Highway corridor. The proposed 2009 Route is located slightly within the spring moose harvesting area (site 303B), near Husky Lakes (Figure 7.8-4; Community of Tuktoyaktuk 1993). In September 2009, during an aerial reconnaissance along the proposed Highway alignment a total of 16 observations of moose were recorded consisting of seven bulls, five cows, three yearlings and one calf. In addition, two observations of moose tracks were documented. Moose or moose sign was present throughout the length of the proposed Highway alignment; however, 55% of the observations below the tree-line, near Inuvik, while 36% were near the southwest end of Husky Lakes, and finally, 9% were closer to Tuktoyaktuk, near granular source 177. Above the tree-line, moose observations were associated with tall shrubs that typically occur along rivers or creeks.

Moose distribution near the tree-line and on the tundra is scattered, with local concentrations associated with lush willow growth along rivers (Photo 9.4-2). South of the tree-line near Inuvik, moose are widely distributed, although typically occurring at low densities (5 to 15 moose per 100 km^2), compared to other northern jurisdictions in the boreal forest. The best areas for moose are characterized by semi-open forest cover, an abundance of willow and aspen stands, and are located close to lakes, river valleys, and stream banks. They prefer deciduous shrubs for fall and winter food and thick conifers for winter cover. In the summer they can be found close to river valleys and lakes where they feed on aquatic vegetation. Moose tend to favour areas previously disturbed (15-30 years prior) by forest fires, as the natural regeneration meets their habitat requirements (GNWT ENR 2005a).

Photo 9.4-2
A number of moose were seen along the proposed road alignment, in association with lush willow growth along rivers

9.4.4 Grizzly Bear

In the Inuvialuit Settlement Region, grizzly bears are co-managed under the Inuvialuit Final Agreement by the GNWT, Yukon Territorial Government, Hunters and Trappers Committees, Inuvialuit Game Council, Wildlife Management Advisory Council (NWT) and the Wildlife Management Advisory Council (North Slope). For the Tuktoyaktuk Grizzly Bear Management Area, there is an estimated 214 bears over the age of two, occurring at a density of six bears per 1,000 km^2, compared to a density of seven to eight bears per 1,000 km^2 in the Inuvialuit Settlement Region (IOL et al. 2004). There is a total allowable harvest of six bears per year.

In the Northwest Territories, the grizzly bear is ranked by GNWT Department of Environment and Natural Resources as Sensitive under the general status program (Working Group on General Status of NWT Species 2006; (GNWT ENR 2009a). Nationally, they have been assessed by COSEWIC as Special Concern (as of 2002), indicating that they are a species that might become threatened or endangered because of a combination of biological characteristics and identified threats (COSEWIC 2009). Grizzly bears do not have a special status under the federal *Species at Risk Act* (Government of Canada 2009).

Grizzly bear are known to occur throughout Tuktoyaktuk Peninsula (GNWT 2004). In particular, the Husky Lakes are an important habitat area (Community of Tuktoyaktuk et al. 2000). The proposed Highway corridor is within occupied grizzly bear habitat (Pearson and Nagy 1976; Nagy et al. 1983; Community of Tuktoyaktuk 1993). In particular, the proposed road alignment occurs within the Grizzly Bear Denning Areas, site 322C, during the period of October to May each year (Figure 7.4-2; Community of Tuktoyaktuk et al. 2000). According to Nolan et al. (1973) the habitat has a quality rating of Class 2 (common use, but less than optimum habitat). Grizzly bears in this region undergo six to seven months of hibernation (Nagy et al. 1983). No dens were identified near the proposed route alignment by Rescan (1999).

However, during discussions with Marsha Branigan of GNWT Department of Environment and Natural Resources in Inuvik (pers. comm. November 20, 2008), several potential grizzly bear denning areas were identified in the vicinity of the access road from Tuktoyaktuk to Source 177, which is located along the northern portion of the Tuktoyaktuk to Inuvik Highway. The GNWT Department of Environment and Natural Resources subsequently conducted an aerial bear den survey of this area on May 17, 2009 on behalf of the GNWT Department of Transportation and reported that there was no evidence of current grizzly bear activity in the area. In addition, no dens were found within 500 m of either side of the access road, or within Source 177 (GNWT ENR 2009c).

In addition, EBA indentified three freshly dug grizzly bear dens (Photo 9.4-3) and a number of old dens during an aerial reconnaissance flight in mid-September 2009. During this fieldwork, a single observation of an adult female grizzly bear accompanied by a cub-of-the-year was recorded along the northern edge of a granular deposit identified as Area 13 or 14 in the EBA map book (Appendix B). All dens were within a two km radius of each other and approximately 3 km from the female and cub and, consequently, they were presumed to have been dug by that female bear. This information was conveyed to GNWT Department of Environment and Natural Resources.

Photo 9.4-3
A number of freshly dug grizzly bear dens were documented, such as this one found on a south facing slope hidden amongst shrubs

9.4.5 Black Bear

Black bears occupy much of the Northwest Territories, including the forested area around Inuvik. The size of the black bear population of the Northwest Territories is unknown, but is estimated conservatively to be 10,000 (GNWT ENR 2005b). Black Bear densities are unknown for the Northwest Territories but the estimated Canadian density is 10 to 40 bears per 100 km^2 (Barichello 1998). They can be expected to be found predominantly in forested habitats. Black bear distribution is generally linked to treed environments, which provide security from predators such as grizzly bears, wolves, and other black bears. During the active season trees provide security, as visual cover for hiding, and escape for climbing (Herrero 1978). Dense shrub communities are also important for security, and are also used for bedding (Jonkel 1978).

Black bear habitat quality is also primarily related to the abundance and availability of seasonally important food items. Their diet consists mainly of vegetation; however, meat, particularly winter-killed ungulates during spring, insects and possibly fish during the summer, may also be important.

After den emergence, bears favour areas with early-emerging vegetation such as wetlands dominated by sedges and cotton-grass. Grasses and horsetails are also important, and black bears may be found on sites such as meadows. Black bears typically dig dens in till material available on eskers, stream banks, or in natural cavities such as an upturned tree roots, crevices or caves. Black bear denning habitat is limited to the forested area that occurs along the southernmost portion of the proposed Highway near Inuvik.

9.4.6 Wolf

Wolves are found in the vicinity of the proposed Highway. They are ecologically important predators and economically important furbearers. Wolf habitat and density is closely related to that of their prey, such as caribou and reindeer. They are often observed in association with barren-ground caribou, especially in the winter (Carruthers et al. 1986; McLean 1992; McLean and Jackson 1992). The wolf population appeared to decline in the 1950s, but recovered in the mid 1970s (Community of Tuktoyaktuk et al. 2000).

Habitat requirements include den sites, typically on steep slopes with stable soils, and as such, are susceptible to habitat displacement. In contrast to grizzly bears, roads may not cause wolves to avoid the area.

9.4.7 Red Fox and Arctic Fox

Foxes are important furbearers in the region. In the Mackenzie Delta area, red foxes are considered widespread below the tree-line, whereas Arctic foxes are widespread above the tree-line, often near coastal areas (Community of Tuktoyaktuk et al. 2000). However, red foxes do occur above the tree-line and four red foxes and one old den site were observed during the aerial reconnaissance in mid-September 2009 (Photo 9.4-4).

Photo 9.4-4
Red foxes commonly occur along the proposed road alignment. Four individuals and one old den site were observed during the aerial reconnaissance in September

Jim Raddi of Tuktoyaktuk, in a November 17, 2008 News/North NWT article reported that "I've never seen so many foxes going back and forth on evenings." He added that family members were trapping one or two an evening by the ocean. Habitat requirements are linked to food sources, such as carrion, birds and small mammals. Denning habitat consist of well-drained, stable soils (Martell et al. 1984), with Arctic fox dens occurring in open areas with little relief. The proposed Highway corridor is located in good Arctic fox habitat.

9.4.8 Wolverine

Wolverines range throughout most of northern and western Canada, including the proposed Highway alignment. Wolverines are difficult to locate during snow-free periods, lead a largely solitary lifestyle, and have a lower population density than wolves or foxes. They have large home ranges and live at low densities even under optimal conditions (Banci 1994). Reproductive rates are low and sexual maturity is delayed, in comparison with some (or most) other carnivores. The population estimate for wolverines in the Northwest Territories is unknown; however, GNWT Department of Environment and Natural Resources estimates that there are 1.6 to 3.7 per 1,000 km^2 for males and lower for females (GNWT ENR 2005c).

Wolverines are scavengers and predators of birds and small mammals, relying on a diversity of foods to offset the uncertainty of availability in the harsh northern environment. There appears to be a correlation between wolverine numbers, ungulate populations, and the presence of more (successful) efficient predators such as wolves (Van Zyll de Jong 1975).

The wolverine (Western population) was assessed by COSEWIC as a species of Special Concern (as of May 2003) (COSEWIC 2009). The wolverine is ranked by GNWT Department of Environment and Natural Resources (2009) as Sensitive under the general status program.

No wolverines were observed during the aerial reconnaissance work in mid-September 2009. However, the proposed road is located within the winter wolverine harvesting area, site 314C (Figure 7.8-9; Community of Tuktoyaktuk et al. 2000).

9.4.9 Marten

The occurrence of martens in the Northwest Territories is linked to the northern boreal forest. The marten populations in the Northwest Territories is estimated to be between 40,000 and 400,000 based on densities ranging from 0.05 to 0.5 per km^2 (GNWT ENR 2009a). They occur throughout the forested portions of the Mackenzie Delta.

Martens are closely associated with late-successional stands of mesic (moist) coniferous forests, particularly those with complex arrangements of light gaps, dead and downed wood, varied shrub understory, and layers of overhead cover (Allen 1984; Buskirk and Powell 1994; Clark *et al.* 1987; Thompson 1994).

Threats to martens within the study area include potential localized over-trapping, particularly during cyclical lows (ENR 2005d). Weaver (2001) indicated martens are moderately resilient to human impacts. Although they require mature coniferous forest stands with complex downed and overhead structures, they are particularly vulnerable to logging. Weaver (2001) indicated martens have a moderate reproductive potential in appropriate habitat.

9.5 BIRDS

9.5.1 Waterfowl (Swans, Geese, Loons and Ducks)

The proposed Highway corridor is located in the vicinity of abundant waterfowl habitat, which is an important area for nesting and staging of geese and swans. Geese are an important source of food for the Inuvialuit while the down is also used for pillows and blankets (Community of Tuktoyaktuk et al. 2000).

Nesting habitat for Tundra Swans (*Cygnus columbianus*) can include wet sedge meadows and ponds, lakes and slow flowing rivers, with brood rearing occurring in deeper water (Palmer 1976).

Canada Geese (*Branta canadensis*) and Brant (*Branta bernicla*) prefer to nest on small islands in ponds, lakes and rivers; Brant also nest on the edge of freshwater or tidal pools (Bellrose 1976). White-fronted Geese (*Anser albifrons frontalis*) are secretive nesters, preferring dispersed, higher and drier nesting sites. Snow Geese (*Chen caerulescens)* are primarily colonial nesters, preferring low grassy tundra and islands in shallow lakes (Bellrose, 1976). Geese and swan populations are stable or increasing (Community of Tuktoyaktuk et al. 2000). The proposed Highway occurs within the spring goose harvesting area, site 304C, but not the summer or fall goose harvesting areas (sites 308C and 312C, respectively) (Figure 7.8-12; Community of Tuktoyaktuk et al. 2000).

Common Loon (*Gavia immer*), Yellow-Billed or King Loon (*Gavia adamsii*), Pacific Loon *Gavia pacifica*) and Red-throated Loon (*Gavia stellata*) occur in the Mackenzie Delta area. All probably nest in the area, but the Pacific and red-throated loons also breed near the proposed Highway route. Nesting habitat consists primarily of shorelines of lakes and ponds.

Ducks are important to the Inuvialuit as a spring and fall food source. Several species occur and nest in the area of the proposed Highway, including King Eider (*Somateria spectabilis*), Common Eider (*Somateria mollissima)*, Scaup, Mallard (*Anas platyrhynchos*), Scoters (Black duck; *Melanitta spp.*), Wigeon (Baldpate duck; *Anas americana)*, Old Squaw (Long-tailed duck; *Clangula hyemalis*), and Pintail (*Anas acuta*) (Community of Tuktoyaktuk et al. 2000). Nests are dispersed and occur in low-lying to upland habitat and may be hundreds of metres from water. Diving ducks, such as Scaup, may nest on shorelines or in emergent vegetation. Eider nests are often found on small islands close to the coast or on inland tundra ponds (Bellrose 1976).

The Horned Grebe occurs in the area, specifically nesting on small ponds within the boreal forest portion of the Delta. The Horned Grebe (western population) has been assessed by COSEWIC as Special Concern (as of April 2009) (COSEWIC 2009). The range includes Yukon, the Mackenzie River Valley in the Northwest Territories, extreme southern Nunavut, and all of the Prairies, where it is most abundant (Sugden 1977; Godfrey 1986; Stedman 2000). In the Northwest Territories, the Horned Grebe nests in low densities throughout much of the boreal and subarctic regions. The highest documented densities (>4 birds/km^2) have been observed in the southern Northwest Territories. Average grebe population densities throughout the rest of the boreal and subarctic Northwest Territories are apparently much lower (probably less than 0.1 bird/km^2 overall) (Stotts 1988; Fournier and Hines 1999; Canadian Wildlife Service 2007). No Horned Grebes were documented during the aerial reconnaissance work in mid-September 2009.

9.5.2 Raptors

The region of the proposed Highway corridor supports several species of raptors including Golden Eagle (*Aquila chrysaetos*), Rough-legged Hawk (*Buteo lagopus*), Northern Harrier (*Circus cyaneus*), Bald Eagle (*Haliaeetus leucocephalus*), Peregrine Falcon anatum/tundrius (*Falco peregrinus anatum/tundrius*), Gyrfalcon (*Falco rusticolus*), Short-eared Owl (*Asio flammeus*), and Snowy Owl (*Bubo scandiacus*). Within the boreal forest portion, the Northern Goshawk (*Accipiter gentilis*), Merlin (*Falco columbarius*), Great Horned Owl (*Bubo virginianus*), and Northern Hawk Owl (*Surnia ulula*) can occur. All these species potentially nest in the region wherever suitable habitat is available. Suitable habitats would typically include large trees and steep terrain such as cliffs, both of which do not exist in the vicinity of the Highway alignment.

Two raptors have been ascribed special conservation status: Peregrine Falcon (*anatum/tundrius*) and the Short-eared Owl. The Peregrine Falcon (*anatum/tundrius*) has been assessed by COSEWIC as Special Concern (as of April 2007) (COSEWIC 2009). The Peregrine Falcon (*anatum/tundrius*) is distributed generally throughout portions of the Northwest Territories below and above the tree-line, with a large population located along the Mackenzie River Valley. There are estimated to be more than 219 breeding pairs Peregrine Falcon (*anatum)* in northern Canada (Northwest Territories, Yukon, Nunavut, northern Quebec) (Johnstone 1997), which includes more than 80 pairs of known breeders in Northwest Territories (mainly along the Mackenzie Valley). Mackenzie River densities have been determined to be 0.7 nests per 100 km^2 (83 nests on a linear 600 km transects along the Mackenzie River) (Shank 1996). Peregrine Falcons have two main habitat requirements; access to optimal nesting habitat, which typically include cliffs adjacent to water, and an adequate supply of prey. Since no cliff areas are present in the vicinity of the proposed Highway alignment, all habitat surveyed along the proposed Highway alignment is considered to be suboptimal nesting habitat for Peregrine Falcons.

The Short-eared Owl is listed by SARA as Special Concern (Schedule III) (Government of Canada 2009), and is ranked by GNWT Department of Environment and Natural Resources as Sensitive under the general status program (Working Group on General Status of NWT Species 2006; GNWT ENR 2009a). In the Northwest Territories, Short-eared Owls are found in low-arctic tundra, open areas, marshes, and prairie (Cadman and Page 1994; Godfrey 1986). The Northwest Territories Short-eared Owl population is unknown but estimated to be between 1,000 and 10,000 individuals (Carrière 2000). Short-eared Owls are found primarily in the Taiga Cordillera and Taiga Plains ecoregions and may occur across the Tuktoyaktuk Peninsula.

During the September aerial reconnaissance survey, two Golden Eagles, three Bald Eagles and one Short-eared Owl were observed.

9.5.3 Upland Birds

Upland birds make up the largest and most diverse group of birds occurring along the proposed Highway route. In particular, the passerines, also known as "perching" birds, include approximately three-fifths of all living birds (Terres 1982) ranging in size from the largest, the raven, to the smallest, the kinglets, warblers and sparrows. Passerines are widely distributed throughout the boreal forest and tundra, and occupy all terrestrial habitat types and, consequently, the represent a large and diverse group of birds, and each species has different food and cover requirements.

One species of passerine, the Rusty Blackbird (*Euphagus carolinus*), is listed by SARA as Special Concern (Government of Canada 2009), and is ranked by GNWT Department of Environment and Natural Resources as May Be At Risk under the general status program (GNWT ENR 2009a). Rusty Blackbirds nest in the boreal forest and favour the shores of wetlands such as slow-moving streams, peat bogs, swamps, and beaver ponds.

No Rusty Blackbirds were observed during the aerial reconnaissance work in mid-September 2009 and are unlikely to be associated with the area of the Highway corridor.

Ptarmigan are another upland bird species occurring along the proposed Highway route. Willow ptarmigan occur year-round within the area of the proposed Highway, particularly within the upland tundra (Photo 9.5-1). Nest sites are commonly located in shrub habitats, including dwarf shrub-heath and alder. Shrub communities are also important for winter habitat (Platt 1976). Ptarmigan are a food source for the Inuvialuit and other area residents (Community of Tuktoyaktuk et al. 2000). Their population varies from year to year.

Photo 9.5-1
Willow ptarmigan commonly occur along the proposed road alignment

9.6 HYDROLOGY

The proposed Highway will cross numerous ephemeral and permanent stream channels and wetland areas, and as such, will be affected by hydrological characteristics of the region. The alignment crosses through the Delta Hydrologic Region (IOL et al. 2004), which is characterized by very large numbers of shallow lakes and ponds that generally drain through small streams into either the Mackenzie River or the Husky Lakes. The hydrology of the northern portion of the route, which is now under construction, is described in Rescan (1999) and EBA (2008).

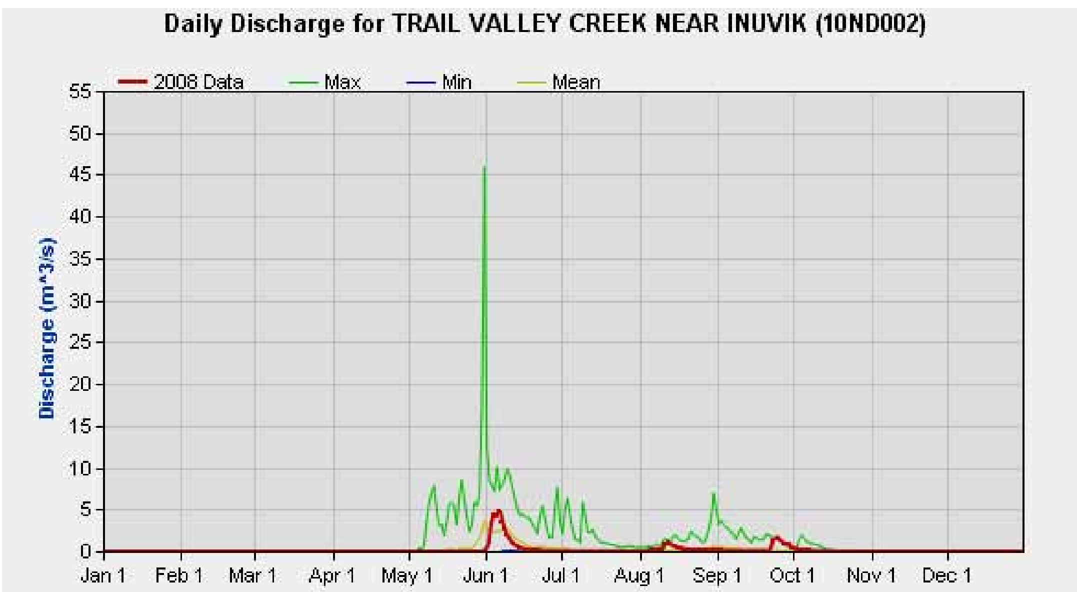
Hydrological characteristics of the area result primarily from climatic factors including long, cold winters, short cool summers, and relatively low precipitation, of which 45-70% falls as snow (IOL et al. 2004). In this area, not more than four months of the year have a mean temperature above 10° C. Based on Environment Canada meteorological data, the mean annual temperatures and precipitation values for Tuktoyaktuk and Inuvik are -10.5° C/142 mm and -9.5° C/257 mm, respectively. The wettest months normally occur in July and August, while the driest months are in March and April. Permafrost underlies the entire area, above which is an active layer that varies in depth.

These climatic factors result in surface runoff patterns that are based on the annual freeze-thaw cycle, although summer rainstorms can cause rapid rises in water levels. Ice formation and deterioration follows an annual pattern, which is identified in Table 9.6-1 for the Inuvik and Tuktoyaktuk areas.

TABLE 9.6-1: APPROXIMATE FREEZE THAW DATES IN SUBARCTIC REGIONS		
	Tuktoyaktuk[2]	Inuvik[3]
First ice	Sep 27	Oct 1
Freeze over	Oct 1	Oct 19
First ice deterioration	May 28	May 13
Clearing of rivers	June 19	June 5
River ice thickness	1.55 m	1.32 m
Lake ice thickness	1.75 m	1.73 m

Source: Allen (1977)

The time of ice melt in May and June results in sudden peaks in the hydrograph that follow a typical pattern, as described in Woo (1993). Meltwater fills the many depressions on the land surface and then flows over frozen ground in sheets or rills. Because the shallow, seasonally thawed suprapermafrost layer cannot retain much meltwater or rainwater, the water table rises rapidly so that water is delivered quickly to lower slopes and stream channels. Fairly rapidly, the active layer increases in depth due to increased solar radiation, causing the water table to drop below the surface and a corresponding decline in surface flows. The hydrograph for Trail Valley Creek near Inuvik (Figure 9.6.1; stream location shown at crossing 23 in the Inuvik to Tuktoyaktuk Highway Map Book, Appendix B) exemplifies this seasonal runoff pattern.



Source: Environment Canada (2006)

Figure 9.6-1
Hydrograph for Trail Valley Creek

[2] Unnamed small lake near Tuktoyaktuk
[3] East Channel Mackenzie River

Ice decay in lakes begins once snow is melted from their surfaces. Increases in lake storage lag behind snowmelt due to melt-water retention within the snow cover and in small depressions which dot the land surface (Woo 1993). Generally, water levels in lakes during spring runoff initially rise beyond their outlet elevations due to snow dams. The breaching of these dams results in rapid increases in downstream discharges. Peak annual outflows occur at this time. The numerous tundra ponds in the Arctic are recharged during spring freshet that results from snowmelt. These freshets create surface flow connections between ponds, but such flow connectivity usually only lasts about 2 weeks. After that, the ponds become separated from lateral drainage (Woo and Guan 2006). The nival regime in the Arctic shows one major flood period in spring followed by a rapid recession to base flow interrupted by rainstorm generated peaks.

During the September, 2009, preliminary reconnaissance field survey, significant water flow was observed only in relatively few stream channels, in particular Zed Creek, Hans Creek, and Trail Valley Creek. These streams have relatively large catchments[4], which results in active flows throughout the ice-free season. Most other streams within the proposed alignment footprint that were viewed during the preliminary reconnaissance survey appeared to be either ephemeral or contained slowly flowing or standing water in discrete pockets. It was further observed that the landform was etched with rills, signifying the myriad of runoff channels that carry meltwater in spring. Observations of flow characteristics at each stream crossing are provided in Section 10.6, Table 10.6-3. These observations were made during aerial reconnaissance, with the intent to confirm flow and channel characteristics during future field investigations.

The highway design will be influenced by the hydrologic patterns and characteristics of the project area. Stream crossing structures and cross drainage culverts will have to be appropriately sized to accommodate flash freshet flows, which can be sudden and intense, as shown in the Trail Valley Creek hydrograph (Figure 9.6-1). Hydrological conditions also govern fish presence, abundance, and behaviour in streams. The flow extremes that are characteristic of the project area diminish the availability and quality of stream habitats in most channels, since these generally carry significant volumes of water for only short periods of time. Such conditions also denote small drainage systems with shallow headwater lakes that generally do not provide suitable spawning, rearing, or overwintering habitat due to a variety of reasons, including extreme flow fluctuations, vegetation encroachment in streams, lack of winter flow, and oxygen deprivation during winter. In contrast, channels draining medium to large catchments, such as Zed Creek, Hans Creek, and Trail Valley Creek, retain flow throughout the ice-free months, and provide suitable habitat conditions to support spawning and rearing during late spring and summer.

[4] Hans Creek watershed: 329 km^2, mean annual flow (MAF) 1.09 m^3/s; Trail Valley Creek watershed: 68.3 km^2, MAF 0.2 m^3/s

9.7 FISH AND FISH HABITAT

The proposed Inuvik to Tuktoyaktuk Highway will cross numerous ephemeral and permanent streams, and come near many lakes along its route. It is therefore important to identify the fish and fish habitat resources that these waterbodies sustain to develop suitable avoidance and mitigation strategies designed to protect fish populations that are ecologically important, and socially and economically valuable to northern residents. This section of the report identifies the species that may be encountered or affected by highway construction and operation, based on previous studies and preliminary reconnaissance observations of existing habitat characteristics. Future field work is required to document species presence and relative abundance. Section 10.6 provides discussion on the potential effects of the highway development and a description of protection measures.

The proposed Highway occurs slightly within and adjacent to the spring, summer, fall, and winter fish harvesting area near Husky Lakes, sites 305C, 307C, 310C, and 316C respectively (Figure 7.8-17; Community of Tuktoyaktuk et al. 2000). As well, the road occurs within the Fish Lakes and Rivers management area, site 704C (Figure 7.4-2; Community of Tuktoyaktuk et al. 2000; Community of Inuvik et al. 2000). This area provides important fish habitat and historic and current subsistence harvest areas for people of Inuvik and Tuktoyaktuk (Community of Tuktoyaktuk et al. 2000; Community of Inuvik et al. 2000).

Limited fish surveys have been conducted previously in streams along the proposed Highway. Results of these surveys were summarized in Rescan (1999) and the Environmental Impact Statement (EIS) for the Mackenzie Gas Project (IOL et al. 2004). Generally, these surveys identified the following fish species as having the potential to utilize habitats in some streams along the proposed route: lake whitefish, round whitefish, inconnu, northern pike, Arctic grayling, lake trout, burbot, least cisco, ninespine stickleback, and sculpin. Actual species presence is dependent on several habitat and watershed characteristics, often including the availability and accessibility of upstream lakes that provide feeding, rearing, and/or overwintering habitats. It is unlikely that any of the streams along the Highway route would provide overwintering habitat due to complete freezing.

Table 9.7-1 provides a generalized summary of habitat preferences and life cycle information for each of the major fish species likely utilizing stream habitats in the vicinity of the proposed Highway. Arctic grayling is the valued species most likely to be affected by Highway construction activities and stream crossing structures. This is because grayling utilize and are dependent upon stream habitats for spawning, juvenile rearing, and adult life stages, and require clean, well oxygenated gravel-cobble substrates to complete their life cycle (Table 9.7-1). As such, their productivity within a system is highly sensitive to perturbations that degrade or alter migration access or habitat quality.

The following sections provide brief life history and habitat preference information for each of the valued fish species that will possibly be encountered along the proposed Highway alignment.

9.7.1 Lake Whitefish

Lake whitefish (*Coregonus clupeaformis*; "Humpback"; "Crooked Backs"; "Pikuktuq") are primarily a freshwater fish, inhabiting lakes and larger rivers. However, they will enter brackish water (Scott and Crossman 1973). Lake whitefish feed on aquatic insects, molluscs, amphipods and a variety of small fish and fish eggs. They are an important commercial and domestic fish in the north.

Lake whitefish are primarily a lake dwelling fish that prefer cool water. They generally move from shallow to deep water during the summer months, and then back into shallow water as the temperature cools. Spawning occurs in early fall, normally in shallow areas of lakes where the substrate is composed of cobble and gravel, and less frequently, sand. Whitefish may on occasion move into tributary streams to spawn. Eggs are broadcast over the substrate and hatch during the following spring. Larval fish tend to stay near steep shorelines, but as juveniles, move into deeper waters during summer.

9.7.2 Round Whitefish

Round whitefish (*Prosopium cylindraceum*) is primarily a freshwater species, although it is known to inhabit brackish estuarial waters, such as in the mouth of the Mackenzie River (Scott and Crossman 1973). Spawning normally occurs during October in northern latitudes, over the gravelly shallows of lakes or river mouths. Eggs hatch in spring. Round whitefish are predominantly found in moderate to deep lakes where they feed on benthic invertebrates. Given their habitat preferences, it is unlikely that these fish will be encountered in the small, shallow streams that make up most of the watercourses crossed by the proposed Highway.

9.7.3 Inconnu

Inconnu (*Stenodus leucichthys;* "Coney"; "Higaq") are the largest and fastest growing member of the whitefish family. They are primarily anadromous (fish are that migrate from the sea to spawn in fresh water), migrating long distances up the Mackenzie River and its major tributaries to spawn just prior to freeze up in October. After spawning, inconnu move back downstream to the lower reaches of the Mackenzie River, Tuktoyaktuk Harbour and west along the Beaufort Sea coast to feed and overwinter (DFO 1998). At maturity, these fish are greater than a half-metre in length (Scott and Crossman 1973). Their size and preference for large tributaries for spawning suggests that they are unlikely to spawn in the small streams that predominate along the proposed Highway corridor

TABLE 9.7-1: LIFE HISTORY INFORMATION FOR COMMON FISH SPECIES IN STREAMS ALONG THE PROPOSED HIGHWAY

Fish Species	Migratory Behaviour	Spawning Period	Spawning Habitat	Hatching Period	Juvenile Freshwater Habitat Preferences	Adult Freshwater Habitat Preferences	Risk of Potential Effects from Road Construction
Burbot *Lota lota* *"Tittaaliq"*	▪ Migrate to lake spawning areas in winter ▪ Migrate to tributaries in late winter/early spring ▪ Migrate to deep water in summer	▪January-March ▪Water temp. 0-4° C	▪Under ice in Lakes or river ▪Sand/gravel substrate ▪shallow (<3 m bays or on gravel shoals	At ice-out	▪Shallow waters ▪Debris cover ▪Rocky riffles ▪Pools or deeper water in lakes	▪Mouths of creeks in fall ▪May be found during winter/spring in coastal embayments (brackish or freshwater ▪Deep water in summer	Moderate
Lake whitefish *Coregonus clupeaformis*	Resident or anadromous	Late September-early October	▪Lakes and large rivers ▪Hard or stony substrate ▪Water <7.5m	Late spring	▪Larvae along steep shorelines ▪Juveniles move to deep water in summer	Deep water in lakes and large rivers.	Low
Round whitefish *Prosopium cylindraceum*	Limited migrations to lake shallows or upstream to rivers	Late September-October	Gravelly shallows of lakes or river mouths	Spring	Near or beneath rocks	Moderate to deep lakes	Low
Least cisco *Coregonus sardinella*	Migrate upstream to spawning grounds in fall	Early October	▪Clear streams ▪Gravel substrates		Lakes, rivers, lowest reaches of tributary streams	▪Lakes and streams ▪estuaries, plume of home river	Moderate
Inconnu (Coney) *Stenodus leucichthys* "Higaq"	▪Anadromous or lake dwelling. ▪Begin upstream migrations at spring break-up. ▪Return to coastal areas or lakes after spawning.	Late September to early October	▪1-3 m depth ▪Fast current ▪Gravel substrate	6 mos. after spawning	Fry washed downstream to coastal areas or lakes	Coastal areas or lakes	Low
Northern pike *Esox lucius* *"Siulik"*	▪Limited range ▪Move from deep water winter habitat to spawning habitat in spring	Early spring, occasionally before ice melt	▪Grassy margins of lake shores ▪slow moving streams or sloughs	Spring, ~30 days after spawning	▪Stream or lake margins ▪Slow flowing waters	▪Lakes ▪Main river channels ▪Slack water areas in rivers	Moderate
Lake trout *Salvelinus namaycush* *"Iqaluakpak"*	▪Limited migrations, usually within resident lake or large, deep river ▪Migrate to nearshore areas for spawning ▪Move into surface waters in winter ▪Move into deeper waters in summer	Early September	▪Littoral areas of lakes ▪Cobble boulder substrates ▪5-40 m water depth	May-June, depending on water temperature	Shallow, inshore waters	▪Large deep lakes (common) ▪Large rivers (less common) ▪Little movement in summer	Low
Arctic grayling *Thymallus arcticus* "Hulukpaugaq"	▪Can be highly migratory at all life stages or non-migratory ▪Usually migrate to winter habitat in early fall	Spring, just as ice breaks up	▪Gravel substrate ▪<20-30% fines ▪Good flow (25-60 cm/s)	Hatch 3 weeks after spawning	Fry: quiet waters near site of hatching	▪Clear small, shallow streams or medium rivers ▪groundwater fed springs ▪overwinter in lakes or lower reaches of rivers ▪segregate in streams by age	High
Slimy sculpin *Cottus cognatus*	Very limited movements	Spring, after breakup	Cobble in shallow water	Hatch 30 days after spawning	Gravel/cobble substrates in streams	Rocky or gravel substrates	Low
Ninespine stickleback *Pungitius pungitius*	Very limited movements	Summer	Male builds nests of vegetation and debris		Quiet, shallow waters in vegetated areas of streams or brackish waters	▪Brackish or freshwater lakes and streams ▪Streams: vegetated areas in quiet waters	Low

9.7.4 Lake Trout

Lake trout (*Salvelinus namaycush*; "Iqaluakpak") are representatives of the char family that live exclusively in deep, cold lakes throughout their life cycle. They spawn during early fall over clean cobble substrates in water that is generally less than 16 m deep (Marsden and Chotkowski 2001). Lake trout occur in several large, deep lakes on the Tuktoyaktuk Peninsula and on the Mackenzie Delta (Rescan 1999), as well as in large rivers and brackish waters (Community of Tuktoyaktuk et al. 2000). The Husky Lakes are important habitat areas for this species. Due to the preference of this species for lake habitats during all life stages, it is unlikely that spawning or rearing would take place in the relatively shallow streams that would be crossed by the proposed Highway.

9.7.5 Northern Pike

Northern pike (*Esox lucius*; "Siulik") are highly carnivorous fish that prefer slow, meandering vegetated rivers or lakes. Spawning takes place in shallow, heavily vegetated areas (Scott and Crossman 1973) soon after ice-out. The eggs adhere to grass, rocks, or other debris. Incubation generally takes about 30 days in the north. Pike fry start life feeding on small crustaceans and insects, but begin eating smaller fish by the time they are only about 5 cm in length. As adults, these voracious feeders principally feed on fish but will also take shore birds, small ducks, muskrats, mice, shrews, and insects. In winter, pike will migrate to large rivers or lakes; smaller lakes are avoided due to the potential for oxygen depletion. Generally, pike migrations between summer and winter habitats are short. In summer, their movements from feeding habitat areas are minimal. Due to the habitats selected by pike, it is expected that the proposed Highway alignment will cross streams used by pike for spawning, rearing, and feeding.

9.7.6 Grayling

Arctic grayling (*Thymallus arcticus*; "Hulukpaugaq"), a cousin of the trout, are game fish of clear, cold streams known for their beautiful colours and flowing, sail-like dorsal fins. They can be highly migratory, or spend much of their lives within a fairly short distance of their preferred section of stream or lake. Generally, grayling spawn in clean, cool streams in spring at about the time of ice break-up, over silt free gravel substrates. They do not create nests (redds), which leaves the eggs vulnerable to high water velocities and streambed disturbances (Beauchamp 1990). During the fall, grayling will migrate to overwintering habitats in lakes or deep sections of slow flowing rivers. Due to their choice of stream habitats for spawning and rearing in summer, the proposed Highway route will inevitably cross streams that support these fish.

9.7.7 Burbot

Burbot (*Lota lota*; "Tittaaliq") are unique in that they spawn in rivers and lakes during the winter under ice. Spawners tend to select shallow waters over gravel substrates. Eggs filter down into interstitial spaces where they develop for the next 4-5 weeks. The newly hatched larvae are only about 3-3.5 mm and are transported downstream into quiet waters where they feed. In streams, young burbot seek out shallow waters that have vegetation and debris. As they grow they move to rocky riffles and then on to pools or beneath undercut banks. Adult burbot prey on smaller fish. The selection of stream habitats by some burbot for both spawning and rearing suggests that they may be encountered in streams crossed by the proposed Highway.

9.7.8 Least Cisco

Least cisco (*Coregonus sardinella;* "Big-Eye Herring") inhabit the fresh and brackish waters of the Mackenzie Delta and also occur as inland, landlocked populations (Rescan 1999). They are less migratory than the Arctic cisco and tend to be associated with the plume of their home river. In freshwater, spawning migrations take place in the fall (late September-early October). Clear streams or lake shores with sand or gravel bottoms are their preferred spawning habitats. They are eaten by predacious coney, pike, and burbot, as well as other mammals and birds (Community of Tuktoyaktuk et al. 2000). The Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2000) identifies the inland lakes of the Mackenzie Delta-Tuktoyaktuk region as important least cisco habitat. However, since this species predominantly prefers lake habitats, it would be uncommon in the small streams that comprise most of the watercourses along the proposed Highway route.

9.7.9 Stream Crossing Site Investigations

A preliminary fish habitat reconnaissance field study was carried out in 2009 over a three day period, from September 15-17. The survey initially involved low level helicopter flights over the proposed and alternate routes to permit visual inspection of streams at stream crossing locations. The overview flights also afforded an opportunity to observe watershed conditions upstream and downstream of the crossing sites as an indication of the potential of these systems to support valued fisheries resources. Stream channels potentially possessing suitable fish habitat were further evaluated on the ground. Because the scope of the preliminary reconnaissance field survey was limited to an overview of channel characteristics along the proposed Highway route, time (and weather) constraints limited ground investigations to the specific stream crossing sites within these selected locations. At these sites, the following basic parameters were identified:

- wetted width;
- total channel width, determined from abrupt changes in elevation and from vegetation changes;
- water depth;
- substrate;
- cover (type and percent);
- flow/habitat characteristic (e.g. riffle, run, pool);
- water temperature; and,
- water velocity (using the timed float method, where there was a sufficient length of unobstructed channel).

The number of sites surveyed on the ground was limited by time and weather constraints, and does not necessarily indicate that these are the only locations potentially supporting fish populations. Some sites (e.g. stream crossing nos. 3 and 21 (Appendix B)) appeared from the air to have only limited habitat potential, although on closer inspection displayed stream characteristics suitable for fish passage, spawning, or rearing, which were obscured by heavy riparian overgrowths of willow (Photos 9.7.1-9.7.4). Further site investigations will be required to provide a more complete inventory of habitat conditions, as well as fish presence and relative abundance in streams that will be crossed along the proposed alignment.

Table 9.7.2 summarizes the information collected at the ten stream crossing locations assessed on the ground. Sampling locations were selected as close as possible to the originally identified proposed stream crossing locations. Stream crossing numbers conform to those identified in the Kiggiak-EBA Inuvik to Tuktoyaktuk Highway Map Book (Appendix B).

Photo 9.7-1
Stream Crossing 03 aerial view

Photo 9.7-2
Stream Crossing 03 ground view, looking upstream

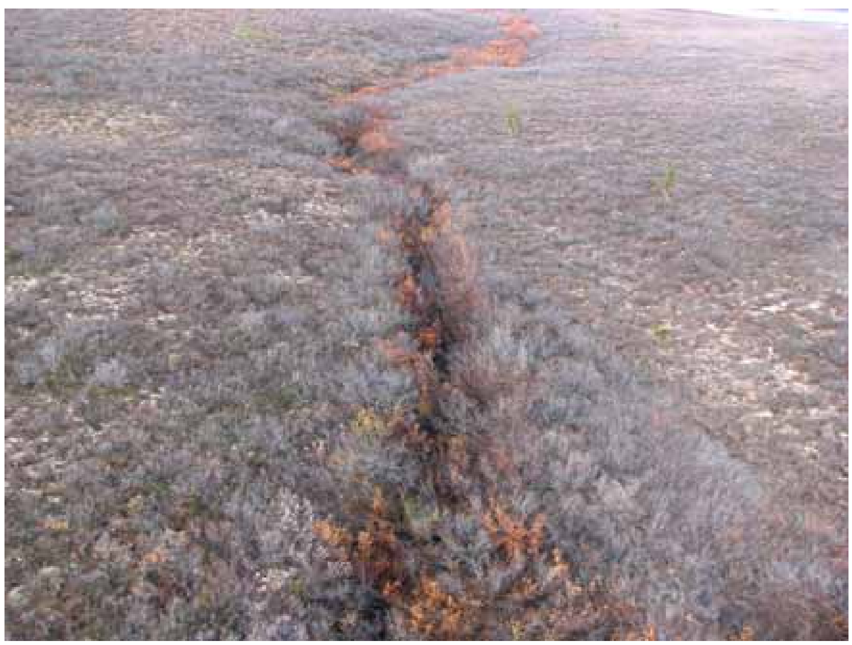


Photo 9.7-3
Stream Crossing 21 aerial view

Photo 9.7-4
Stream Crossing 21 ground view, looking upstream

TABLE 9.7-2: STREAM CHANNEL AND HABITAT CHARACTERISTICS AT SELECTED STREAM CROSSING LOCATIONS ALONG THE PROPOSED HIGHWAY, SEPTEMBER 2009

Location	Stream Crossing No.	Water Temp. (°C)	Wetted Width (m)	Total Width (m)¹	Water Depth (cm)	Substrate	Overhead Cover		Instream Cover		Habitat Type	Water Velocity (m/s)	Comments
							Type	%	Type	%			
KM 2.5	03	5	2.6	10.5	0.61	silt	willow grass Birch	10 30 30	LWD SWD	20 10	riffle-pool	N/A	Crossing location at pool. Channel narrows and becomes shallower and faster flowing with a more complete canopy cover upstream. Velocity measurement not taken due to insufficient length of unobstructed stream. Substrate upstream appears to consist of gravel/cobble. Large upstream watershed. Good potential for spawning/rearing fish.
KM 26	18	8	3	15.5	0.43	gravel/ cobble/silt	willow	100	LWD SWD	30 40	riffle	N/A	Major tributary to Jimmy Lake. Potential habitat productive capacity may be reduced due to heavy willow cover reducing light penetration, and because there are no major lakes upstream of the crossing. Fish from Jimmy Lake may migrate for spawning (grayling). Velocity estimated at 1 m/s. Could not be measured due to insufficient length of unobstructed stream for float.
KM 28	21	8	1.3	6	0.33	gravel/ cobble/silt	willow /grass	80	LWD SWD	30 40	riffle	N/A	Well defined tributary to Jimmy Lake. Heavy canopy cover may restrict productivity. Medium sized lakes upstream. Fish from Jimmy Lake may migrate for spawning (grayling). Velocity approximated at 1 m/s. Could not be measured due to insufficient length of unobstructed stream for float.
KM 40	23a Trail Valley Creek	5	1.5	17	0.43	cobble	willow /grass	60	SWD	20	riffle	1	Well defined tributary to Husky Lakes. Very good habitat potential due to partial canopy, good flow, and cobble substrate. Habitat likely restricted to spawning and rearing for Husky Lakes' fish as there are no significant lakes upstream.
On PWC Route, ~KM 54.5	30 Hans Creek												Hans Creek. Accessed on ground. No measurements made due to high water/velocity that prevented wading. Similar in width and depth to Zed Creek. Appears to have gravel/cobble substrate. Known from previous reports to support Arctic grayling and sculpin.
KM 67.5	31 Zed Creek	8	9	29	0.43	gravel 75% cobble 25%	willow	5	N/A		riffle-run	1	Zed Creek (also called Parsons Creek). Excellent migratory, spawning, and rearing habitat. May have the potential for very high flows during freshet. Known (from previous reports) to support lake whitefish, round whitefish, lake trout, Arctic grayling, stickleback, and sculpin.
On PWC Route, KM 75	33	5	2.8	30	0.17	silt	willow	90	SWD	20	pool	N/A	Habitat is limited due to sluggish flow, silt substrate, and almost complete willow canopy cover. However, a juvenile grayling (tentative identification) was observed (~9cm) during the ground survey. This stream flows into Zed Lake, located a short distance downstream of the proposed crossing. The upstream watershed contains several small lakes. Stream has low-moderate fisheries potential.
On PWC Route, no kilometre marking	35	6	2.75	39	0.28	gravel/ cobble	willow	65	SWD	10	riffle	N/A	Velocity was high; measurement not taken due to insufficient length of unobstructed stream. Downstream pool weedy and silted. From the air, several weedy, slow flowing areas identified as having good potential for northern pike spawning, rearing, and feeding habitat. Faster flowing area has good potential for grayling spawning, and grayling/whitefish rearing. Total length of channel is less than 2 km. It drains a series of mid-size lakes and flows into an arm of Husky Lakes. Subsequent to the field investigation, the crossing location was moved further upstream to an area just below the source lake (Stream Crossing 35a) for this stream. No ground-truthing was carried out at that site. However, the stream channel was observed from the air to be wider than at Stream Crossing 35 with considerably less overhead cover.
On PWC Route, no kilometre marking	38	5	1.9	20	0.36	gravel/ cobble/silt	willow	80	SWD	10	glide/ pool	0.13	Channel has sluggish flow, but may provide limited spawning/rearing habitat for upstream spawning migrants (grayling). Stream flows into a small lake and then into Husky Lakes. Subsequent to the field investigation, the crossing location was moved upstream to Stream Crossing 38a (not ground-truthed), located just downstream of a mid-size lake. Observations from the air suggest that the stream at that location is made up of a series of heavily overgrown, weedy pools. That habitat, in proximity to the lake, may be suitable for pike spawning, if the lake is of sufficient depth to provide overwintering.
KM 106	39	7	5.3	12	0.26	silt	willow	60	SWD	10	glide/ pool	0.15	Channel connects a large lake system to the Husky Lakes. Substrate varies with stream width and water velocity. Gravel dominates the area just downstream of the crossing site. Stream has good habitat potential. Stickleback observed.
KM 109.5	39a	6	0.7	11	0.11	gravel	willow	100	SWD	10	riffle/r un	N/A	Potentially good habitat, with good flow. Flows into Husky Lakes. Subsequent to the field investigation, the crossing location was moved further upstream in the same drainage. That crossing is over a short length of stream connecting two small lakes. That section of stream was not ground-truthed, but shows to be a well defined channel on a Google Earth image.

1 Wetted width was measured as the horizontal distance between the edge of water on both sides of the stream, measured perpendicular to the direction of flow.

2 Total width was measured between the tops of the banks on each side of the stream, measured perpendicular to the direction of flow. Top of bank was determined as a distinct change in gradient or by a change in vegetation.

3 LWD=large woody debris (dead wood >5 cm diameter over a minimum 2 m length; SWD=small woody debris (dead wood smaller than LWD).

Results of previous stream surveys along the proposed Highway route were summarized in Rescan (1999) and the Environmental Impact Statement (EIS) for Mackenzie Gas Project (IOL et al. 2004). Rescan (1999) reported that fish had been sampled in Jimmy Creek (Stream Crossing 'N'), Hans Creek (Stream Crossing 30; Photo 9.7.5), and Zed Creek (a.k.a. Parsons Creek; Stream Crossing 31; Photo 9.7-6). Sampled fish included lake whitefish, round whitefish, lake trout, Arctic grayling, ninespine stickleback, and slimy sculpin. IOL et al. (2004) provided sampling results for Zed Creek, Hans Creek, Jimmy Creek, and in a stream crossed twice at crossings 'L' and 'M' along the original PWC 1977 route (Appendix B). That survey identified the following fish species as having the potential to utilize habitats in streams along the proposed route: northern pike, lake whitefish, round whitefish, Arctic grayling, lake trout, burbot, ninespine stickleback, and sculpin.

Photo 9.7-5
Stream Crossing 30, Hans Creek, looking upstream

Photo 9.7-6
Stream Crossing 31, Zed Creek, looking upstream

Actual species presence would be dependent on several habitat and watershed characteristics. As indicated earlier, it is unlikely that any of the stream locations along the highway route would provide overwintering habitat due to complete freezing. Similarly, many of the small, shallow headwater lakes within the watersheds crossed by the proposed route would freeze either to the bottom or to a sufficient depth to preclude the possibility of overwintering, partly due to a diminishment of oxygen to lethal levels (Cott et al. 2008b).

9.8 HUMAN ENVIRONMENT

9.8.1 Tuktoyaktuk (Community Profile)

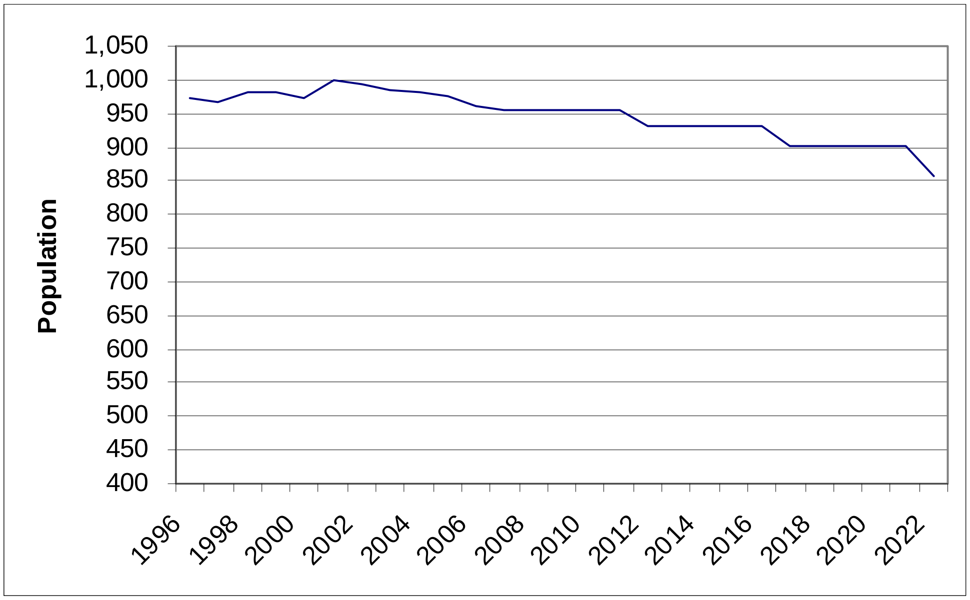
9.8.1.1 Background

The Hamlet of Tuktoyaktuk is located on the shores of the Arctic Ocean, on the Tuktoyaktuk Peninsula at 69°27'N and 133°02'W. The community is the most northerly community on mainland Canada and is located approximately 137 km north of Inuvik and 1,130 km northwest of Yellowknife. Tuktoyaktuk is accessible by air, winter ice road, and water during the ice free period.

9.8.1.2 Population

The majority of the Tuktoyaktuk population is Inuvialuit. Approximately 97% of Tuktoyaktuk's population is Aboriginal (NWT Bureau of Statistics 2008a).

The historic and projected population of Tuktoyaktuk is provided in Figure 9.8-1 Tuktoyaktuk's population has generally decreased from 972 to 956 between 1996 and 2007, indicating a declining average annual growth rate of -0.2 (NWT Bureau of Statistics 2008a). In 2001, the population peaked at 1,001. At the moment, the population is projected to decrease to 930 by 2012 and 858 by 2022.

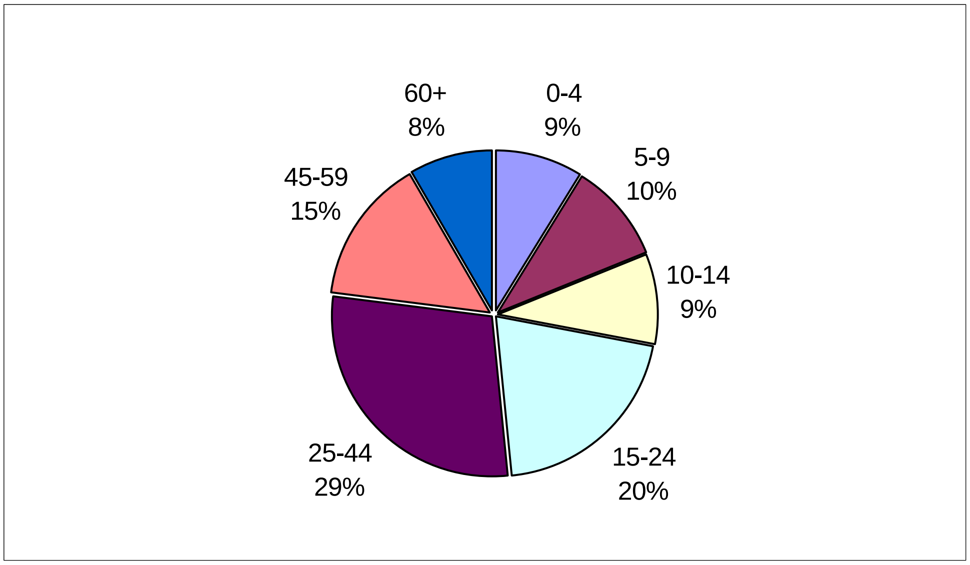


Source: NWT Bureau of Statistics (2008a)

Figure 9.8-1
Tuktoyaktuk Historic and Projected Population, 1996 - 2022

From 1996 to 2005, there were 14 to 25 births each year, with an average of 19.4 births per year over the ten year period. The number of teen births has ranged between 1 and 6 per year between 1996 and 2005, with an average of 3.7 teen births per year. The annual death rate has ranged between 1 and 10 deaths per year between 1996 and 2005.

The population by age and gender is described in Figure 9.8-2 and Table 9.8-1, respectively. Data indicate that 48% of the population is aged 24 or younger. There are a slightly greater number of males than females in the community.



Source: NWT Bureau of Statistics (2008a)

Figure 9.8-2
Tuktoyaktuk Population by Age Group, 2007

TABLE 9.8-1: TUKTOYAKTUK POPULATION BY GENDER, 2007		
Gender	**Population**	**Percent**
Male	499	52%
Female	457	48%

Source: NWT Bureau of Statistics (2008a)

9.8.1.3 Employment

Community employment data are provided in Figure 9.8-3. In 2006, 625 residents were aged 15 years and older. Employment data indicate that of those aged 15 years and older, 245 residents were employed, 120 residents were unemployed, and 265[5] residents were not in the labour force. Of the 365 residents in the labour force, this translates into a participation rate of 58.4% and an unemployment rate of 32.9%. Both employment and unemployment rates have fluctuated between 1986 and 2005. The overall trend in employment is a slight increase, while unemployment shows a slight decrease.

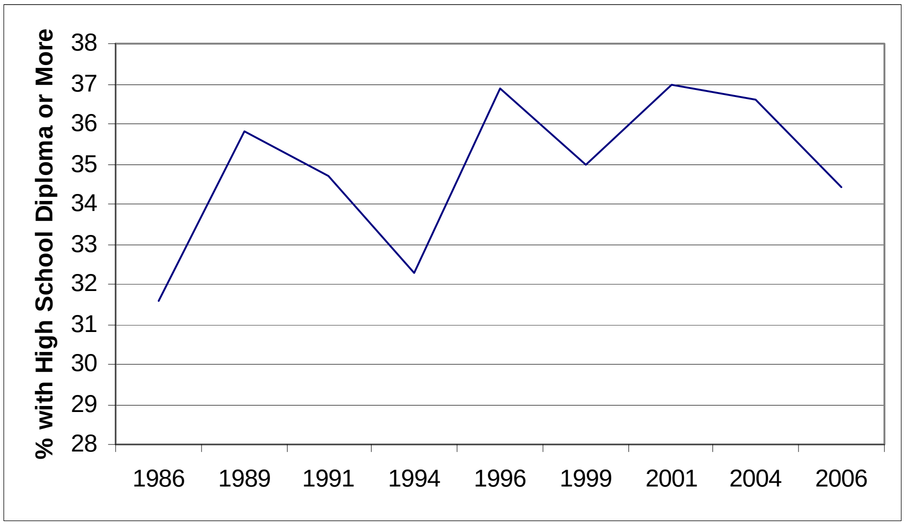
[5] The NWT Bureau of Statistics do not provide an explanation for the discrepancy in the data provided (i.e., the number of unemployed, employed and not participating in the labour force do not equal the number of residents over the age of 15).

Source: NWT Bureau of Statistics (2008a)

Figure 9.8-3
Tuktoyaktuk Employment and Unemployment Rates, 1986 - 2006

9.8.1.4 Education

The percent of residents achieving a high school diploma has generally increased since 1986 (Figure 9.8-4). In 1986, 31.6% of the population had completed high school, compared to 34.4% in 2006. Data for specific educational levels, such as trade, technical, and university certificates and diplomas were unavailable.



Source: NWT Bureau of Statistics (2008a)

Figure 9.8-4
Tuktoyaktuk Educational Level, 1986 - 2006

9.8.1.5 Traditional Activities

According to the NWT Bureau of Statistics (2008a), the level of involvement in traditional activities recorded in 2003 was:

- 56.9% of residents hunted and fished;
- 8.4% of residents trapped; and
- 49.5% of residents consumed country foods.

In comparison, the level of involvement in traditional activities in 1994 was:

- 53.5% of residents hunted and fished; and
- 13.4% of residents trapped (NWT Bureau of Statistics 1994).

Data regarding consumption of country foods are not available for 1994.

9.8.1.6 Language

The percentage of Tuktoyaktuk's population that speaks an Aboriginal language has been slowly declining. In 1984, 35.8% of the Inuvialuit population could speak Inuvialuktun, but this subsequently declined to 28.3% in 2004 (NWT Bureau of Statistics 2008a).

9.8.1.7 Community Services

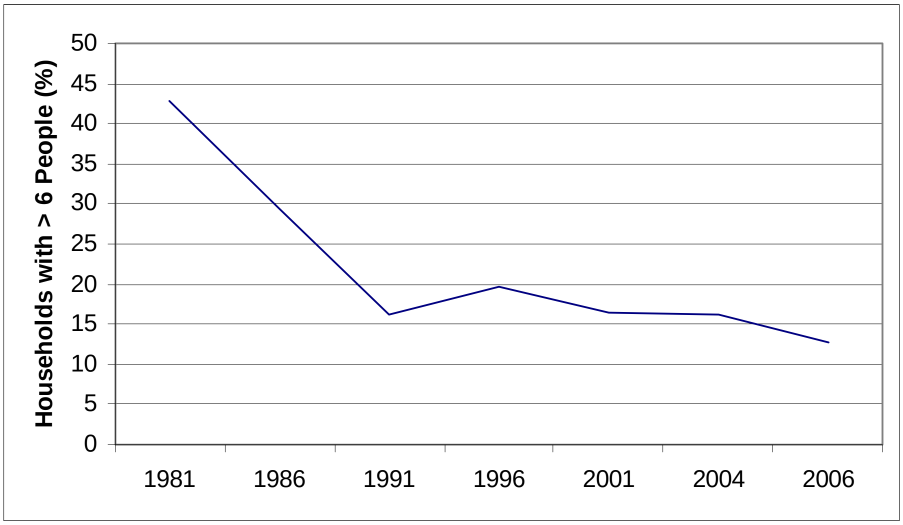
Several community services are offered in Tuktoyaktuk through the Beaufort-Delta Health and Social Services Authority. Services include the Crisis Centre for Family Violence, the Rosie Ovayouk Health Centre, and the Tuktoyaktuk Social Services Office (Northwest Territories Health and Social Services 2009). A post office and RCMP detachment in Tuktoyaktuk; however, no banks are located there (NWT Infrastructure n.d.(a)).

Other community services include recreation facilities, school (to grade 12), grocery stores, and accommodations. Municipal services include sewage and solid waste collection and public works (NWT Infrastructure n.d.(a)).

9.8.1.8 Housing

In 2006, there were 270 houses in the community. Of these, 95 were owned and 180 were rented[6]. The percentage of households with more than six people has declined since 1981 (Figure 9.8-5). In 1981, 42.9% of households had more than six people living in the household; by 2003, this percentage had declined to 12.7% (NWT Bureau of Statistics 2008a).

[6] The NWT Bureau of Statistics do not provide an explanation for the discrepancy in the data provided (i.e., the number of owned and rented houses exceed the total number of houses).

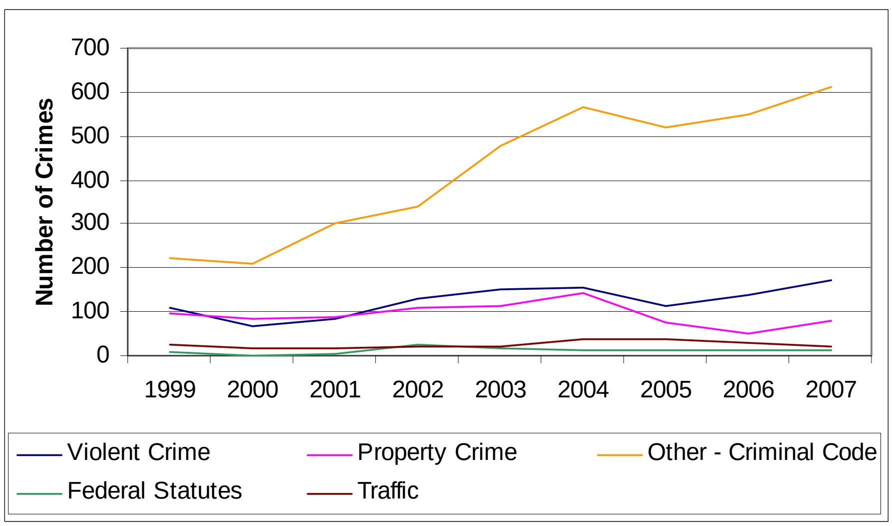


Source: NWT Bureau of Statistics (2008a)

Figure 9.8-5
Tuktoyaktuk Households with More Than Six People, 1981 - 2006

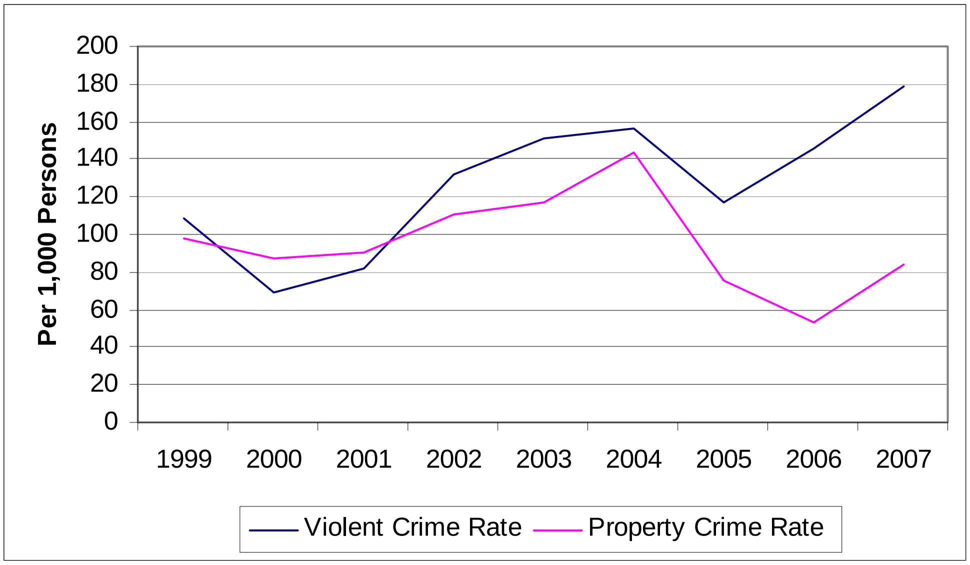
9.8.1.9 Crime

The Tuktoyaktuk RCMP detachment reports on crime statistics. Crime levels have generally increased since 1999, with noticeable increases in crimes recorded between 2002 and 2004 with a slight decline in 2005, followed by an increasing trend (Figure 9.8-6). Similar trends occurred with the violent crime rate and property crime rate per 1,000 persons (Figure 9.8-7).



Source: NWT Bureau of Statistics (2008a)

Figure 9.8-6
Tuktoyaktuk Crimes, 1999 - 2007

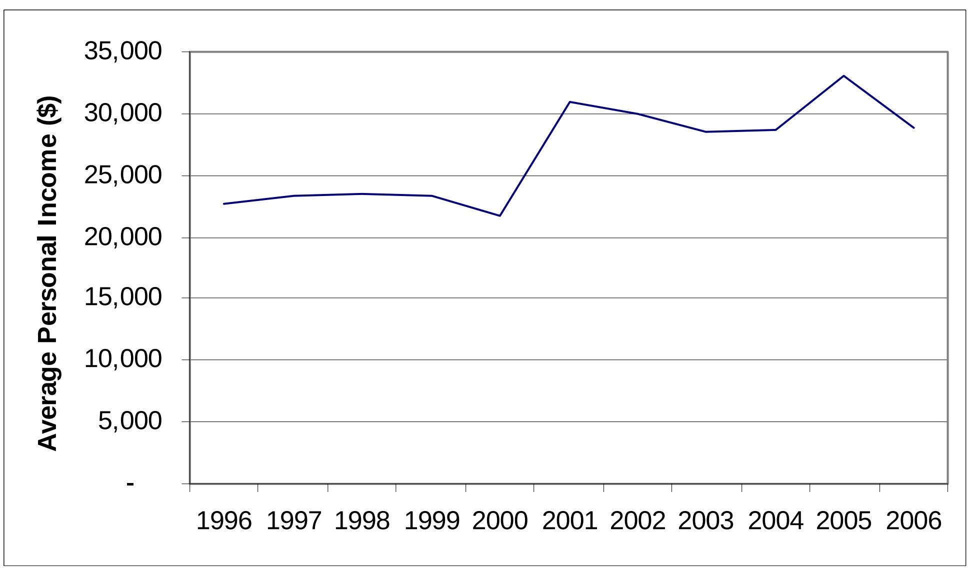


Source: NWT Bureau of Statistics (2008a)

Figure 9.8-7
Tuktoyaktuk Violent Crime and Property Crime Rates, 1999 - 2007

9.8.1.10 Income

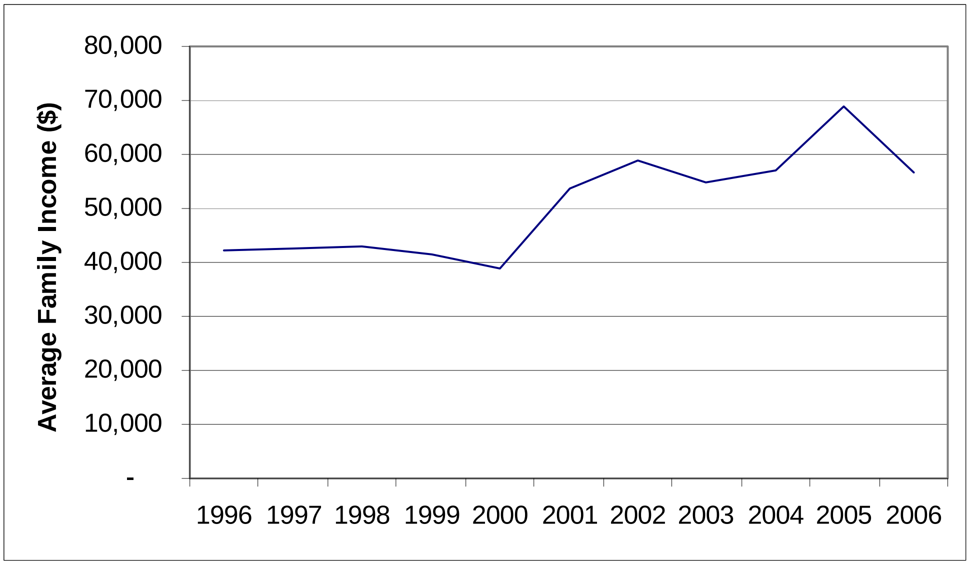
The average personal income for residents of Tuktoyaktuk has increased since 1996 (Figure 9.8-8). Average income in 1996 was $22,740 and had increased to $28,902 by 2006.



Source: NWT Bureau of Statistics (2008a)

Figure 9.8-8
Tuktoyaktuk Average Personal Income, 1996 - 2006

Similarly, the average family income had generally increased since 1996 (Figure 9.8-9). In 1996, the average family income was $42,114 and had increased to $56,724 by 2006.



Source: NWT Bureau of Statistics (2008a)

Figure 9.8-9
Tuktoyaktuk Average Family Income, 1996 - 2006.

9.8.2 Inuvik (Community Profile)

9.8.2.1 Background

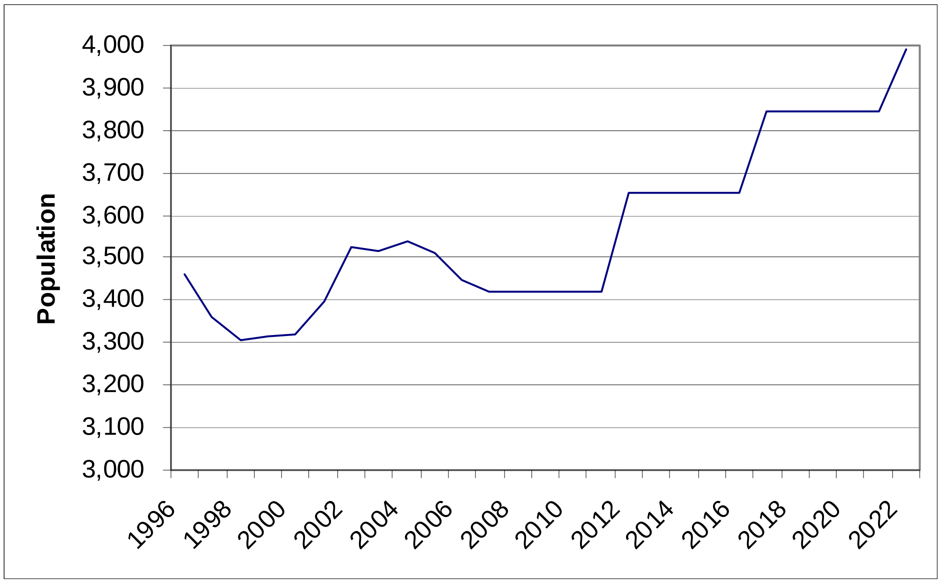
The Town of Inuvik is located on the Mackenzie River Delta at 68°21'N and 133°43'W. The community is located approximately 1,086 km northwest of Yellowknife. Inuvik is accessible year-round by air or all-weather road (Dempster Highway) and by water during the ice free season.

Inuvik is the government centre, and transportation and recreation hub for the Canadian Western Arctic. Due to its strategic location, Inuvik is also the main headquarters for the oil and gas industry operating in the Beaufort Sea/Mackenzie Delta (Town of Inuvik 2009). The airport, government services, recreational programs and hospitality industry attract residents from neighbouring communities and those traveling to and from other communities.

9.8.2.2 Population

The majority (58.4%) of the Inuvik population is Aboriginal (Inuvialuit and Gwich'in) (NWT Bureau of Statistics 2008b).

The historic and projected population of Inuvik is provided in Figure 9.8-10. Inuvik's population has fluctuated between 1996 and 2007 with an overall population decrease of 3,462 to 3,420, indicating a declining average annual growth rate of -0.1 (NWT Bureau of Statistics 2008b). Despite this, the NWT Bureau of Statistics projects that the population will increase to 3,654 by 2012 and 3,992 by 2022.

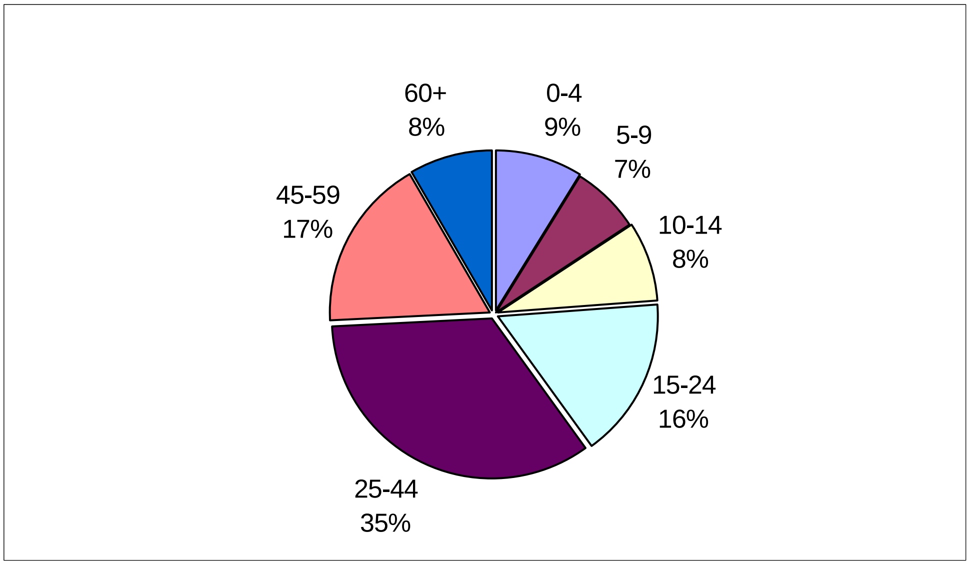


Source: NWT Bureau of Statistics (2008b)

Figure 9.8-10
Inuvik Historic and Projected Population, 1996 - 2022

From 1996 to 2005, there were 48 to 88 births each year, with an average of 65.6 births per year over the ten year period. The number of teen births has ranged between 3 and 13 per year between 1996 and 2005, with an average of 7.8 teen births per year. The annual death rate has ranged between 9 and 21 deaths per year between 1996 and 2005.

The population by age and gender is described in Figure 9.8-11 and Table 9.8-2, respectively. Data indicate that there are fairly even proportions of each group, with declining proportions for older age groups. There are a slightly greater number of males than females in the community.



Source: NWT Bureau of Statistics (2008b)

Figure 9.8-11
Inuvik Population by Age Group, 2007

TABLE 9.8-2: INUVIK POPULATION BY GENDER, 2007		
Gender	Population	Percent
Male	1,759	51%
Female	1,661	49%

Source: NWT Bureau of Statistics (2008b)

9.8.2.3 Employment

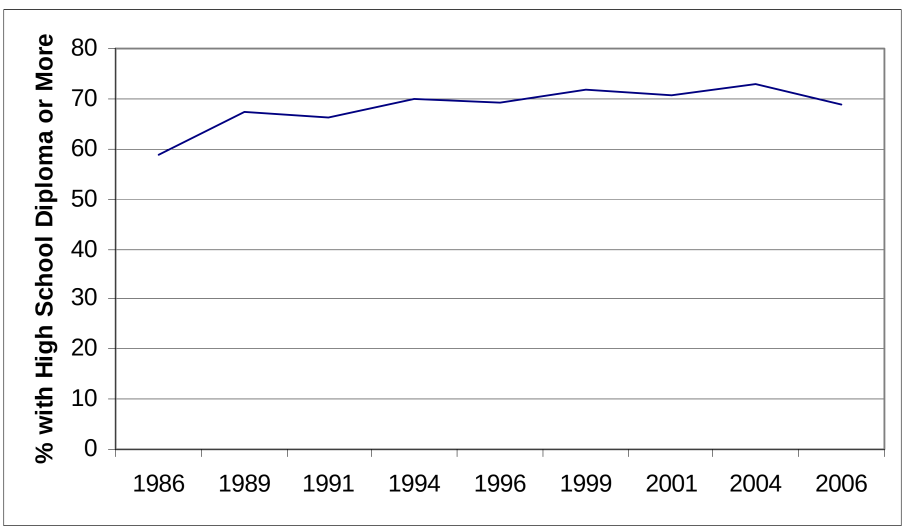
Community employment data are provided in Figure 9.8-12. In 2006, 2,570 residents were aged 15 years and older. Employment data indicate that of the population aged 15 years and older 1,825 residents were employed, 230 residents were unemployed, and 515 residents were not in the labour force. Of the 2,055 residents in the labour force, this translates into a participation rate of 80.0% and an unemployment rate of 11.2%. Both employment and unemployment rates have remained relatively stable between 1986 and 2005, with some fluctuations from 1991 to 1996.

Source: NWT Bureau of Statistics (2008b)

Figure 9.8-12
Inuvik Employment and Unemployment Rates, 1986 – 2006

9.8.2.4 Education

The percent of residents achieving a high school diploma has generally increased since 1986 (Figure 9.8-13). In 1986, 58.7% of the population had completed high school, compared to 68.8% by 2006. Data for specific educational levels, such as trade, technical, and university certificates and diplomas were unavailable.



Source: NWT Bureau of Statistics (2008b)

Figure 9.8-13
Inuvik Educational Level, 1986 - 2006.

9.8.2.5 Traditional Activities

According to the NWT Bureau of Statistics (2008b), the level of involvement of Inuvik residents in traditional activities recorded in 2003 was:

- 32.6% of residents hunted and fished;
- 7.2% of residents trapped; and
- 17.7% of residents consumed country foods.

In comparison, the level of involvement in traditional activities in 1994 was:

- 9.8% of residents hunted and fished; and
- 6.9% of residents trapped (NWT Bureau of Statistics 1994).

Data regarding consumption of country foods were not available for 1994, nor is there an explanation for the significant increase in percentage of residents that hunted and fished from 1994 to 2003.

9.8.2.6 Language

The percentage of Inuvik's Aboriginal population that speaks an Aboriginal language (Inuvialuktun and Gwich'in) is slowly declining. In 1984, 35.2% of the Aboriginal population could speak an Aboriginal language, this has since declined to 17.6% in 2004 (NWT Bureau of Statistics 2008b).

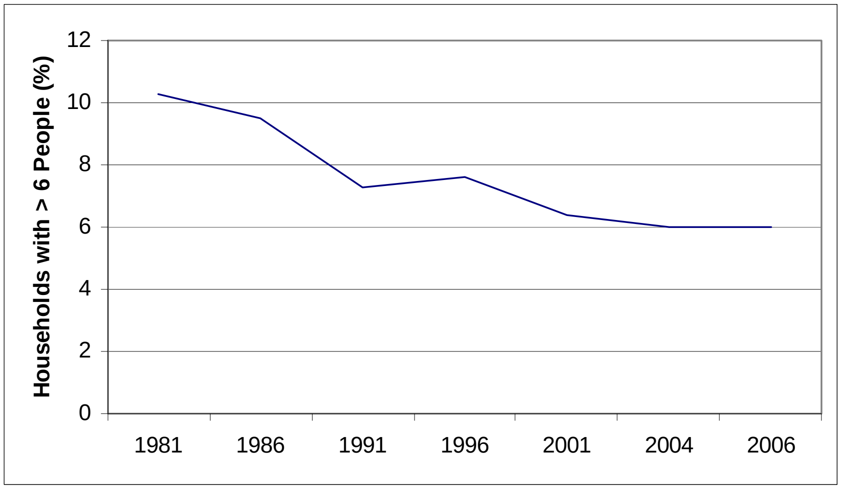
9.8.2.7 Community Services

Several community services are offered in Inuvik through the Beaufort-Delta Health and Social Services Authority. Services include the Billy Moore Home and Charlotte Vehus Group Home (adult handicapped group homes), Inuvik Regional Hospital, Public Health Unit, Senior Citizens Centre, Transition House (women/ children shelter), Reliance Group Home (child welfare facility), and Inuvik Social Services Office (Northwest Territories Health and Social Services 2009). An RCMP detachment is also located in Inuvik (NWT Infrastructure n.d.(b)).

Other community services include recreation facilities, chartered bank, primary and secondary school, Aurora College, grocery stores, restaurants and accommodations. Municipal services include trucked/ piped sewage, solid waste collection and public works (NWT Infrastructure n.d.(b)).

9.8.2.8 Housing

In 2006, there were 1,245 houses in the community. Of these, 420 were owned and 820 were rented, and 5 were not classified. The percentage of households with more than six people has declined since 1981 (Figure 9.8-14). In 1981, 10.3% of households had more than six people living in the household; by 2003, this percentage had declined to 6.0% (NWT Bureau of Statistics 2008b).

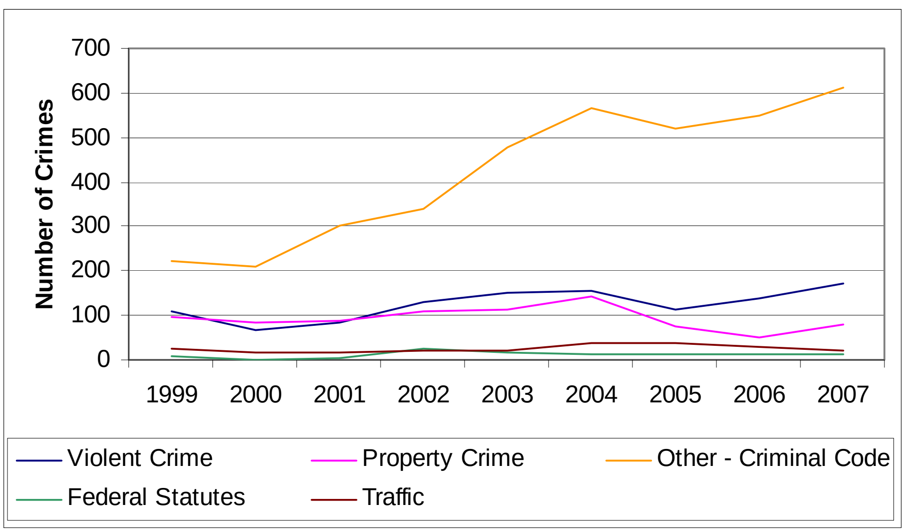


Source: NWT Bureau of Statistics (2008b)

Figure 9.8-14
Inuvik Households with More Than Six People, 1981 - 2006

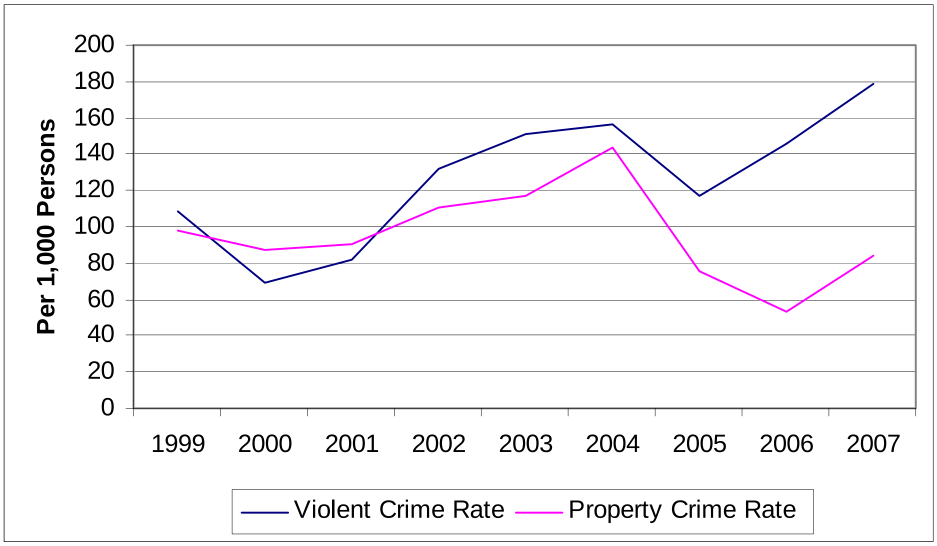
9.8.2.9 Crime

The Inuvik RCMP detachment reports on crime statistics. Crime levels have generally increased since 1999, with noticeable increases in crimes recorded between 2002 and 2004, with a slight decline in 2005 to 2006, followed by an increase (Figure 9.8-15). Similar trends occurred with the violent crime rate and property crime rate per 1,000 persons (Figure-9.816).



Source: NWT Bureau of Statistics (2008b)

Figure 9.8-15
Inuvik Crimes, 1999 - 2007

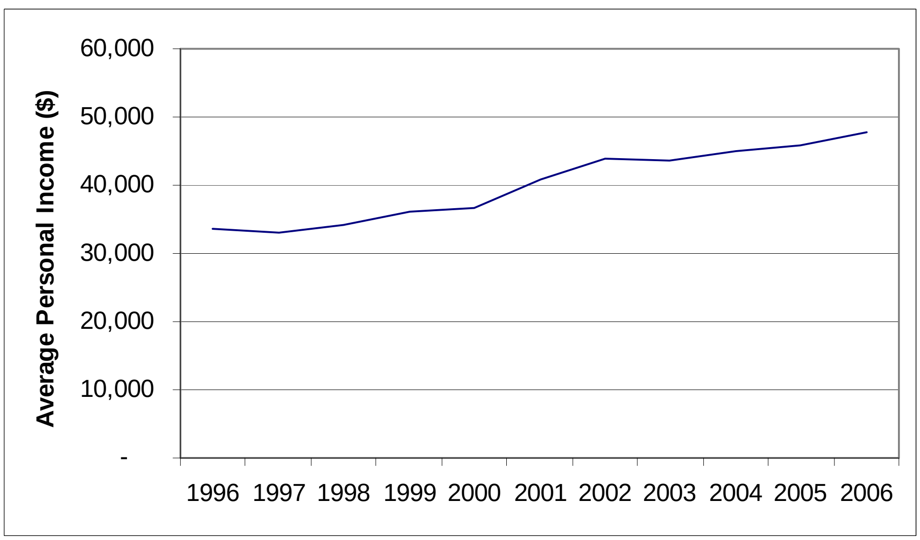


Source: NWT Bureau of Statistics (2008b)

Figure 9.8-16
Inuvik Violent Crime and Property Crime Rates, 1999 - 2007

9.8.2.10 Income

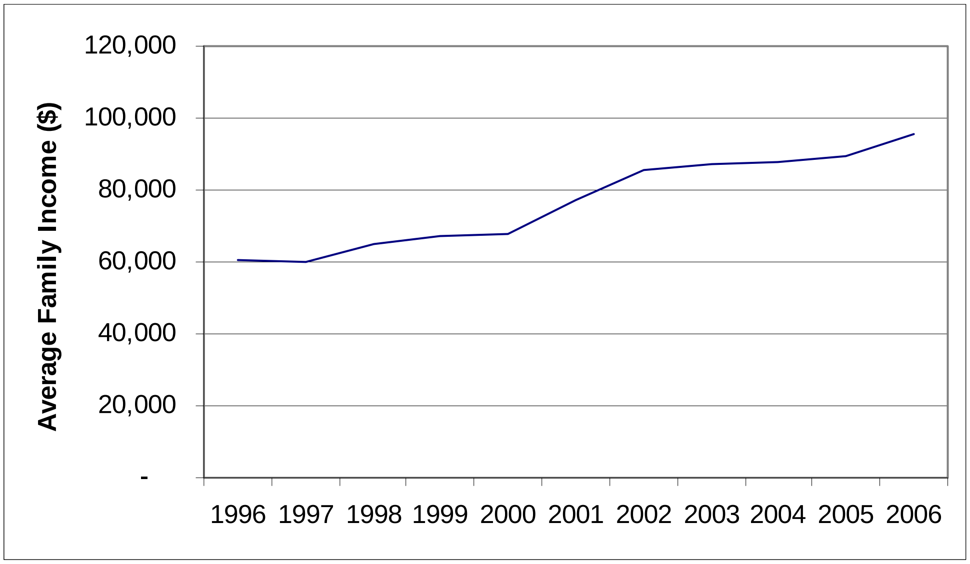
The average personal income for residents of Inuvik has increased since 1996 (Figure 9.8-17). Average income in 1996 was $33,657 and has increased to $47,665 by 2006.



Source: NWT Bureau of Statistics (2008b)

Figure 9.8-17
Inuvik Average Personal Income, 1996 - 2006

Similarly, the average family income has generally increased since 1996 (Figure 9.8-18). In 1996, the average family income was $60,497 and had increased to $95,392 by 2006.



Source: NWT Bureau of Statistics (2008b)

Figure 9.8-18
Inuvik Average Family Income, 1996 - 2006

10.0 ANTICIPATED ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

The following section reviews the proposed project activities, potential environmental effects and mitigation measures associated with the construction of the proposed Inuvik to Tuktoyaktuk Highway.

10.1 APPROACH TO ENVIRONMENTAL MANAGEMENT

The Partners are committed to constructing the proposed Inuvik to Tuktoyaktuk Highway, borrow sources, and associated winter access roads in a safe and environmentally responsible manner. Extensive environmental studies have been conducted in the area for previously proposed roads and oil and gas development. The Partners are committed to incorporating existing information and building upon this knowledge base.

The existing framework for environmental management of the highway construction project consists of:

- Regulatory and other management instruments that define environmental terms and conditions, including:
  - EISC Screening Decision Report, including recommended Terms and Conditions;
  - ILA Land Use and Quarry Permit Terms and Conditions;
  - INAC Land Use Permit Conditions;
  - Northwest Territories Water Board Licence Terms and Conditions;
  - Navigable Waters Protection Act Approvals Terms and Conditions;
  - Conformance with DFO Operational Statements, Letters of Advice and potential Fisheries Authorization(s); and
  - HTC and Co-Management Body directions.
- Use of experienced, local construction contractors.
- Avoidance and protection of sensitive terrain and habitats.
- Avoidance of identified heritage and archaeological sites.
- Construction environmental and wildlife monitoring.

A requirement for contractors to be selected regarding environmental management for the Highway construction project will include the provision and implementation of the following management plans:

- Contractor health, safety and environment (HSE) manuals including general spill contingency and emergency response plans.
- Contractor work procedures documents.
- Site-specific health and safety plans.
- Site-specific spill contingency plans.

A copy of a typical contractor's spill contingency and emergency response plan is provided in Appendix C. The development of site-specific plans will take place in the future upon award of contracts to the successful contractors. However, examples of the noted health, safety, and environmental management plans can be made available upon request.

This section of the Project Description Report focuses on the anticipated environmental effects associated with the relatively short-term construction and how these effects can and will be mitigated. Issues that may arise in the future because of proposed operational changes related to the highway are also discussed.

10.2 AIR QUALITY AND NOISE

Dust, air emissions and noise associated with the relatively short-term construction of the highway and aggregate borrow sources are expected to have limited, localized and generally temporary effects on air quality and the sound environment in the vicinity of the highway.

Dust particles of various sizes are expected. Larger particles (> 44 microns diameter) are typically associated with nuisance issues, while smaller particles (< 10 microns diameter) can potentially create human health issues at elevated levels in populated areas. Emissions from diesel engine combustion exhaust (CO, NO_x, SO_2 and PM) during construction and operation are also expected to be generated.

10.2.1 Air Quality

During aggregate borrow activities and the highway construction phase, typical dust sources will include: heavy equipment movements, loading and unloading of raw materials, crushing, screening, blasting, erosion from sand and gravel stockpiles, etc. The application of water from nearby, suitable lakes, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998), will be effective during summer in controlling dust created by loading and unloading materials, stockpiling and wind erosion. Any water extracted for dust control or other purposes will be undertaken in accordance with Northwest Territories Water Licence requirements and DFO water withdrawal criteria.

Emissions from diesel engine combustion exhaust during the construction phase are considered to be relatively minor. Construction-related emissions are expected to be localized, short-term and intermittent.

10.2.2 Noise

Highway construction activities will be intermittent, temporary and transient in nature. Most of the noise during the construction phase will be associated with equipment operation and, if required, blasting activities to break up the frozen borrow material during excavation. Although there are no local noise regulations that directly apply to construction noises, the contractors will be directed to apply reasonable mitigation to reduce possible effects associated with construction noise. These will include adequate maintenance of their construction equipment, including mufflers. Blasting activities will be timed to avoid periods when sensitive wildlife species are in the area. Prudent design, best management practices and mitigation can be combined to minimize sound levels during the construction phase.

Trucks will typically be dump trucks or other haul trucks, operating at slow speeds. Noise levels associated with such trucks are typically within 78-82 dBA at 15 m from the truck, which would not be expected to create excessive noise levels near the highway. These levels will be intermittent.

Aggregate borrow activities, including blasting will be intermittent and temporary in nature. Most of the noise will be associated with earth-moving equipment operation during periods of aggregate borrow activity. Best management practices and mitigation measures will be applied to reduce the effect of noise.

Examples of prudent design and management practices include:

- Limitation of construction activity during sensitive to minimize effects on wildlife;
- Effective logistics planning such as the use of vans or extended cab pick-up trucks to transport workers to minimize vehicle movements; and,
- Regular maintenance of equipment and provision of appropriate mufflers for all internal combustion engines.

10.3 SENSITIVE TERRAIN

The highway will traverse tundra and will be constructed using end dumping methods to initially lay down the borrow material on geotextile followed by placement of the finer surfacing material for the highway. A detailed discussion of sensitive terrain features is provided in Section 5.6.2 and further baseline information is provided in Section 9.2.2.3.

The highway will be constructed in the winter months to minimize ground disturbance that could cause permafrost degradation. The highway will be constructed with sufficient cross drainage to prevent or minimize potential water ponding. Ponding conditions could lead to permafrost thaw which could cause ground disturbance, changes to existing drainage conditions and slope instability.

Activities that will affect the terrain during highway construction include the removal of overburden at borrow sites, the excavation of highway construction material from the borrow sources, the construction of the highway, and the re-contouring of construction sites and associated facilities.

As previously indicated in Section 5.3 of this Project Description Report, the average width of the highway footprint will be 20 to 28 m (depending on the surface finish width) including the embankment. Considering the full 137 km length of the preferred highway alignment the total highway footprint would directly impact approximately 329 ha of terrain and associated vegetation.

Borrow sources will be located as close to the highway route as possible to minimize haul distances. The borrow sources will be operated and reclaimed in a manner consistent with ILA and INAC permit requirements and existing environmental standards and guidelines. To further minimize potential impacts on terrain and associated vegetation, temporary winter access roads, constructed of snow and ice over the frozen ground, will be employed for access to the borrow sources.

Site-specific reclamation plans will be prepared and approved prior to the commencement of operations at each borrow source. All borrow source sites will be permanently reclaimed when use of that source is complete in accordance the applicable reclamation plan. Progressive reclamation will occur to ensure that only areas with active borrowing will be disturbed. Mined out areas will be recontoured and revegetated, if possible to mimic the surrounding terrain upon completion of borrowing activities.

The potential effects of activities on terrain can be related to surface disturbance during construction that can cause damage to soils, permafrost, cause erosion and alter landforms. Mitigation strategies to reduce effects on soils and landforms include:

- Reducing surface disturbance;
- Controlling potential erosion;
- Stabilizing slopes, if required; and
- Revegetation, if possible.

To minimize impacts on the existing terrain of the project area, the footprint of the highway, the temporary construction camps, and the borrow sources will be confined to the extent possible. With the application of the proposed mitigation measures, the effects of the highway and associated borrow activities on the terrain of the project area are generally expected to be limited to the physical footprint and are considered to be minor in the context of the overall project area.

10.4 VEGETATION

10.4.1 Footprint

As previously indicated, the average width of the highway footprint will be 20 to 28 m (depending on the surface finish width) including the embankment. Considering the full 137 km length of the preferred highway alignment the total highway footprint would directly impact approximately 329 ha of terrain and associated vegetation.

10.4.2 Construction

Construction of the highway will involve the excavation of material from borrow sites and the end-dumping of this material over geotextile fabric placed on the frozen ground surface along the right-of-way. These activities will impact the vegetation cover by direct removal at the borrow sites and the burial of vegetation beneath the Highway right-of-way.

As described in Section 10.2.1 construction activities are expected to generate dust at times which could affect the vegetation cover in areas adjacent to the applicable activities. The application of water from nearby, suitable lakes, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998), will be effective during summer in controlling dust created by loading and unloading materials, stockpiling and wind erosion. Any water extracted for dust control or other purposes will be undertaken in accordance with Northwest Territories Water Licence requirements and DFO water withdrawal criteria.

In wet lowland areas, the placement of the highway has the potential to affect local surface water hydrological conditions, which could, in turn, affect the aquatic vegetation communities of these areas. To assist in mitigating this potential concern, culverts will be used, where appropriate, to maintain existing hydrological conditions and to avoid or minimize ponding along the Highway or the drying out of isolated sections of potentially affected wet lowland.

10.4.3 Equipment Traffic

Construction activities will be limited, to the extent possible, to the planned footprint of the highway. All care will be taken during the operations to ensure that travel by heavy equipment and trucks will take place only within the right-of-way or snow compacted and flooded accesses and turn-arounds. Temporary winter access roads, constructed of snow and ice over the frozen ground, will be used to access the borrow sites. The use of these winter access roads will assist in minimizing potential impacts on terrain and associated vegetation.

10.4.4 Mitigation Measures

Consistent with the approach being taken with the Tuktoyaktuk to Source 177 Access Road construction project, geotextile fabric will be used as an underlay to protect the terrain and permafrost. By design, the project will avoid disturbing vegetation and permafrost. The design avoids the use of "cut" slopes as a means of reducing grades because the goal is to construct the highway in a way that protects the permafrost underlying the Highway. The fill that will be used will be placed to an adequate depth to protect the permafrost.

Snow removal and grading will be necessary during winter operations. The build-up of snow on the sides of the highway has the potential to affect the vegetation community adjacent to the highway due to delayed melting in spring.

Potential strategies for mitigating potential effects on the vegetation communities in the vicinity of the highway and associated borrow operations are provided in Table 10.4-1. With the application of the proposed mitigation measures, effects on vegetation are generally expected to be limited to the physical footprint and are considered to be minor in the context of the overall project area.

TABLE 10.4-1: POTENTIAL EFFECTS AND MITIGATION STRATEGIES FOR VEGETATION ALONG THE HIGHWAY		
Potential Effect	**Potential Consequence**	**Mitigation**
Vegetation Infill	Loss of vegetation; increase in ecosystem fragmentation; loss of ecosystems with restricted distribution	Minimize footprint; minimize development on ecosystem types with restricted distribution; avoid sensitive ecosystems; minimize off-site activities such as ATV use; reclaim to viable and wherever practical, self-sustaining ecosystems.
Alteration of Surface Hydrology	Change in water flow, quantity and direction	Ensure adequate drainage in wet lowland areas through the installation of culverts as necessary.
Dust	Temporary seasonal effects on vegetation in adjacent areas	Diligent application of water as per the GNWT *Guideline for Dust Suppression* (GNWT 1998)

10.5 WILDLIFE

Roads can affect wildlife in several possible ways. Roads can be considered habitat when they provide wildlife with some requisites for survival such as food or shelter (e.g., insect relief for caribou). A road is a conduit when wildlife moves along it (e.g., a wolf traveling on a wind-swept road during winter). Roads may be barriers or filters if wildlife movements across them are blocked completely or selectively, respectively. Roads may act as sources (provide habitat) if wildlife living in the corridor disperses into surrounding habitat (e.g., small mammals such as ground squirrels). Alternatively, they may act as sinks if wildlife is attracted and dies as a result (e.g., collisions).

The physical existence of the Highway, the habitats it traverses, patterns and intensity of use by wildlife, and patterns and intensity of vehicle traffic all play major roles in determining the extent to which a road may affect wildlife. Wildlife responses to the construction activities of the proposed Highway and its associated borrow source developments, the physical presence of the proposed Highway, and human activity along the proposed Highway depend, in part, on whether or not they are resident, seasonally resident or migratory. Species are likely to exhibit some degree of habituation to activities associated with the all-weather operation of the proposed Highway.

Two of the most important wildlife species to stakeholders are caribou and grizzly bears. Caribou are a central link in the food chain for other wildlife species and are relied upon by the communities as a source of food. Grizzly bears are a concern as they are considered a vulnerable species and are known to be potentially dangerous in certain human/ bear encounters. However, other ecosystem components are also important and include furbearers, birds and small mammals. Furbearers such as wolves and wolverine are of economic importance. Birds occupy a tremendous variety of ecological niches, and some, mainly waterfowl species, are an important source of food for the communities. Small mammals are an important component of the biodiversity of arctic ecosystems and comprise part of the prey base for carnivorous mammals and birds.

The majority of disturbances to wildlife will be of a temporary nature. Biological effects experienced during construction of the proposed Highway and the physical existence of the Highway afterwards are not anticipated to affect the ecological integrity of the local or regional area.

10.5.1 Potential Effects on Wildlife and Wildlife Habitat

Effects on wildlife associated with the construction of the proposed Highway and its associated borrow sources can be in the form of impacts on habitat and impacts on wildlife. Habitat effects refer to the loss and degradation of habitat. Habitat may be lost or degraded, reducing its value for wildlife. Habitat loss will occur primarily during the construction phase. Degradation of habitat is a secondary effect of habitat loss during construction and operation. The majority of construction for the proposed Highway and excavation of the associated borrow sources will occur during the winter period, a time when most wildlife are not in the area. Consequently, impacts from construction activities will be mainly temporal and limited.

Impacts on wildlife from construction of the proposed Highway and its associated borrow sources, the physical existence of the proposed Highway, and vehicular traffic include, physical and physiological disturbance, displacement and habituation. Wildlife may respond in the following primary ways:

- Move away from the proposed Highway;
- Increase activity and energy expenditure near the proposed Highway;
- Delay crossing or fail to cross the proposed Highway;
- Reduce use of habitats adjacent to the proposed Highway;
- Be injured or killed by collisions with vehicles;
- Be killed as a result of hunting and trapping along the proposed Highway; and
- Be attracted and become habituated to human food at camps and garbage along the proposed Highway.

Potential wildlife issues that are common to most of the species are classed as direct habitat loss, disturbance, mortality, habituation and attraction and increased harvesting pressure. These are discussed in the following sections. Wildlife and wildlife habitat issues and their respective mitigation measures are discussed in Section 10.5.2.

10.5.1.1 Habitat Loss

Roads eliminate the habitat upon which they are built by burying the vegetation that it covers. Potential impacts of a road are dependent on the road route and the type of construction. The footprint of this proposed Highway is anticipated to be approximately 137 km long by 12-15 m wide. The amount of habitat lost to the Highway is estimated to approximately 329 ha.

Although habitat is lost by road construction, roads can also change habitat from one form to another. As a terrain feature in the environment, the physical presence of a gravel road is roughly analogous to natural features such as eskers, kames and gravel bars on stream flood plains. Such habitats may attract caribou seeking insect relief and small mammals such as ground squirrels, mice etc. for burrowing and dens.

The majority of the proposed Highway alignment is situated on upland tundra habitats, which are generally poorer quality wildlife habitat than the lower lying, more productive wetlands or riparian zones. While they represent a loss, in particular for small mammals, some bird species and ground squirrels, this loss is small compared to the amount of similar habitat available. The amount of wetland and shrub riparian habitat along the corridor is minimal and surrounded by poorer habitat in the form of upland habitat. The more productive habitats are found in the form of wetland areas and riparian tall shrub communities. Wherever possible, these habitats will be avoided during Highway construction.

Borrow excavation activities may cause some localized, temporary habitat loss. Because these activities will be generally limited to the winter period, effects on wildlife habitat are anticipated to be minimal. Progressive reclamation will occur to ensure that only active areas will be disturbed. Areas will be re-contoured and revegetated, if possible to match the surrounding terrain upon completion of excavation activities.

Wildlife will experience some negligible to minor habitat loss associated with the proposed Highway and associated borrow sources. Minimization of habitat loss combined with employee education on wildlife issues will reduce the potential for wildlife impacts. Particular attention will be focused on the protection of caribou and grizzly bears.

Mitigation measures consist of consideration of habitat quality during design of the Highway. Important habitats, where possible, will be avoided and habitat loss minimized. For example, deposits used as sources of sand and gravel will be assessed for their use and importance for grizzly bear denning.

10.5.1.2 Habitat Degradation

Habitat degradation resulting from the project may include damage to local vegetation, either physically or through the effects of dust or other contaminants. Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of environmental effects.

Air emissions associated with the project are unlikely to affect feeding habitats for wildlife. Air quality effects associated with particular project activities and local meteorological conditions will be minimal and temporary.

Dust created by road traffic during the summer months is expected to settle within 300 m of roads. The quantity of dust is unlikely to have a major effect on vegetation and wildlife and water will be employed to minimize potential issues associated with dust. The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential hazard. In the event of a spill, cleanup measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies.

10.5.1.3 Disturbance

Certain species can be sensitive to disturbance, and displacement from habitat adjacent to roads has been widely reported. Habitat displacement can result in reductions in access to security areas and in the efficiency of foraging strategies, with possible population-level consequences. Disturbance can affect wildlife within a zone of influence (ZOI) around the source. However, habitat within the ZOI is not lost; it is just reduced in effectiveness.

The ZOI is a horizontal measure of the area in which wildlife could be affected by an activity. Many factors affect the distance of ZOI such as topography and the presence of security cover. Environmental conditions such as wind and snow cover can also affect ZOI ratings. How wildlife respond to various stimuli is influenced by the degree of habituation of the individual involved.

Habituation of wildlife to traffic and industrial activity can be beneficial as it reduces the intensity of displacement from those disturbances. Some wildlife may habituate fairly quickly to predictable disturbances, as long as they are not associated with strongly negative consequences such as shooting or direct harassment. In the case of the proposed Highway, it is likely that wildlife will initially behave warily, but will habituate over time.

10.5.1.4 Wildlife Mortality

Hunting

Wildlife mortality could increase through hunting and/ or road kills. The proposed Highway will allow hunters and trappers more ready access to harvesting areas and, consequently, human-induced mortality for caribou, furbearers, and waterfowl may potentially increase. The proposed Highway could also assist in providing trappers with access into previously more remote areas along the corridor.

Residents of Tuktoyaktuk have expressed concern that hunting pressure on caribou and other wildlife may increase as a direct consequence of building the Highway. To protect wildlife, organizations such as the ILA, HTC, ITC, WMAC, and GNWT Department of Environment and Natural Resources will need to continue to work together to develop guidelines and conditions for use of the Highway. The consultant's discussions with these agencies identified a shared view that the success of this approach would require a high level of voluntary compliance from the users of the proposed Highway and a public awareness program that would include signage along the Highway alignment highlighting hunting restrictions and discouraging excessive hunting along the corridor.

For the period July 1, 2008 to June 30, 2009, Area I/BC/07, which includes the area of the proposed Highway, was closed to the hunting of barren-ground caribou for all hunters.

Road Kills

Traffic-related mortality can be linked to several factors including traffic density, vehicle speed and/ or road width. Any of these factors can directly affect the success of an animal reaching the opposite side of the road, with an increase in any factor reducing the probability of an animal crossing safely.

The Inuvik to Tuktoyaktuk Highway is expected to have low levels of traffic (in the order of 60 vehicles per day) at most times. Such low levels of traffic would be expected to reduce the occurrence of potential traffic-related mortality along this Highway.

10.5.1.5 Carnivore Dens

Construction and operation of the Highway may potentially affect carnivore denning activities through Highway traffic, noise and vibration. There is some evidence that bears in their dens can be disturbed by human activity, leading to den abandonment, cub mortality and decreased survival (Goodrich and Berger 1994). Linnell et al. (2000) reported that grizzly bears might abandon dens in response to activity within 1 km, and especially within 200 m, but that responses were variable. However, Reynolds et al. (1986) found that no bears deserted their dens despite seismic activity within 800 m and the passage of a supply train within 100 m. Results are too few to generalize. The amount of snow cover for insulation and proximity of activities (Blix and Lentfer 1992), and the type, intensity and duration of activities may be factors contributing to whether bears in dens are disturbed.

Discussions with GNWT Department of Environment and Natural Resources in 2008 (P. Voudrach and M. Branigan, pers. comm. November 20, 2008) identified several areas in the vicinity of the proposed Highway that provide suitable south-facing cutbanks or slopes that may be suitable for grizzly bear denning. Monitors will be made aware of these areas, and will assist with identifying habitat use for the purposes of avoidance and worker safety. The GNWT Department of Environment and Natural Resources subsequently conducted an aerial bear den survey of this area on May 17, 2009 on behalf of the GNWT Department of Transportation and reported that there was no evidence of current grizzly bear activity in the area. In addition, no dens were found within 500 m of either side of the access road, or within Source 177 (GNWT ENR 2009c).

10.5.2 Wildlife Protection and Mitigation Measures

10.5.2.1 Wildlife Protection

Management decisions related to the protection of wildlife and wildlife habitat for the Inuvik to Tuktoyaktuk Highway are based on background information; field investigations; inputs from the Tuktoyaktuk and Inuvik Hunters and Trappers Committees; and the application of, appropriate best management practices. The primary wildlife species of concern to the operation of the proposed Highway are caribou, moose, wolves, wolverines, foxes, grizzly bears, and the high value fur-bearers, such as lynx and marten. The objectives of wildlife management activities along the proposed Highway will be to mitigate potentially negative effects on wildlife in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via project design;
- Minimize direct mortality due to collisions with vehicles;
- Minimize attractants at camps through responsible waste management and effective environmental awareness programs;
- Minimize the volume, duration, and frequency of noise producing activities;
- Selective timing of Project activities to avoid critical periods for wildlife;
- Conform with pre-determined setback distances from key wildlife habitat features;
- Ensure proper storage, transportation and disposal of wastes;
- Ensure Project personnel have appropriate levels of wildlife training and awareness; and
- Encourage agencies such as the HTCs, WMAC and GNWT Department of Environment and Natural Resources to work together to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

10.5.2.2 Mitigation Measures

The following section summarizes the types of mitigation measures that can be undertaken to minimize potential impacts on wildlife species. The GNWT Department of Transportation's operational policies are designed to mitigate potential impacts on wildlife and wildlife habitat. Three types of reduction measures exist: spatial, temporal and operational. Spatial measures are designed to reduce impacts through avoiding important habitat areas such as wetlands used by staging waterfowl; temporal measures are designed to reduce disturbance during critical periods such as avoiding areas during northern migration; and, operational measures are designed to embrace good work practices such as alerting drivers to the presence of caribou in the area of a road or the proper procedure for waste disposal.

Tables 10.5-1, 10.5-2, and 10.5-3, adapted from GNWT Department of Transportation (2009), present the typical types of mitigation measures that have been or can be integrated into the project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on wildlife including mammals and birds.

TABLE 10.5-1 SUMMARY OF WILDLIFE-RELATED PROJECT DESIGN MITIGATION MEASURES

Potential Effect	Design Mitigation
Habitat Disturbance / Deterioration	• Project footprint has been minimized and previously disturbed areas will be used, wherever possible. • Access to the Project site will be shared, wherever possible. • Waste will be trucked out, rather than using a sump.
Sensory and other Disturbances	• Wherever possible, technologies to minimize sound disturbance have been incorporated into Project design. • Blasting activities, if required, will be limited to borrow sites and will only be undertaken during the winter period.
Wildlife Incidents	• Provide field workers with education and awareness of the Wildlife Management Plan guidelines and programs. • The Field Supervisor and Safety Advisor will educate all field workers on the applicable practices contained within the Wildlife Management Plan. • The Field Supervisor and Safety Advisor will provide all field workers with Bear Aware training and general wildlife awareness. • Implement wildlife-human interaction procedures, which will include Bear Aware training and safe working distances from wildlife. • Workers must avoid all interactions with wildlife unless crew safety is at risk. • Field workers will not feed, harass or approach wildlife. • Birds, nests and eggs must be left intact. If an active nest is directly near or in the path of the borrow source site a no-work zone will be established and crews will work in another area within the approved borrow site until birds have vacated the nests. • All human/wildlife conflicts and incidents will be reported to the Field Supervisor and Safety Advisor and documented. • Access to the surface facilities will be limited. • All significant wildlife features, such as nests and dens will be documented and reported. • Implementation of No Firearms and No Hunting/Fishing policy for field workers. • Firearms will not be allowed on-site except for firearms in the possession and control of the authorized wildlife monitors. • No hunting or fishing by Project-related employees will be permitted. • All food and stored garbage should be kept in bear-proof areas or bear proof containers. • Any grease, oils, fuels stored on-site must be stored in bear-proof areas or containers. • Operators will implement the Observe, Record and Report Policy, encouraging workers to report any suspicious activities related to wildlife. The Field Supervisor and Safety Advisor will be responsible for obtaining and reporting this information to the appropriate responsible agency • Wildlife sightings will be recorded (including GPS location data if possible) to be submitted to the GNWT Department of Transportation Planning, Policy and Environmental Division and GNWT Department of Environment and Natural Resources Inuvik office upon completion of the project.

TABLE 10.5-1 SUMMARY OF WILDLIFE-RELATED PROJECT DESIGN MITIGATION MEASURES

Potential Effect	Design Mitigation
Wildlife Attraction to Site and Waste Management	• Waste Management that minimizes and disposes of attractants to wildlife such as garbage, food wastes and other edible and aromatic substances will include the following measures: - Minimize and dispose of attractants to wildlife such as garbage, food wastes and other edible and aromatic substances. - Store all food and garbage in either: airtight sealed container, bear proof containers or in an enclosed bear proof area. - Store on-site grease, oils, fuels in bear-proof areas or containers. - No waste will be incinerated on- or off-site. Waste will be transported and disposed of at the Tuktoyaktuk and/or Inuvik municipal solid waste facilities in accordance with the municipalities' terms and conditions for usage of the facilities. The following will be identified: • List of hazardous, non-hazardous waste and any wastes of special concern, if any. • Waste types and volumes expected to be produced • List of storage and transport methods and disposal locations for these wastes. • List of odorous wastes that may attract wildlife, and the identification of its storage and method of transport to prevent wildlife attraction. • Indicate whether odorous waste is stored for the purpose of on- or off-site disposal (i.e. road or air transport).
Wildlife Mortality	• Immediately consult with appropriate territorial (ENR) and federal (CWS) wildlife authorities. Any key species mortality will be reported to ENR and CWS. • Situation and site will be assessed, including potential for further wildlife mortality. Consider increased wildlife deterrent mechanisms and security, including fencing and lights to ensure wildlife and personnel safety. • Multiple mortalities of other species should be reported to CWS (e.g. multiple birds striking infrastructure over several months, or single incident of a large flock of migratory birds striking infrastructure).
Spills of Hydrocarbons or Toxic Substances Resulting in Injury to Wildlife and/or Wildlife Habitat	• Territorial (ENR) and federal (CWS) authorities will be contacted immediately to determine appropriate course of action, which may include capturing, relocating or treating contaminated wildlife. • Spill response and containment will be completed expeditiously in accordance with the site-specific spill contingency plan and the contractor's HSE manual and procedures. • The spill area will be monitored closely by the environmental monitor and appropriate deterrents (e.g., warning noises, flagging) employed to discourage wildlife from entering the affected area and ingesting toxic substances or becoming covered in spill material.

Source: GNWT DOT 2009

TABLE 10.5-2 SUMMARY OF MITIGATION MEASURES FOR TERRESTRIAL MAMMALS			
Project Activity	Potential Effect	Mitigation Measures	Frequency
All Activities	Disturbance to wildlife: Disturbance or injury to wildlife and their habitat.	• Project personnel will be provided with wildlife awareness training.	Ongoing throughout the life of the Project.
All Activities	Disturbance of denning mammals: Denning bears or wolverines could be disturbed and could abandon den sites near Project activities during the winter. Presence of key wildlife feature (e.g., nest, den).	• If active bear or wolverine dens are discovered within 500 m of Project sites, ENR will be contacted immediately to determine the appropriate course of action. Activities may be temporarily suspended pending consultation with ENR. • ILA wildlife monitors will be on-site during construction to monitor wildlife and manage risks. • Personnel are to maintain a minimum distance of 300 m between sighted and/or known bear den sites for the duration of the Project. • If a den is identified, the animal may be hazed away (permit required) to discourage it from continuing to construct a den there. This action will be taken in consultation with ENR and will involve the wildlife monitor. • If a key wildlife feature of a Species at Risk is discovered, ENR will be contacted. Activities may be temporarily suspended pending consultation with these agencies.	Continuous throughout the life of the Project.
All Activities	Disturbance of denning and other mammals by workers walking off-site may disturb denning bears during the winter months or other mammals (e.g., fox, wolverine) year-round.	• Workers will not walk off-site onto land at any time of year, unless there is a specific requirement (i.e., waste recovery), and these activities will be scheduled to avoid sensitive wildlife periods. • All workers will receive, at minimum, a basic wildlife orientation, and will be instructed not to disturb any wildlife. • Personnel are to maintain a minimum distance of 300 m between sighted and/or known bear den sites for the duration of the Project.	Ongoing throughout the life of the Project while personnel are onsite.
All Activities	Wildlife incident or mortality: wildlife (e.g., grizzly bear, polar	• ENR will be contacted if an active grizzly bear or wolverine den is identified within 500 m of Project activities to determine appropriate course of action. Any polar bear	Ongoing throughout the life of the Project while personnel

TABLE 10.5-2 SUMMARY OF MITIGATION MEASURES FOR TERRESTRIAL MAMMALS			
Project Activity	**Potential Effect**	**Mitigation Measures**	**Frequency**
	bear) may approach sites while workers are present potentially resulting in a wildlife incident or mortality.	observed within 1 km of Project sites will be reported to ENR and CWS. • The wildlife monitor and designated, trained staff will have access to bear deterrent materials including bear spray, cracker shells, and a 12 gauge shotgun with plastic slugs. All work crews will have at least one can of bear spray during periods when bears may be present. The use of any deterrent method will be reported to ENR.	are onsite.
All Activities	Wildlife incident or mortality: Wildlife (e.g., grizzly bear, polar bear) may approach sites while workers are present potentially resulting in wildlife incident or mortality.	• Suitable hazing/herding techniques (permits required) will be used to move wildlife from Project facilities, as per consultation with ENR and CWS. The wildlife monitors will advise personnel regarding the appropriate course of action. • Snow will be removed around buildings and work areas to increase visibility. • Adequate lighting will be installed in areas where it is essential to detect bears that may be in the vicinity. • Camps and associated infrastructure will be designed to incorporate proper bear safety, including avoiding blind corners, installing adequate lighting, incorporating proper waste management, cleaning and maintaining the kitchen and dining area, fencing, and wildlife detection.	Ongoing throughout the life of the Project while personnel are onsite.
Waste Storage	Wildlife incident or mortality: poorly secured waste can blow off site and pose risk of mortality to wildlife	• All waste products will be properly secured, stored and transported. This includes the use of bear-proof storage containers that reduce odours at all times. • Waste removal crews will be sent out to areas surrounding each construction site before the arrival of breeding birds in the spring to collect and properly dispose of any waste material that have blown off site. • Fencing will be considered around areas that might attract wildlife (i.e., waste and food storage facilities). • The main wastes produced during the construction of the Highway will be typical domestic garbage and sewage.	Ongoing throughout the life of the Project.

TABLE 10.5-2 SUMMARY OF MITIGATION MEASURES FOR TERRESTRIAL MAMMALS			
Project Activity	Potential Effect	Mitigation Measures	Frequency
Vehicle/ Equipment Use	Wildlife incident or mortality: spills or leaks may harm wildlife.	• Best management practices, mitigation measures, emergency response and spill contingency plans will be implemented where necessary to prevent and address leaks and spills (details will be outlined in the contractor's emergency response and spill contingency plans). • All vehicles will be equipped with spill kits. • Drip trays will be placed under all vehicles and equipment when such vehicles and equipment are parked. • All fuel tanks and sloops used on the project will be double-walled with 100% containment. • All fuelling locations will be an appropriate distances from waterbodies with strategically placed berms. • Equipment used in or near water will be clean and free of oil, grease or other deleterious substances. • In the event of a spill, all efforts will be made to properly contain and manage the spill, including wildlife removal and treatment if necessary. • As per the contractor's emergency response and spill contingency plan, the spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage wildlife from entering the affected area and ingesting toxic substances or becoming covered with spill material.	Ongoing throughout the life of the Project while personnel are onsite.
All Activities	Disturbance to barren-ground caribou	• No person shall hunt barren-ground Caribou in the Aklavik/ Inuvik/ Tuktoyaktuk Barren-Ground Management Area I/BC/07 • Maintain a minimum distance of 500 m between field operations and barren-ground caribou for the duration of the project.	Ongoing throughout the life of the Project while personnel are onsite.

Source: GNWT DOT 2009.

TABLE 10.5-3 SUMMARY OF MITIGATION MEASURES FOR BIRDS			
Project Activity	Potential Effect	Mitigation Measures	Frequency
Off-site Activities	Wildlife incident or mortality: Workers walking off-site may disturb nesting songbirds, shorebirds and waterfowl during the breeding season and cause nest abandonment and chick/egg mortality.	• Workers will not walk off-site onto land at any time of year, unless there is a specific need (e.g., waste clean-up, emergency). • Planned activities will be scheduled to occur outside of peak breeding times. • All workers will be instructed not to disturb any birds or nests observed. • Where practical, workers will avoid conducting project activities within 500 m of an active raptor nest during nesting season. • If active nesting sites are discovered within 500 m of Project sites, ENR and CWS authorities will be contacted immediately to determine the appropriate course of action. Activities may be temporarily suspended pending consultation with ENR. • ILA wildlife monitors will be on-site during construction to monitor wildlife and manage risks. • If a key wildlife and nesting feature of a Species at Risk is discovered, both ENR and CWS will be contacted. Activities may be temporarily suspended pending consultation with these agencies.	Ongoing throughout the life of the Project while personnel are onsite.
Waste Storage	Wildlife incident or mortality: poorly secured waste can blow off site and pose risk of mortality to nearby nesting or foraging songbirds, shorebirds and waterfowl through the ingestion of wastes or entanglement in waste materials; poorly secured waste can attract predators, which may increase predation pressure on nearby nesting songbirds, shorebirds and waterfowl.	• All waste products will be properly secured, stored and transported. This includes the use of bear-proof storage containers that reduce odours at all times. • Waste removal crews will be sent to areas surrounding each construction site before the arrival of breeding birds in the spring to collect and properly dispose of any waste material that has blown off site. • The main wastes produced during the construction of the Highway will be typical domestic garbage and sewage.	Ongoing throughout the life of the Project.
Vehicle/ Equipmen t Use	Wildlife incident or mortality: Spills or leaks may harm wildlife.	• Best management practices, mitigation measures, emergency response and spill contingency plans	Ongoing throughout the life of the Project.

TABLE 10.5-3 SUMMARY OF MITIGATION MEASURES FOR BIRDS			
Project Activity	Potential Effect	Mitigation Measures	Frequency
		will be implemented where necessary to prevent and address leaks and spills (details will be outlined in the contractor's emergency response and spill contingency plans). • All fuelling locations will be appropriate distances from waterbodies with strategically placed berms	
Vehicle/ Equipmen t Use	Wildlife incident or mortality: Spills or leaks may harm wildlife.	• Equipment used in or near water will be clean and free of oil, grease or other deleterious substances. • In the event of a spill, all efforts will be made to properly contain and manage the spill, including wildlife removal and treatment if necessary. The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage wildlife from entering the affected area and ingesting toxic substances or becoming covered with spill material.	Ongoing throughout the life of the Project.

10.5.3 Mitigation Measures for Species at Risk

Table 10.5-4 outlines mitigation measures for Species at Risk. Species that may occur within the project corridor that are protected by Species at Risk Act (SARA) include the Woodland caribou (Boreal Population) (listed as Threatened April 2007) and the Eskimo curlew (listed as Endangered November 2009) (Government of Canada 2009). The Rusty Blackbird is listed by SARA as Special Concern (Schedule 1) (Government of Canada 2009). Species listed as Special Concern under Schedule 1 do not benefit from full legal protection under the Act. However a management plan for the conservation of the species of Special Concern and its habitat must be prepared within three years. The Short-eared Owl and Peregrine Falcon (*Falco peregrinus tundrius*) are listed by SARA as Special Concern (Schedule 3) and are not afforded protection under SARA (Government of Canada 2009). The wolverine and grizzly bear have been assessed by the COSEWIC as Special Concern (COSEWIC 2009) and are not afforded protection under SARA.

Project activities have the potential to adversely affect these species through direct habitat loss, sensory disturbance and accidental mortality. The contractors will be required to employ an adaptive management approach to ensuring sensitive species/ species at risk are adequately protected during all phases of road construction and borrow source work.

The mitigation measures outlined in Tables 10.5-1 to 10.5-4 will be implemented to mitigate potential impacts on all wildlife, including Species at Risk.

TABLE 10.5-4 SUMMARY OF MITIGATION MEASURES FOR SPECIES AT RISK

Activity/Potential Effect	Mitigation Measure
Eskimo Curlew - SARA Schedule 1 – Endangered; ENR - At Risk under their general status program Rusty Blackbird – SARA Schedule 1 - Special Concern; ENR – May Be At Risk under their general status program	
Birds may be at risk of mortality from leaks and spills. Nests may be abandoned due to disturbance from Project activities.	• The prevention and response measures to manage spills and leaks will be outlined in the contractor's emergency response and spill contingency plans. • In the event of a spill, all efforts will be made to properly contain and manage the spill, including wildlife removal and treatment if necessary, as per the contractor's emergency response and spill contingency plans. The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage wildlife from entering the affected area and ingesting toxic substances or being covered with spill material. • Appropriate federal (CWS) and territorial (ENR) authorities will be contacted immediately before continuing work if a nest is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).
Short-eared Owl - SARA Schedule 3 - Special Concern; ENR – Sensitive under their general status program	
Nest sites may be abandoned due to disturbance from Project activities.	• Activities that cannot be conducted between October and April will be scheduled to occur outside the sensitive nesting period in June. Project activities scheduled for June are of intermittent continuation of grading and compaction. This precludes emergency activities. • Appropriate federal (CWS) and territorial (ENR) authorities will be contacted immediately before continuing work if a nest of a key wildlife species is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).
Birds may be at risk of mortality from leaks and spills.	• The prevention and response measures to manage spills and leaks will be outlined in the contractor's emergency response and spill contingency plans. • In the event of a spill, all efforts will be made to properly contain and manage the spill, including wildlife removal and treatment if necessary, as per the Emergency Preparedness and Response Plan. The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage wildlife from entering the affected area and ingesting toxic substances or being covered with spill material.
Birds may be at risk of mortality	• The prevention and response measures to manage spills and leaks will be outlined in the contractor's emergency response and spill contingency plans.

TABLE 10.5-4 SUMMARY OF MITIGATION MEASURES FOR SPECIES AT RISK	
Activity/Potential Effect	**Mitigation Measure**
Peregrine falcon (*F. p. tundrius*) – SARA Schedule 3 - Special Concern; ENR – Not Assessed under their general status program	
Birds can collide with communication towers and other facilities, especially during the migration period.	• Guy wires will not be used.
Lighting of communication towers and other facilities can attract birds at night, especially during the migration period, resulting in injury or mortality.	• Lights will be positioned to shine down or fixed with shielding to direct light downward on buildings and other infrastructure sites, wherever possible. Lighting will be switched off, whenever possible (i.e., when camps and facilities are unmanned); this may include the use of remote control of lighting, motion detectors, etc.
Wolverine - COSEWIC - Special Concern; ENR – Sensitive under their general status program	
Wolverines and/or wolverine denning sites may be disturbed by Project activities.	• All staff will receive, at minimum, an orientation to this Wildlife Management Plan and the Bear Response Guidelines. Wildlife monitors will be onsite at all times during construction activities to report and advise as needed. • If, for any reason, spring disturbance is unavoidable, pre-disturbance surveys will be conducted in cooperation with ENR, as required. If a den is found, it will be reported immediately to ENR and a 500 m set-back will be in place around an active den during activities. If a wolverine, not denning, is identified within 500 m, ENR will be contacted to determine an appropriate course of action.
Grizzly Bear – COSEWIC - Special Concern; ENR – Sensitive under their general status program	
Grizzly bear and/or grizzly bear denning sites may be disturbed by Project activities.	• ENR will be contacted prior to construction start-up to determine locations of any known denning sites near the Project area. Ongoing consultation with HTCs and IGC will occur to ensure awareness of Project activities and obtain any local knowledge. • If possible, no activities will take place within 500 m of an active den during the denning period, between October and April. If active dens or if a grizzly bear are observed within 500 m of the site during activities, territorial (ENR) and federal (CWS) agencies will be contacted immediately and an appropriate course of action will be determined. • All staff will receive at minimum a wildlife orientation and basic wildlife training. Wildlife monitors will be onsite for the duration of the seasonal construction program.

10.6 FISH AND FISH HABITAT

10.6.1 Construction Effects and Mitigation

The assessment of the potential effects of road construction on aquatic resources, including fish and fish habitat, and the development of effective avoidance or mitigation measures, are major components of the environmental assessment of the proposed Inuvik to Tuktoyaktuk highway. From the perspective of fish and fish habitat protection and management, three categories of streams are recognized along the highway route:

- Non-fish bearing: streams that are not utilized by fish for any part of their life cycles;
- Migratory channels: ephemeral and perennial (except in winter) streams that are utilized by fish only for migration during open water periods or that contribute to downstream habitat quality; and,
- Spawning/rearing/feeding streams: ephemeral and perennial streams that are utilized by one or more life cycle stages of fish during open water periods, in addition to migration.

Table 10.6-1 identifies the principal fish habitat issues which must be considered as part of the regulatory approval process. The appropriate crossing structures and avoidance or mitigation measures designed to achieve no net loss (NNL) of productive capacity of fish habitat will be guided in part by the designated category of stream for each site. Table 10.6.1 provides generalized avoidance or mitigation measures to minimize adverse effects. However, more complete site specific measures will be developed based on individual conditions and requirements, and appropriate DFO timing windows (DFO 2009a) will be consulted to avoid instream work in fish bearing streams during critical time periods.

TABLE 10.6-1: EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON FISH AND FISH HABITAT

Activity	Potential Effect	Avoidance or Mitigation
Bridge construction	• Direct loss of riparian habitat due to abutments	• Minimize riparian disturbance
	• Direct loss of instream habitat due to piles/piers	• Construct clear span bridges • Minimize instream work • Implement erosion and sediment control measures
	• Flow changes due to stream constriction	• Abutments to be placed at a sufficient distance from active stream channel
Culvert installation	• Direct loss of habitat	• Avoid critical habitats
	• Migration barrier	• Employ best management practices for culvert installation • Annual monitoring to detect culvert

TABLE 10.6-1: EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON FISH AND FISH HABITAT

Activity	Potential Effect	Avoidance or Mitigation
		subsidence or lifting
	• Sediment release during construction	• Employ sediment and erosion control measures
	• Changes in stream flow patterns	• Appropriate sizing of culverts based on hydrological assessments.
Use of heavy equipment	• Soil erosion and sedimentation	• Employ erosion and sediment control measures
	• Fuel, lubricant spills	• Regular maintenance of equipment away from water bodies • On-site spill containment equipment
Highway design	• Direct loss of habitat	• Avoid critical habitats • Design appropriate crossing structures based on site conditions
	• Erosion and sedimentation	• Maintain sufficient distance from lakes, if possible • Install sediment control in ditches and cross drainage channels
Quarry development	• Erosion and sedimentation	• Maintain sufficient distance of undisturbed land between quarry and any waterbody • Apply erosion and sediment control measures and best management practices
Water extraction	• Oxygen level depression • Exposure of eggs and larvae • Reduction of available habitat for spring spawners	• Follow DFO Protocol for Winter Water Withdrawal
Public access	• Increased exploitation due to improved access to remote fishing areas	• Public education

10.6.1.1 Stream Crossings

Among other factors, consideration will be given to the category of stream in determining the type of crossing structure at each location that would be best suited to avoid the harmful alteration, disruption, or destruction (HADD) of fish habitat, as prohibited by Section 35. (1) of the *Fisheries Act*. Table 10.6-2 provides general guidance in this regard, although site specific conditions may dictate alternative measures:

TABLE 10.6-2: GENERALIZED STREAM CROSSING STRUCTURE AND MITIGATION RECOMMENDATIONS	
Stream Category	Stream Crossing Guide
Non-fish bearing	*Culvert*. Apply sediment and erosion control best management practices during construction.
Migratory channels	*Culvert*[7]. Sizing and placement of culvert is critical to avoid excessive velocities. Culvert should be set into the substrate to prevent erosion at downstream invert. Where possible, culvert should be installed in areas having a hard (gravel/cobble) bottom. Where culvert twinning is required, only one culvert should be set to permit fish passage at low flows. Apply sediment and erosion control best management practices during construction. Follow the DFO Operational Statement for Temporary Stream Crossings (DFO 2009b) where these are necessary.
Spawning/rearing/ feeding streams	*Clear span bridge*. Follow DFO Operational Statement for Clear Span Bridges (DFO 2009c). Apply sediment and erosion control best management practices during construction.

Table 10.6-3 provides a summary of the stream crossing structures recommended at each crossing location, based solely on fish and fish habitat considerations. As indicated in the table, there are a number of crossing locations requiring further field investigation to remove uncertainty regarding the quality of available fish habitat and the type of structure that should be constructed. Ground surveys will provide information on fish and habitat presence or potential, and hence, the appropriate construction and environmental management measures that should be adopted at each site. The locations where clear span bridges are recommended due to known fish presence and/or habitat quality are identified in the route map shown in Figure 10.6-1.

The preliminary reconnaissance findings indicate that the majority of channels crossed by the proposed Highway are small, ephemeral streams that generally drain terrestrial upland areas or small, shallow lakes or ponds, most of which do not provide suitable fish habitat features. Appropriately sized culverts (800-900 mm diameter) installed at these locations will require the implementation of appropriate erosion and sediment control measures to protect downstream habitats, but would not directly impact fish or fish habitat.

[7] Open bottom culverts are normally preferred where culverts must be installed in fish bearing streams in lieu of clear span bridges. It is understood that open bottom culverts are not suitable for use along the proposed Highway corridor for geotechnical reasons.

TABLE 10.6-3: PRELIMINARY STREAM CROSSING STRUCTURE RECOMMENDATIONS[1] BASED ON STREAM AND FISH HABITAT CHARACTERISTICS OR POTENTIAL				
Crossing No./ Kilometre Post	Culvert (no fish habitat)	Culvert (moderate or seasonal fish habitat)	Bridge(good or known fish habitat)	Comments
01	✓			Ephemeral, no headwater lakes
02	✓			Ephemeral, very small drainage
03			?	Good habitat. Stream crossing structure to be determined.
04			?	Good habitat. Similar to crossing #04.
05	✓			Ephemeral, very small headwater lakes
06	✓			Ephemeral, short runoff channel
07	✓			Ephemeral, short runoff channel
08		?		Requires field check
09	?			Appears from preliminary aerial reconnaissance to be ephemeral. Requires field check.
10	✓			Ephemeral, no headwater lakes
11	✓			Ephemeral, no headwater lakes
12		?		Small, flowing channel. Requires field check.
13	✓			No visible stream channel.
13a (KM 17)			✓	Short, wide migration channel between lakes. Likely migration corridor.
14	✓			Ephemeral, very short drainage channel draining small headwater lake.
15	✓			Ephemeral. Drains small upstream headwater lake.
16	✓			Ephemeral. Drains small upstream headwater lake.
17	✓			Ephemeral. Very small drainage.
18 (KM 26)			√	Good habitat. Tributary to Jimmy Lake.
19	✓			Ephemeral drainage channel.
20	✓			Ephemeral drainage channel.
21a			?	Good habitat with perennial flow.
21a	✓			Ephemeral. Drains small lakes in upper portion of watershed.
22a		?		Requires field check
23a (KM 40)			✓	Good perennial habitat. Trail Valley

TABLE 10.6-3: PRELIMINARY STREAM CROSSING STRUCTURE RECOMMENDATIONS[1] BASED ON STREAM AND FISH HABITAT CHARACTERISTICS OR POTENTIAL

Crossing No./ Kilometre Post	Culvert (no fish habitat)	Culvert (moderate or seasonal fish habitat)	Bridge(good or known fish habitat)	Comments
				Creek
24a	✓			Ephemeral. Very small drainage.
25	✓			Ephemeral. Very small drainage. No lakes upstream.
26	✓			Ephemeral. Very small drainage.
27a	✓			Ephemeral. Very small drainage. Only one small pond upstream.
27b	✓			Short drainage channel.
28a		✓		Short connection channel between lakes. Migration corridor.
29	✓			Short runoff channel in headwaters.
29a (KM 55.5)			✓	Drains small headwater lake. Tributary to Hans Creek.
30a (KM 56.5)			✓	Hans Creek. Known fish habitat.
31 (KM 67.5)			✓	Zed Creek. Known fish habitat.
32	✓			Ephemeral. Headwater tributary to Zed Creek.
33		✓		Small perennial stream. Known fish habitat (fish observed).
34a	✓			Ephemeral drainage channels from small headwater lakes.
34b	✓			Not shown in map book. NW of km 89 on alternate route. Appears to be ephemeral on Google Earth.
34e	✓			Ephemeral, short channel draining very small upstream lakes.
35a (KM 89.5)			✓	Good habitat, perennial flow.
38a		✓		Perennial stream. Moderate to poor habitat conditions.
39 (KM 109)			✓	Good habitat. Perennial stream, large drainage.
39a			?	Short, wide channel between 2 lakes. Requires field check.

[1] '?' Indicates uncertainty related to the quality of fish habitat and the type of crossing structure required. Further field investigation is required.

10.6.1.2 Sediment Control

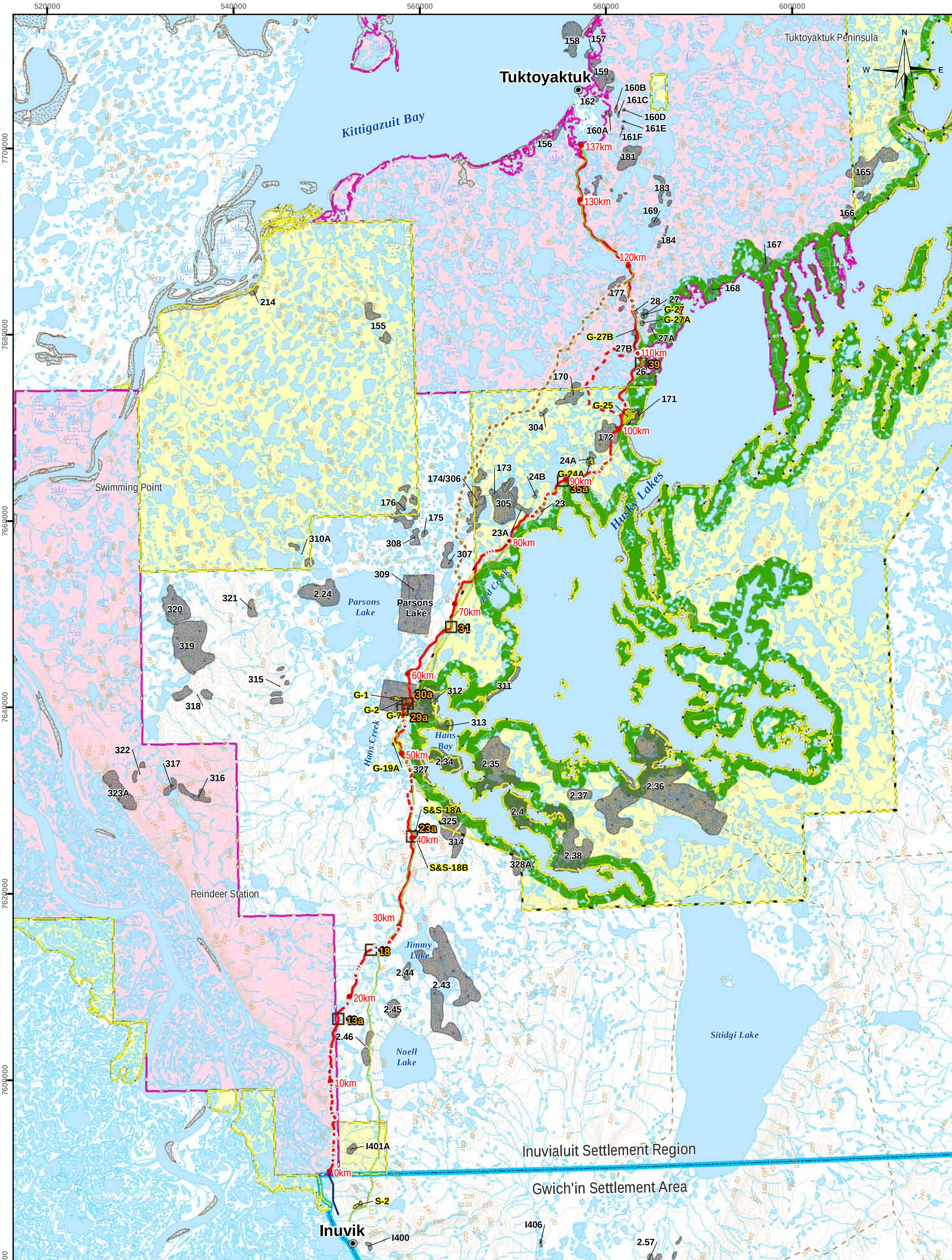
By their nature, road construction activities have the potential to cause erosion and the consequent sedimentation of receiving streams and lakes. Sediment released to streams and lakes, both in suspended and settled forms, presents a serious risk to fish and fish habitat. The effects of sediment on fish and their habitat includes, but is not limited to: degradation of potential spawning areas; smothering of eggs and the benthic invertebrate food supply; reduction in feeding efficiency; avoidance of potentially suitable habitats; and, abrasion of fish tissues (Birtwell 1999; Lloyd et al. 1987). For example, Arctic grayling have been found to be displaced downstream of their preferred habitats at suspended sediment levels greater than 100 mg/L (McLeay et al. 1987); Scannell (1988) determined that only 10% of Arctic grayling food supply would be available at suspended sediment concentrations of about 63 mg/L; and, Birtwell (1999) reports dramatic decreases in salmonid egg survival with increasing levels of fine sediments in the gravel.

Sediment releases from road and aggregate borrow source development originate from exposure of soils during site preparation and grubbing, the erosion of particulates that make up the highway surface and slopes, and the erosion of soils in unstable ditches, which is then carried in runoff. In recognition of the potential adverse effects of sediment, it is recommended that an environmental management plan (EMP) be prepared prior to construction and approved by regulators, to provide specific and detailed guidance to avoid sediment releases to the aquatic environment. The EMP should refer to appropriate erosion and sediment control guidelines, best management practices, and measures outlined in the DFO (1993) Land Development Guidelines for the Protection of Aquatic Habitat.

Some of the important measures to be followed include:

- limiting the use of construction equipment to the immediate footprint of the highway or quarry;
- minimizing vegetation removal and conducting progressive reclamation at the quarry sites;
- keeping ice bridge and ice road surfaces free from soils and fine gravel that may be tracked out of the quarry by vehicles;
- avoiding the use of heavy equipment in streams or on stream banks and the adherence to the DFO Operations Statement for Temporary Stream Crossings, where these are deemed necessary;
- installation of silt fencing and/or check dams, and cross drainage culverts as necessary to minimize siltation in runoff near water bodies; and,
- appropriate sizing and installation of culverts to avoid backwatering and washouts.

Q:\Vancouver\GIS\ENVIRONMENTAL\V232\V23201098_TUK-Road-PDR\Maps\PDR\V23201098_PDR-Map006-Fish-StreamX.mxd modified 1/14/2010 by kwarrendorf



LEGEND

- Stream Crossing
- 18 Stream Crossing - Potential Bridge
- 2009 Route
- Other Alignments Considered
- Upland Route
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Highway Borrow Sources
- Borrow Sources
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand
- Husky Lakes 1000m Setback

NOTES

Base data source: NTS 1:250,000

Borrow Sources, ILA Lands, Husky Lakes 1000m - Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Stream Crossing Field Assessment Sites September 2009

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000

5 2.5 0 5 10

Kilometres

FILE NO. V23201098_PDR-Map006-Fish-StreamX.mxd

PROJECT NO.	DWN	CKD	REV
V23201098	KWM	DM	1

OFFICE	DATE
EBA-VANC	January 14, 2009

Town of Inuvik

Northwest Territories

KIGGIAK - EBA

Figure 10.6-1

10.6.1.3 Water Extraction

Considerable amounts of water will be required for highway construction and associated aggregate borrow activities. It is proposed that water for these purposes will be extracted from lakes in proximity to the highway corridor. Since construction will take place in winter, water will necessarily be pumped from water beneath ice cover. It is anticipated that water requirements will exceed 300 m^3/day, which will trigger the need for a NWTWB Type A Water Licence.

The extraction of water from ice covered lakes can potentially contribute to lethal and sub-lethal effects on fish due to depression of dissolved oxygen concentrations, exposure or freezing of littoral spawning beds due to falling water levels, and loss of important habitats for spring spawning fish (e.g. northern pike) if water levels do not sufficiently rebound to flood critical spawning habitats (Cott et al. 2008a; Cott et al. 2008b). As a result, DFO, in conjunction with other regulators and industry, has developed the *Protocol for Winter Water Withdrawal in the Northwest Territories* (DFO 2005), for projects where a water withdrawal of greater than 100 m^3 is required from any individual waterbody that has the potential to provide fish habitat. Based on recent research in NWT lakes, this protocol sets limits to water withdrawal as a percentage of available under ice water volume, with consideration given to latitude and maximum lake water depth (Cott et al. 2008b). Those water withdrawal thresholds for the region encompassing the Inuvik to Tuktoyaktuk Highway are:

- 0% for lakes with less than 1.5 m of free water below the maximum ice thickness (i.e. 2 m);
- 10% of available under ice water volume for lakes with a minimum depth of ≥ 3.5 m;
- 100% if the maximum depth of the water body is less than the predicted maximum ice thickness (implying no available overwintering fish habitat).

In addition, the protocol directs that water be withdrawn from areas of a lake that are greater than 2m below the ice surface to avoid removing the more highly oxygenated water that tends to collect at the water-ice interface. Water intake screening with mesh of 2.5 mm should be used to avoid entrainment of fish (DFO 1995).

To conform to the thresholds set out in the DFO Protocol, it may be necessary to carry out bathymetric surveys on some of the lakes proposed for water extraction. Minimum requirements for the collection and submission of bathymetric survey information are provided in the Protocol, and are further detailed in Cott et al. (2005).

10.6.2 Monitoring

Compliance monitoring during construction is normally required to ensure that prescribed mitigation measures and best management practices are implemented, and to detect and correct unanticipated problems. Monitoring of the highway construction will be carried out by trained ILA environmental and wildlife monitors. During Highway construction, wildlife and environmental monitors will be onsite. The wildlife monitors will be individuals authorized by the local HTCs and employed by the Contractor. Environmental monitors will be employed by and under the direction of the ILA. As previously stated, monitors will be on-site at all times during any time that construction activities are being undertaken.

10.7 CONSEQUENCES OF ACCIDENTS OR MALFUNCTIONS

Accidents or malfunctions can be associated with any human activities, including those associated with the short-term construction periods projected for the 138 km Inuvik to Tuktoyaktuk Highway. Environmental consequences of potential accidents or malfunctions associated with the highway and associated aggregate borrow and construction camp activities would be primarily limited to those related to:

- Vehicle accidents; and
- Fuel storage, transportation and handling system failures.

To minimize risks of accidents or malfunctions occurring and to minimize possible risks to the environment from such potential accidents or malfunctions, a number of preventative and mitigation measures will be employed. The overriding preventative and mitigation measures to be employed include:

- Implementation of best management and industry practices as appropriate to prevent or minimize the occurrence of accidents or malfunctions;
- Ensuring that all contractors onsite have industry-compliant and satisfactory Health, Safety and Environmental (HSE) policies, programs and manuals and that they are successfully implemented throughout the project:
- Compliance with ILA and INAC Land Use Permit and Borrow Permit requirements and conditions issued for the construction project;
- Conformance with existing applicable GNWT and Workers Compensation Board standards;
- Fuel and other hydrocarbons will be stored in accordance to storage tank regulations under the Canadian Environmental Protection Act and the CCME's environmental code of practice for storage of these products (CCME 2003);
- All vehicles and equipment will be refueled at least 30 m from water bodies following DIAND fuel storage guidelines;
- Any uncontrolled discharge will be immediately managed to stop discharge and begin the mitigation process. Spills will be reported to the 24-hour Spill Report Line (867-920-8130) according to current guidelines; and
- Spill containment and cleanup activities will be implemented in accordance with the site-specific spill contingency plans that will be developed by the prime construction contractors selected for the Inuvik to Tuktoyaktuk Highway Project (e.g. Appendix C).

The key strategy will be to prevent accidents from occurring through education and enforcement. With the application and implementation of the preventative and mitigation measures as outlined, no significant fuel, chemical or other product spills are expected to occur.

The vast majority of the proposed activities will be conducted on the proposed Highway itself and negligible or minor environmental effects are anticipated. The Construction Team will work closely with the ILA environmental and wildlife monitors present when the proposed Highway is being constructed.

10.7.1 Fuel Storage

Fuel needed for the aggregate borrow and highway construction activities will be stored in double-walled fuel storage units. All fuel will be stored in accordance with CCME (2003) as previously indicated.

10.7.2 Refuelling Operations

All vehicles and equipment will be refueled at least 30 m from water bodies following DIAND fuel storage guidelines.

10.7.3 Waste Management

The main wastes produced during the construction of the Inuvik to Tuktoyaktuk Highway will be typical domestic garbage and sewage. The intent is to haul all garbage and other solid wastes to either Inuvik or Tuktoyaktuk for disposal in approved facilities. The camps will use Pacto toilets, which collect sanitary waste in plastic bags, or other accepted sewage management practices. The bags will be subject to hygienic handling procedures and will be incinerated at off-site incinerator units located in Inuvik or Tuktoyaktuk.

10.8 EFFECTS OF ENVIRONMENT ON PROJECT – CLIMATE CHANGE

Climate Change is occurring and the effects are already observed in some regions. As previously discussed in more detail in Section 9.1.5, projections show that increase of ground and air temperatures due to climate change is expected to be most significant in Canada's northern territories.

The stability of permafrost and the stability of infrastructure built on it depend on maintaining ground temperatures to minimize the thickness of the active layer, and to impede thaw. The proposed Highway is located within the permafrost region and stability of highway structure will be dependent on maintaining the perennially frozen ground.

The frozen ground has variable proportions of ground ice. When thaw occurs, the excess water is expelled and consolidation produces substantial settlements. The thermal stability of the frozen ground is sensitive to minor changes in heat transfer at the ground surface. These minor changes in heat transfer alter the surface heat balance, initiating thaw and increased active layer thickness. Such heat transfer and potential settlement due to thaw is possible in permafrost regions even without climate warming. Subtle increases in temperature and extreme weather events that result in extreme precipitation and rapid snow melt can contribute to the thaw and accelerate it.

A risk-based approach for incorporating climate change into design of highway infrastructure on permafrost is now recommended practice. The challenge for design and construction over thaw-sensitive permafrost terrain is to assess the capital cost of constructing the Highway and the long term maintenance implications. The design parameters and construction techniques take into account consideration of these risks and provide mitigative approaches in the Highway design. The two most significant elements of the design are the use of non-woven geotextile between the existing ground and the embankment, and maintaining minimum height, based on terrain type, to mitigate heat gain that can result in thawing of the permafrost.

Other risk factors that are related to climate uncertainty are precipitation, including both summer rain and winter snow. Building conservatism into a design to account for climatic warming is more complex than simply projecting air temperature trends into the future. The greatest risk is often associated with extreme events that are now being observed in the northern Canada. Unprecedented warm winters are often followed by rapid and early thaw. High snow cover years are resulting in extreme snow drifting that blankets the downwind sideslopes, insulating the surface and raising the ground temperature under the fringes of the embankment. Standing water against the sideslopes retards winter freezeback of the active layer and can accelerate thaw below the sideslopes.

Key mitigative measures that have been incorporated into the design parameters to manage uncertainty related to future climate trends and extremes in the permafrost region that this Highway will be constructed in include:

- thick embankments that insulate and stabilize the active layer and the use of non-woven geotextiles for reinforcement;
- where available, use of porous embankment materials such as coarser gravels to reduce the risk of ponding along the toe of the embankment;
- where such material is not available, the use of culverts to balance surface flow has been included; and
- adoption of construction methods that eliminate cuts and minimize disturbance of the natural vegetation before fill is placed.

Of greater importance is what activities are undertaken after the Highway is put into operation. Given the uncertainty of the events associated with climate change, greater vigilance and effort on the part of maintenance operators will be required including, greater effort for spring culvert clearing and fall protection of culverts and drainage structures, more frequent inspections, and monitoring of the performance of the infrastructure. There will also be a greater need for additional resources for maintenance and rehabilitation in the face of potential permafrost degradation.

11.0 ANTICIPATED HUMAN ENVIRONMENT EFFECTS AND PROPOSED MITIGATION/ MANAGEMENT MEASURES

The purpose of this section is to present the current socio-economic realities, identify potential effects and mitigation measures, and the significance of any residual effects. The Inuvik to Tuktoyaktuk all-weather Highway will be the first all-weather highway connection in Canada to the Arctic Ocean, and is expected to provide substantial benefits at the national, regional and local levels.

The socio-economic issues evaluated for the Project are the potential effects on:

- The regional economy;
- Infrastructure;
- Individual, family and community wellness;
- Traditional culture;
- Non-traditional land and resource use; and
- Heritage resources.

The study area for the socio-economic effects assessment is limited to the Town of Inuvik, Hamlet of Tuktoyaktuk, and the area between the two communities, including the Husky Lakes area.

11.1 REGIONAL ECONOMIC EFFECTS

11.1.1 Capital and Operating Expenditures

The Project will generate a demand for goods, services and labour during the construction phase and an ongoing demand for labour and services during the operations phase. It is anticipated that local and regional suppliers, contractors and residents will be able to provide the overwhelming majority of construction and related services. Should it be necessary, supply requirements will be fulfilled from beyond the region.

It is anticipated that the overwhelming majority of the project investment will occur within the Inuvialuit Settlement Region.

A study titled "Benefit-Cost and Regional Economic Impact Analysis: Inuvik to Tuktoyaktuk Highway" was conducted by Nichols Applied Management for GNWT Department of Transportation in March 1999. Nichols Applied Management (1999) concluded that local hiring of construction workers; spending on wages, materials and equipment during construction of the all-weather highway; and increased tourism; would result in regional impacts of $77 million of business and labour income, and 600 person-years of employment. It should be noted that other benefits, such as benefits from potential oil and gas exploration and development, were not quantified in the study. Since 1999, when Nichols Applied Management conducted the study, more opportunities for benefits have become available as prime construction and subsequent operations and maintenance contractors are now located in the region. Therefore, it is anticipated that the regional economic impact of this Project will be greater than $200 million in business and labour income.

On a national scale, economic spinoffs of the Highway would accrue to other parts of Canada since the highway construction and maintenance equipment is manufactured mainly in central Canada (Ontario and Quebec). In addition, the federal and territorial governments will benefit from the business and personal taxes generated by economic developments in the region.

11.1.2 Employment

Direct employment during the construction phase is identified in Section 5.9.5. As indicated in Table 11.1-1, the number of personnel requirements will vary per spread.

TABLE 11.1-1: ESTIMATED PERSONNEL REQUIREMENTS

Activity	Personnel
I. Winter Highway Construction	120 to 140
II. Winter Gravel Haul	220 to 260
III. Summer Grade and Compact (June 1 – Sept. 1, 2009/2010)	40 to 60
IV. Fall/Early Winter Aggregate Pit Development and Material Production	60 to 80

Indirect employment opportunities will be derived from increased tourism to Tuktoyaktuk and Inuvik, and additional employment opportunities from anticipated expanded oil and gas development, and other possible developments identified in this study.

Table 11.1-2 describes the potential available labour supply (as of 2004). Potential available labour supply refers to those persons who are unemployed. They can be classified into various categories, including those who would want to do rotational work, gender, ethnicity, or level of schooling (NWT Bureau of Statistics 2008a; 2008b)

TABLE 11.1-2: POTENTIAL AVAILABLE LABOUR SUPPLY (2004)

	Inuvik	Tuktoyaktuk
Number of Unemployed	155 in 2004 230 in 2006	117 in 2004 120 in 2006
% Willing to Do Rotational Work	65.2	76.1
% Male	52.3	60.7
% Aboriginal	83.9	98.3
% Less than High School Diploma	30.3	69.2

Source: NWT Bureau of Statistics (2008a; 2008b).

11.1.3 Labour Income

Project-related construction employment will lead to increased household income in the region throughout the construction period. This will be comprised of direct project-related income and indirectly by those producing goods and services for the Project and its employees. It is anticipated that the local Project employees will spend a portion of their incomes at local businesses that will create secondary and tertiary economic benefits in the region as local businesses procure goods and services from other local and regional businesses. During the construction phase of the project, labour income effects will be positive over the short-term.

During the maintenance and operation phase, fewer people will be employed to maintain and operate the highway. However, it is anticipated that all of the employment created for highway maintenance will be supplied by the Mackenzie Delta communities. Therefore, labour income effects will be positive over the long-term as well.

11.1.4 Demography and Population Mobility

Most of the labour supply for the project will come from either Inuvik or Tuktoyaktuk residents. In past years, many Inuvialuit have moved to other regions for employment opportunities. It was observed during the construction of the Tuktoyaktuk to Gravel Source 177 Access Road that many Inuvialuit living in other regions returned to the community to work on the project. Based on this experience, in-migration to the by returning residents is anticipated. This project may also reduce out-migration as more opportunities for local and regional employment become available.

It is anticipated that some people may migrate into these communities to fill indirect and induced employment opportunities in other goods and services sectors. However, this is not anticipated to have much overall significance.

11.2 INFRASTRUCTURE

11.2.1 Transportation

The Project will significantly improve transportation infrastructure between Inuvik and Tuktoyaktuk through the development of the all-weather highway instead of a seasonal, winter-only road. This will enable easier transportation of goods, services, and people into and out of Tuktoyaktuk. Furthermore, it will facilitate commercial and recreational access to the region and completes the highway to the arctic sea coast.

The Project is expected to cause some seasonal increases in the traffic using the Dempster Highway, as people travel north to the Beaufort Sea.

The proponents of the Project include the Town of Inuvik, Hamlet of Tuktoyaktuk and the GNWT Department of Transportation. Therefore, any necessary agreements regarding coordination of highway maintenance activities or use of the highway will be arranged. No mitigation measures are anticipated to be required.

11.2.2 Energy and Utilities

During the construction and operations phases, the Project will have no effects on the energy and utilities systems of any community, as the Project will use its own generators for power. Accordingly, there is no need to detail project effects on energy and utilities infrastructure during either phase. All communities have sufficient capacity to accommodate any foreseeable, minor energy demands created by the projected level of temporary workers that may be in the area over the short-term.

11.2.3 Housing

Project effects on housing and accommodations will include direct demands for short-term accommodation. Demands for short-term accommodation will be reduced by providing project construction camps. As the labour supply will be primarily from Inuvik or Tuktoyaktuk, limited short-term pressures may occur only during the construction phase and no long-term pressures for accommodation are expected to arise during the long-term maintenance and operation phase.

11.3 INDIVIDUAL, FAMILY AND COMMUNITY WELLNESS

This section is focused on the possible effects of the project construction phase, when there will be higher levels of employment and income, and the project operations phase, when there will be year-round mobility between communities, which may affect individual, family, and community wellness. When the construction phase concludes, there will be a decline in short term construction related employment and income to the level that will remain during the operations phase. Highway maintenance and operations personnel will be stationed primarily in Inuvik and Tuktoyaktuk.

11.3.1 Cost of Living

As described in Section 5.1, the presence of the Highway is expected to significantly reduce the cost of living for Tuktoyaktuk residents as goods may be shipped overland year-round. To give an example: according to the latest figures published by NWT Bureau of Statistics (2004), the 2004 Food Price Index for Tuktoyaktuk is 206, compared to 140 for Inuvik (Yellowknife being 100). Thus, food in Tuktoyaktuk is 47% more expensive than in Inuvik. The Highway will allow year road trucking of most of the items that currently must be flown in during the majority of the year. This is expected to provide long-term positive effects on the communities, community members, and local businesses.

Any negative impacts on the airline industry are anticipated to be temporary and the economic stimulus provided by roads to previously isolated communities is expected to create more business for the airline and barge services over the long term.

11.3.2 Community Wellness and Delivery of Social Services

Some of the issues that community wellness centers deal with in the communities include substance abuse and violence. There are two commonly held views regarding the link between increased incomes and potential links to substance abuse and violence. The first view is that increased incomes from project employment could potentially contribute to substance abuse-related problems, and to the burdens on social workers who try to deal with the problems in the communities. The second view is that increased individual incomes and overall community wealth may lead to a decrease in social problems by providing opportunities, options and, therefore, choices for individuals. This improves self-esteem, self-worth and self-sufficiency.

A review of the substance abuse and violence statistics in communities such as Tuktoyaktuk indicate that incidences of violence and other criminal behaviour typically seems to decrease significantly during periods of economic activity. Such potential effects will be primarily limited to the construction phase, as there will be more employees hired at that time.

The Town of Inuvik has a number of available community wellness services, and it is likely that these services will be used. The effect of the Highway may also have a positive effect by providing more direct access to community wellness services for Tuktoyaktuk residents.

In terms of recreational opportunities, the ability to travel year-round between communities will provide new recreational opportunities for all residents. In particular, this will significantly increase the recreational opportunities for regional school and youth teams to interact and/or use other community's facilities more frequently due to the reduced transportation costs. This may affect the existing recreational facilities by having more people use them, but this may also be a positive benefit associated with promoting family and community interactions.

11.3.3 Training

For the construction of the Tuktoyaktuk to Source 177 Access Road, a number of training programs were implemented. For example, the contractor conducted a successful heavy equipment operator course. Likewise, the ILA sponsored an environmental monitor training program.

For the Inuvik to Tuktoyaktuk Highway project, it is anticipated that additional funds for training programs will become available in association with the Project. This training will be beneficial for the Project and for the region as it increases the overall skill and competence of the workforce.

11.3.4 Health Conditions and Health Care Services

Overall health conditions are expected to improve due to the presence of the highway. The Husky Lakes area is a popular fishing, hunting, and recreational area. The Highway will provide easier and cheaper access to primary health centers in Tuktoyaktuk or Inuvik, as well as medical transfer between communities.

According to IOL (2004), the most serious threats to health in communities continue to be posed by substance abuse and derivative accidental or violent injuries. It is not anticipated that the proposed project will place significant additional pressures on the Tuktoyaktuk health center or Inuvik Hospital.

11.3.5 Human Health Risks

The project will have no significant effects on air, water or soil quality during the construction or operations phases that could induce potentially adverse effects on the health of humans, plants or animals harvested by the local population.

11.3.6 Public Safety and Protection Services

There are RCMP detachments in Tuktoyaktuk and Inuvik. Controlling alcohol and drug abuse will be the most effective way to mitigate many policing issues. Levels of crime in each community have been increasing. The proposed Highway may facilitate easier access between communities, but the Highway itself will not be the cause of the crime.

11.3.7 Education Attainment and Services

Education attainment in the region is not anticipated to be affected negatively by the Highway. The short-term construction jobs are not anticipated to induce adolescents to leave school prematurely. To ensure this, a minimum employment age for the project should be put into effect.

Education attainment for residents of Tuktoyaktuk may be positively affected due to the increased access to the education services in Inuvik. If this occurs, there may be a minor effect on the demand exists for educational facilities and services in Inuvik.

11.4 TRADITIONAL CULTURE

11.4.1 Traditional Harvesting and Land Use

Many community members continue to hunt and fish. Project employment may affect harvesting due to the time needed for employment. Some Aboriginal workers may find the paid work rewarding; however, Aboriginal workers may be adversely affected due to potential effects on their traditional lifestyle. Any potential effects on the ability to harvest would be short-term in nature, and likely limited to the construction phase. Due to the proximity of the project site to Tuktoyaktuk and Inuvik, it is anticipated that Aboriginal employees will have sufficient time off during the days that they are not working on the project, to continue their traditional harvesting pursuits. Most construction will take place during the winter period; therefore, construction activities should not affect traditional harvesting activities, which generally occur during spring, summer and fall.

The presence of the Highway is expected to provide easier access to harvesting areas. This may be considered either a positive or a negative effect, depending on the person asked. As with other public highways, the project proponents have limited responsibility for managing the activities of people using the Highway.

11.4.2 Preservation of Traditional Language and Culture

The proposed Highway is expected to facilitate family interactions by providing year-round access between the communities. Tuktoyaktuk, until now, has been isolated from other communities for much of the year, with access only by air and water during periods when the winter road is not open. The development of the Highway will allow the residents of Tuktoyaktuk to be less isolated from the other Delta communities, and from the rest of Canada.

The project is not anticipated to affect the transference of traditional language skills, knowledge of and identification with traditional culture. It is anticipated that a large proportion of the employees will be Aboriginal, and that there will be opportunities to use traditional language while on the work-site. Assuming that more tourists visit Tuktoyaktuk and Inuvik, this will provide new and greater opportunities for the community to market their local crafts.

11.5 NON-TRADITIONAL LAND AND RESOURCE USE

Potential project effects from the Project on land, resources, commercial and recreational activities were assessed. Effects were considered during the planning, construction and operations phase of the Project.

11.5.1 Protected Areas

The Northwest Territories Protected Area Strategy has been reviewed and considered in the assessment of potential Project effects. The proposed Highway avoids all protected areas and generally conforms to the extent possible with the Husky Lakes criteria for the protection of this critically important area. To further mitigate effects, Highway construction will occur primarily during the winter period.

11.5.2 Granular Resources

The proposed Highway will use a large quantity of the known granular resources, but the majority of these granular resources will remain intact. The proposed Highway will facilitate year-round access to additional granular resources for community use and for future development, if needed. The Project Partners are committed to ensuring that adequate granular resources will remain available for community use for the foreseeable future.

11.5.3 Oil and Gas Activities

By facilitating all-weather access, the Highway could contribute to reduced costs for future onshore and offshore oil and gas exploration and development in the area between Inuvik and Tuktoyaktuk. The oil and gas companies will need to determine if and how they may choose to benefit from the existence of the proposed Inuvik to Tuktoyaktuk Highway.

11.5.4 Tourism Activities

The proposed Highway will provide all-weather access from southern Canada to the Beaufort Sea. This will likely attract tourists to the area, and generate positive effects for the existing businesses and commercial activities over the long term. In particular, the hospitality and tourism industries are likely to be positively affected. Assuming that more tourists visit Tuktoyaktuk and Inuvik, this will provide new and greater opportunities for the community to market their local crafts.

11.5.5 Commercial Activities

The connection of Tuktoyaktuk to Inuvik and the Dempster Highway will provide opportunity for year-round business expansion into the Yukon Territory, and/or potentially reduce overhead transportation costs.

The Highway will open up year-round business opportunities in the rest of the region for the Tuktoyaktuk businesses and service providers. It will also allow the Inuvik and other regionally based businesses to compete for resource related and government business opportunities in the area between and within Inuvik and Tuktoyaktuk. This enhanced competition will lead to higher quality and lower cost services for government and resource development sectors.

The construction of the Inuvik to Tuktoyaktuk Highway will also create various spin-off business opportunities for Tuktoyaktuk, Inuvik and other regional businesses, such as fuel and gas service stations and highway maintenance services. The increase in tourism and the creation of new business opportunities will also provide important year-round employment and training opportunities for local Inuvik and Tuktoyaktuk residents.

11.6 NATIONAL SOVEREIGNTY

Construction of the Inuvik to Tuktoyaktuk Highway will demonstrate to the international community that Canada is prepared to make significant financial investments to protect Canadian sovereignty. The Inuvik to Tuktoyaktuk Highway would allow easier and cheaper access for sovereignty and security related operations in the western Arctic Ocean, which could be based in Tuktoyaktuk and/or Inuvik.

Nationally, the Inuvik to Tuktoyaktuk Highway will establish a permanent transportation link to a formerly remote community and Canada's arctic coastline.

11.7 POLLUTION PREVENTION AND SPILL RESPONSE IN THE ARCTIC OCEAN

The presence of the Highway can potentially contribute to the effectiveness of the Canadian Coast Guard's Tuktoyaktuk-based arctic pollution prevention and spill response planning and operations. The Highway would facilitate transportation of equipment and materials required to respond to potential spills in the summer/fall Arctic shipping season; at present any emergency equipment and supplies must be flown to Tuktoyaktuk.

12.0 CUMULATIVE EFFECTS

Cumulative effects are changes to the environment that "are likely to result from the project in combination with other projects or activities that have been or will be carried out" (CEAA 2003). Overall cumulative effects are effects of all land or water uses on a Valued Ecosystem Component (VEC), including effects caused by the project.

An assessment of cumulative effects provides a more complete understanding of what might happen to VECs beyond the influence of the project alone. This is useful for regulatory decision-makers and land and resource managers as they review and plan future development. Thus, an assessment of cumulative effects provides a glimpse into environmental and socio-economic conditions now and how they may change in the future with development. This contributes to a better understanding of what might or might not happen if the project proceeds.

Typically, cumulative effects assessments address effects that:

- extend over a larger area;
- are of longer term duration;
- act in conjunction with other projects/activities on the same VECs; and
- are reasonably probable, considering possible future projects/activities and impacts.

For the proposed Inuvik to Tuktoyaktuk Highway Project, the assessment of cumulative effects has involved the application of four basic questions as outlined by Kavik-Axys (2002) for proposed developments in the Inuvialuit Settlement Region.

- Is the project likely to have negative environmental effects on VECs in the ISR?
- If so, will the residual negative environmental effects that remain after mitigation, combine with the effects of other projects, past, present, or future?
- What is the significance of the overall cumulative environmental effects, including the effect of the project?
- If this project, in combination with other projects in the area, is likely to create a "significant negative cumulative effect", are there further mitigation measures that could reduce or eliminate the project's contribution to these effects so that the combined effect does not threaten the VEC?

As noted in the Environmental Effects and Mitigation Measures section of this Project Description Report (Section 10.0), it has been determined that, with the application of proposed mitigation measures, for all environmental VECs, the residual environmental effects associated with the construction and future operation of the Inuvik to Tuktoyaktuk Highway Project are anticipated to be low in magnitude and local in extent.

However, while individually no significant effects are anticipated, it is the role of the cumulative effects assessment (CEA) to consider the potential additive and synergistic effects of overall residual effects, in combination with past, existing or known planned activities in the vicinity of the proposed Inuvik to Tuktoyaktuk Highway Project.

Thus in accordance with the EISC/EIRB guide for conducting cumulative effects assessments in the Inuvialuit Settlement Region (Kavik-Axys 2002) the following assessment has considered and addressed the following key questions:

- Is the project likely to have negative environmental effects on VECs in the ISR?
- If so, will the residual negative environmental effects that remain after mitigation combine with the effects of other projects, past, present or future?
- What is the significance of the overall cumulative environmental effects, including the effect of the project?
- If this project, in combination with other projects in the area, is likely to create a "significant negative cumulative effect", are there further mitigation measures that could reduce or eliminate the project's contribution to these effects so that the combined effect does not threaten the VEC?

12.1 SPATIAL BOUNDARIES

For purposes of this CEA, the spatial boundaries include the portion of the Mackenzie Delta and the Tuktoyaktuk Peninsula in the general vicinity of the proposed Inuvik to Tuktoyaktuk Highway corridor, extending between Inuvik and Tuktoyaktuk, including alternate alignments considered (as illustrated in Figure 12.1-1). The easterly boundary extends from the westerly shores of the Husky Lakes to the westerly boundary, which extends from the eastern side of the Mackenzie River. This general area encompasses the entire proposed Highway, the range of environments that could be impacted by the Highway, and the past, present and future projects that may have a potential to contribute to potential cumulative effects.

12.2 TEMPORAL BOUNDARIES

For purposes of this CEA, the temporal (time frame) for the assessment will be the next three (3) to ten (10) years, during which time construction of the proposed Highway is anticipated to be completed and the highway will potentially have been in operation for more than five (5) years. It remains unknown at this time whether construction of other proposed future projects, in particular, the Mackenzie Gas Project and the Tuktoyaktuk Harbour Project will have commenced or not within this 10 year time-frame.

12.3 PAST, PRESENT AND FUTURE PROJECTS / ACTIVITIES CONSIDERED

During the October 2009 community and regulatory consultations, a number of possible projects and activities were identified that should be considered in the CEA. In addition, several other projects and/or activities warranted consideration based on the Project Team's understanding of past, existing, and potential future projects and activities in the area of interest. The projects and activities considered in this CEA include:

Past and Existing Projects

- Ikhil Gas Development and Pipeline Project
- Tuktoyaktuk to Source 177 Access Road
- Winter Access Trails
- Former NCPC Power Pole
- Seismic Lines
- Oil and Gas Well Sites

Potential Future Projects/ Activities

- Parsons Lake Gas Field, Associated Infrastructure and Gathering Pipeline
- Mackenzie Gas Project Pipeline
- Tuktoyaktuk Harbour Project
- Husky Lakes Development

Brief descriptions of each of these past, existing and potential future projects and activities, and to what degree they may contribute to a possible cumulative effect in relation to the proposed construction and operation of the Inuvik to Tuktoyaktuk Highway are provided in the following sections. Figure 12.1-1 depicts existing land use in the general vicinity of the proposed Highway.

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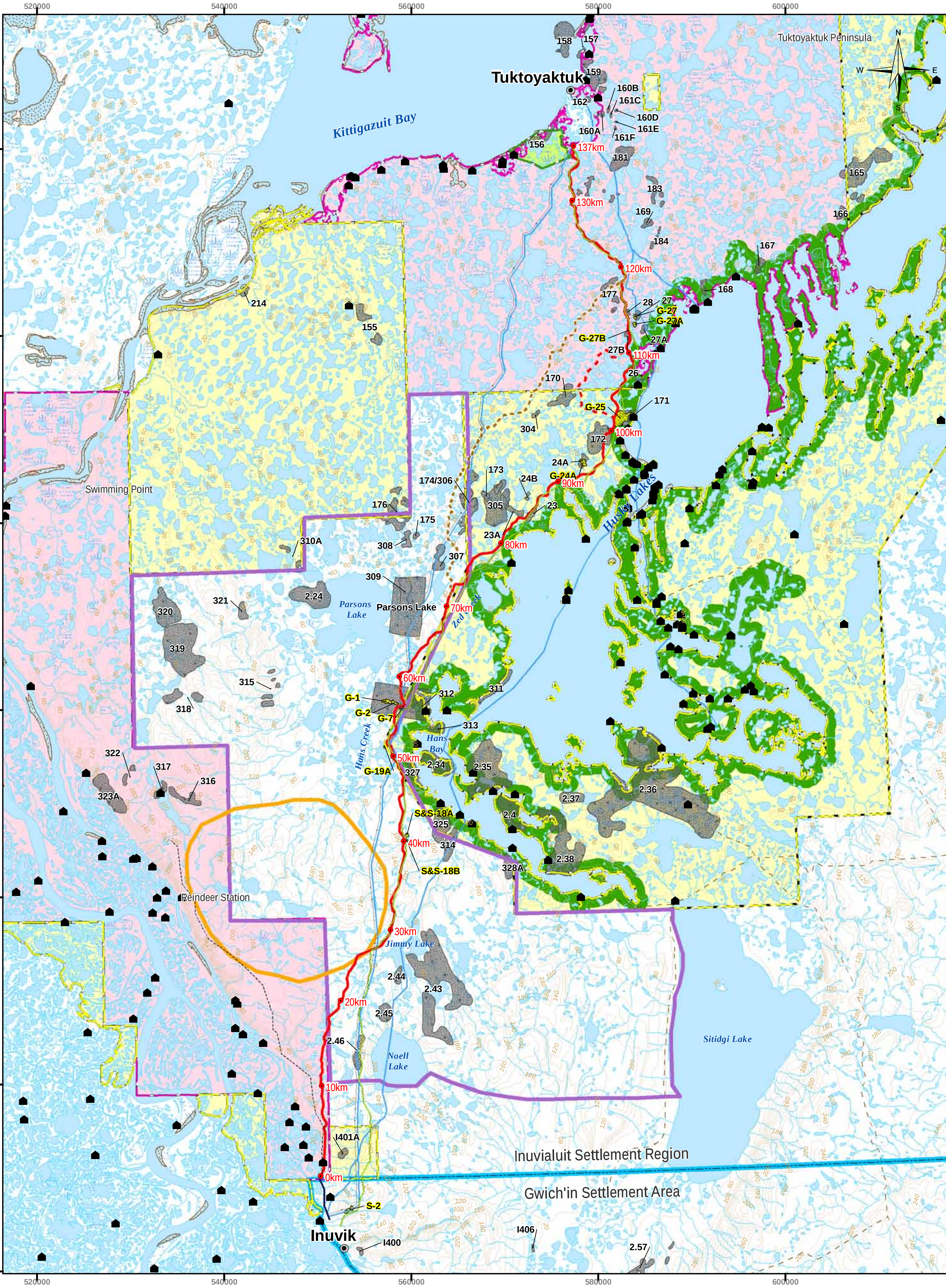

LEGEND

- Residential Leases
- 2009 Route
- Other Alignments Considered
- Upland Route
- Proposed Alignment (PWC'77)
- Navy Road
- Snowmobile Trails
- Highway Borrow Sources
- Borrow Sources
- Approximate Winter Reindeer Range
- Approximate Allotment B
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Former Powerline
- Ikhil Gas Pipeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand
- Husky Lakes 1000m Setback

NOTES

Base data source: NTS 1:250,000
Borrow Sources, powerline, ILA Lands, Husky Lakes 1000m - Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Existing Land Uses

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000

5 2.5 0 5 10

Kilometres

FILE NO.
V23201098_PDR-Map022-CEA-ExistLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201098	KWM	RH	1

OFFICE	DATE
EBA-VANC	February 11, 2010

Town of Inuvik

Northwest Territories

KIGGIAK - EBA

Figure 12.1-1

12.3.1 Past and Existing Projects

12.3.1.1 Ikhil Gas Development and Pipeline Project

The Ikhil Gas Development and Pipeline Project consists of two producing gas wells, associated feeder lines, a small gas processing plant and a 50 km (30 miles) long, 168.3 mm (6 inch) diameter buried gas pipeline. The gas production site is located approximately 50 km north of Inuvik in the Caribou Hills, and extends south from there to a pressure regulation and metering facility near the Northwest Territories Power Corporation power plant in Inuvik (Figure 12.1-1).

The pipeline component of the project was presented and reviewed by the EISC during the summer of 1997. Their review concluded that the project would not result in significant environmental impacts, and as a result the project was not referred to the EIRB for a more rigorous assessment (North of 60 Engineering 2004).

An environmental screening of the project was also performed by the NEB as mandated under CEAA. Their review also found the project environmental impact to be small and manageable through the application of appropriate mitigation measures.

The project was developed during the period 1997 to 1999 and is expected to be in service for the foreseeable future.

The pipeline is buried in permafrost and parallels the East Channel of the Mackenzie River for its entire 50 km. Where the pipeline crosses the Douglas Creek Valley, it is supported by piles above ground to avoid disturbance to the slopes on either side of the creek. Since the gas is cooled to below freezing temperatures at the Ikhil production facility, limited melting of the permafrost will occur as the gas passes through the pipeline. Pipeline and right-of-way (ROW) performance has been monitored on an ongoing basis by Inuvik Gas operations personnel (North of 60 Engineering 2004).

Restoration and re-vegetation efforts have been very successful, with hardly any disturbance visible over the ditch centre-line (Photo 12.3-1). There are currently no geotechnical of groundwater related issues associated with the operation of the pipeline. The pipeline has performed as designed. Based on visual inspections there has been no significant frost heave or thaw settlement along the line.

The buried gas pipeline approaches the proposed Inuvik to Tuktoyaktuk Highway alignment at KM 5 and then runs parallel to the proposed Highway alignment heading south towards the end of Navy Road in Inuvik. The pipeline is located within an established 30 m wide utility ROW. To ensure that the pipeline will not be disturbed or affected in any way, the proposed Inuvik to Tuktoyaktuk Highway alignment will be located at an appropriate and approved distance from the existing gas pipeline ROW.

The development of the highway may facilitate access to the portion of the buried gas pipeline that will be located adjacent to the highway. However, with the application of the planned mitigation measures, there will be no interactions or opportunity for a potentially significant cumulative environmental effect to occur.

Photo 12.3-1
Right-of-way at the end of Navy Road

12.3.1.2 Tuktoyaktuk to Source 177 Access Road

The Tuktoyaktuk to Source 177 Access Road is a 19 km long road that is currently under construction. The proposed Highway alignment follows the same general route as originally selected for the northernmost 19 km of the proposed all-weather Highway between Inuvik and Tuktoyaktuk. The alignment is located entirely on Inuvialuit Private Lands.

In January 2009, the EISC concluded that the development, if authorized subject to the environmental terms and conditions recommended by the Screening Committee, would have no significant negative impact on the environment in the Inuvialuit Settlement Region (EISC 2009).

Following receipt of ILA permits, construction of the first 12 km of the access road commenced in February and was completed in April 2009. All aggregate materials used for construction of the road were obtained from Source 177. The road design was developed by FSC Architects and Engineers in accordance with GNWT Department of Transportation design requirements.

The road is being constructed by an experienced regional road construction contractor. The basic road construction sequence included the clearing of snow from the right-of-way, the placement of geotextile fabric directly onto the undisturbed frozen surface, the placement (by end-dumping) of aggregate material in lifts onto the liner and the compacting of the road grade. The second winter of construction will proceed in early 2010. Photos 5.2-3, 5.8-1, 5.8-2, and 5.8-3 in Section 5.0 of this Project Description Report illustrate the construction methods employed and the appearance of portions of the completed road in spring/summer 2009.

Most of the streams crossed by the Tuktoyaktuk to Source 177 Access Road are ephemeral but for potentially fish-bearing streams, the stream crossings are being constructed in conformance with DFO Operational Procedures designed to protect fish habitat. Areas with surface runoff were addressed with the installation of standard diameter (800 mm to 2,000 mm) roadway culverts. Follow-up monitoring during the spring/summer of 2009 determined that some areas of ponding occurred and plans have been developed to mitigate these minor issues.

As part of the construction of the Inuvik to Tuktoyaktuk Highway, there will be a need to upgrade the current Tuktoyaktuk to Source 177 portion of the overall alignment to meet the highway design criteria. During both the October 2009 and January 2010 consultation sessions, several questions were raised regarding what would need to be done to complete this section of the highway in the future. It was indicated that the current horizontal alignment of the Tuktoyaktuk to Source 177 Access Road would continue to be used for the new Highway. However, there will be a need to build up the road embankment to achieve the highway design criteria.

The existing Tuktoyaktuk to Source 177 Access Road will represent the northernmost portion of the overall Inuvik to Tuktoyaktuk Highway. However, with the application of the planned mitigation measures there will be no opportunity for a potentially significant cumulative environmental effect to occur.

It is anticipated that the completed highway will make it easier for people to access the land for their various traditional, recreational and cultural pursuits. To ensure that the environment of the area remains protected, it will be important for the users of the highway to abide by access controls and limitations that may need to be developed for the Highway by the resource management agencies and co-management bodies in consultation with the HTCs and other interested stakeholders.

12.3.1.3 Winter Access Trails

Since the introduction of snow machines, winter access trails have been developed each winter as needed, to allow residents of Tuktoyaktuk and Inuvik to pursue their traditional recreational, hunting, trapping and other activities on the Tuktoyaktuk Peninsula and in the Mackenzie Delta, including the general area of the proposed Inuvik to Tuktoyaktuk Highway. One of the major winter routes that has become established every winter are the traditional routes from Tuktoyaktuk and Inuvik to the Husky Lakes area (Figure 12.1-1).

The consultations sessions held in October 2009 and January 2010 confirmed that many families have and continue to use the traditional winter routes to the Husky Lakes. The consultations also identified a second, more overland route, which generally followed the alignment of the former Northern Canada Power Commission (NCPC) transmission line ROW that extended from Inuvik to Tuktoyaktuk (Figure 12.1-1).

The winter access trails are considered to be of a low impact nature, disappearing with the annual spring snowmelt, and leaving behind minimal evidence that they were ever there. With the development of the highway, it is anticipated that most north-south traffic will use the highway, with snow machines and all terrain vehicles (ATVs) being towed by trailer to points along the highway where they would continue to be used to access the adjacent land, as was done previously.

The presence of the highway will make it easier for people to access the land for their various traditional, recreational and cultural pursuits. To ensure that the environment of the area remains protected, it will be important for the users of the highway to abide by access controls and limitations that may need to be developed for the highway by the resource management agencies and co-management bodies in consultation with the HTCs and other interested stakeholders.

12.3.1.4 Former NCPC Power Line

In 1972, a 144 km wood pole transmission line (69 KV) was constructed by the Northern Canada Power Commission from Inuvik to Tuktoyaktuk, the only line of its type in the world north of the Arctic Circle (NTPC 2009). The route of this former power line is illustrated in Figure 12.1-1.

Due to high maintenance costs, this line was abandoned and salvaged in the late 1980s and replaced with diesel power generation facilities installed at Tuktoyaktuk (A. Martin, NTPC Pers. Com. 2009). Currently the Hamlet of Tuktoyaktuk is serviced by a complement of three diesel generators with a total installed capacity of 2,205 KW. As previously indicated, the former power line ROW was used as a winter trail between Tuktoyaktuk and Inuvik. The power line was used to mark the route and also served to help harvesters on the land to determine their location (G. Colton, NTPC Pers. Com. 2009). Today little physical evidence remains of the former NCPC power line.

12.3.1.5 Seismic Lines

Since the 1960s the most extensive non-traditional land use that has occurred in the Mackenzie Delta, including the area in the vicinity of the proposed Inuvik to Tuktoyaktuk Highway, has been seismic exploration. As an example, in the 41,105 ha Parsons Lake Study Area defined for the Mackenzie Gas Project, approximately 1.5% of that Study Area had been subjected to seismic lines and associated activities (IOL et al. 2004).

In some areas of the Mackenzie Delta, particularly in forested areas near Inuvik, visible evidence of the historic, linear seismic lines remains today. However, on the open tundra of the Tuktoyaktuk Peninsula, very few of the historic seismic lines can be detected at this time. Although from the air the vegetation along the seismic lines sometimes appears to have a different colour, on the ground, little physical evidence remains of these historic seismic programs. As a result, there will be little opportunity for a potentially cumulative environmental effect to occur between the limited residual effects of historic seismic lines and the construction and operation of the proposed Highway.

12.3.1.6 Oil and Gas Well Sites

A number of exploratory oil and gas wells were completed by Imperial Oil near the proposed Highway right-of-way near Tuktoyaktuk on the Tuktoyaktuk Peninsula. For example, 13 wells were drilled in the mid-1980s during Imperial Oil's Tuktoyaktuk Tertiary program. In addition, Gulf drilled a number of exploratory and development wells in the Parsons Lake area in the early 1970's.

12.3.2 Potential Future Projects/ Activities

12.3.2.1 Mackenzie Gas Project

Developing a natural gas pipeline from the Mackenzie Delta through the Northwest Territories to southern markets has been contemplated for many years. Various pipeline projects have been proposed during the last 30 years that consider economics, regulatory requirements, socio-economic and environmental conditions, and engineering and geotechnical issues in the decision-making process (IOL et al. 2004).

The proponents of the proposed Mackenzie Gas Project include Imperial Oil Resources Ventures Limited Partnership (IOL), ConocoPhillips Canada (North) Limited (ConocoPhillips), ExxonMobil Canada Properties (ExxonMobil), Shell Canada Limited (Shell) and Mackenzie Valley Aboriginal Pipeline Limited (MVAPL) partnership.

The purpose of the proposed project is to develop three onshore natural gas fields (anchor gas fields) in the Mackenzie Delta and to transport natural gas and natural gas liquids (NGLs) by pipeline to market (Figure 12.3-1). The main Mackenzie Delta components of the project include:

- The facilities (field development, flow lines, gas conditioning and production facilities and associated infrastructure to be located at each of three anchor fields at Niglintgak, Taglu and Parsons Lake;
- A gathering system including gathering pipelines to transport the natural gas and NGLs from the three anchor fields to a facility to be located near Inuvik;
- A pigging facility at Storm Hills and a gas processing facility and supporting facilities near Inuvik to recover NGLs from the gas stream;
- A pipeline (the NGL pipeline) to transport NGLs south from the Inuvik area facility to Norman Wells, where it will be tied into the existing Enbridge Inc. pipeline; and

- A pipeline to transport natural gas from the Inuvik area facility to the NOVA Gas Transmission Ltd. (NGTL) interconnect located near the Northwest Territories-Alberta boundary.

The environmental impact assessment for the Mackenzie Gas Project conducted a comprehensive assessment of the available information, including several years (2001-2004) of additional, new scientific field survey data, the results of community consultations and Traditional Knowledge studies, with detailed descriptions of the importance and value of wildlife and wildlife habitat to the local residents. The potential effects on populations and harvest practices, as determined from the results of harvest studies, were measured against the assessment criteria (IOL et al. 2004).

Based on their assessment, it was determined that the Mackenzie Gas project would likely have some minor effects on wildlife and wildlife habitat at the local level that could last throughout the life of the project, and in some cases beyond. Noise from facilities and flares might also affect wildlife during operations (IOL et al. 2004).

Their assessment determined that some local wildlife movements might be affected near the project, but no effects on the seasonal movements or migration patterns of wildlife would occur, with the possible exception of the movements of barren-ground caribou from the Cape Bathurst herd in fall and winter. No other possible effects on the seasonal distribution of barren-ground caribou were expected to occur (IOL et al. 2004).

The key conclusions of the cumulative effects assessment conducted for the Mackenzie Gas Project (IOL et al. 2004) were as follows:

- The Mackenzie Gas Project would not contribute significant cumulative effects.
- There were no significant overall cumulative effects.
- The project could contribute to one potential cumulative effect of management concern, direct grizzly bear mortality, which could be addressed with diligent monitoring and management by responsible parties.
- Based on the project footprint, the project would disturb a negligible proportion of the regional study area.
- The project might encourage other development, particularly gas exploration and production in the Northwest Territories; however, information to adequately assess potential cumulative effects contributions from such possible developments were not yet available.
- The pattern of any future hydrocarbon development on the land, such as additional production fields, and any effects from such activities would likely be similar to effects predicted for current and reasonably foreseeable land use. Those developments would be subject to their own environmental impact assessment, including cumulative effects.

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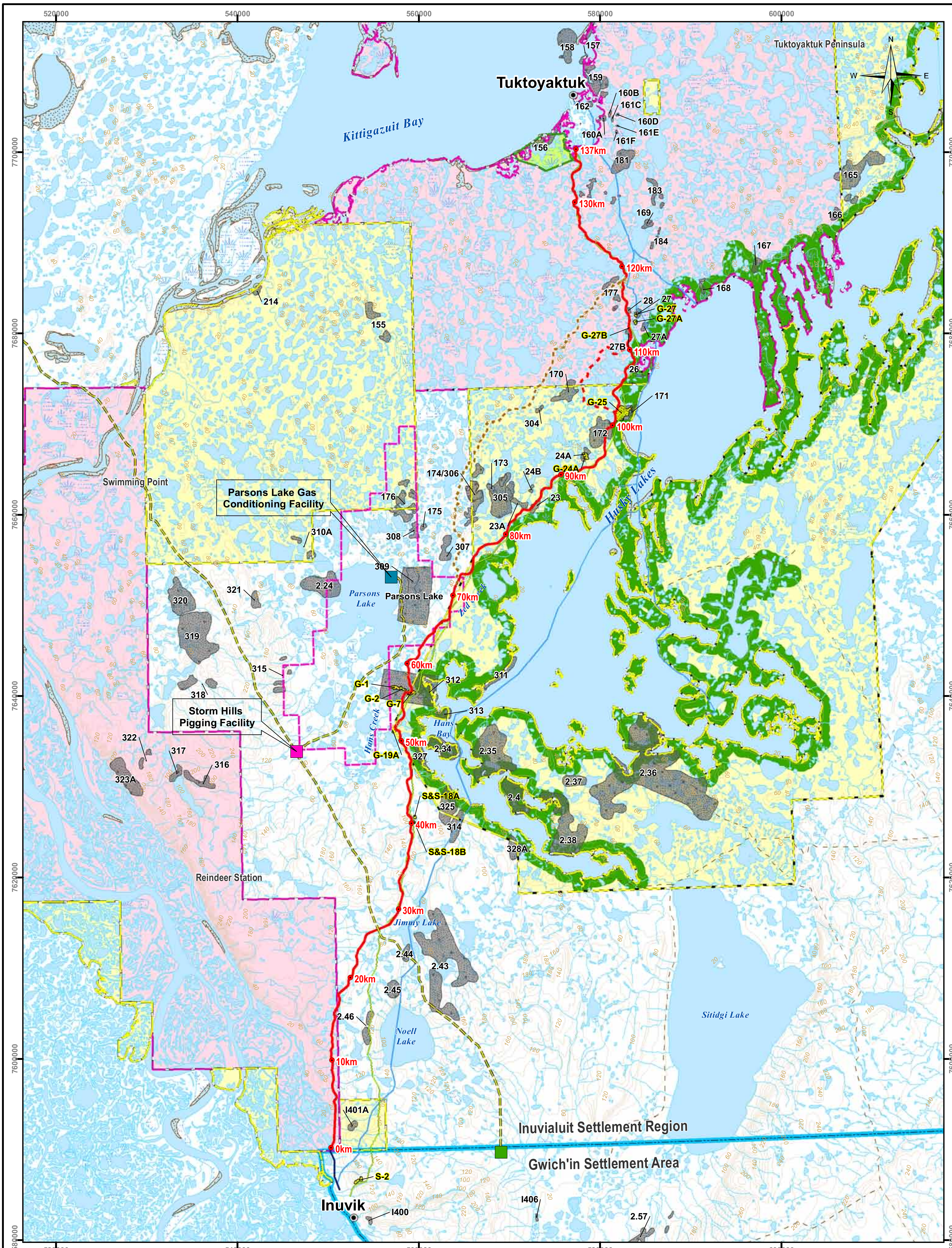

LEGEND

- Facility Site
- Gas Conditioning Facility
- Pigging Facility Site
- Route of Gathering Pipelines
- Significant Discovery Licence Area
- 2009 Route
- Other Alignments Considered
- Upland Route
- Proposed Alignment (PWC'77)
- Navy Road
- Snowmobile Trails
- HighwayBorrow Sources
- Borrow Sources
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, powerline, ILA Lands, - Inuvialuit Land Administration
Mackenzie Gas Project 2004

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Proposed Future Land Uses

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:400,000
5 2.5 0 5 10
Kilometres

FILE NO.
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PROJECT NO.	DWN	CKD	REV
V23201098	KWM	RH	0

OFFICE	DATE
EBA-VANC	January 25, 2010

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 12.3-1

These conclusions indicated that, despite the size and duration of operations, the contribution to cumulative effects by the Mackenzie Gas Project on the regions and communities of the Northwest Territories were not expected to be significant. The conclusions also meant that there was no reason to believe, based on available information and the assessment method, that in the future there would be an issue of management concern associated with cumulative effects on a particular valued component from this project. These conclusions were based on the assumption that appropriate management and monitoring programs, as outlined in the EIS prepared for the Mackenzie Gas Project would be carried out (IOL et al. 2004).

At this time it must be emphasized that the proposed Mackenzie Gas Project is still awaiting the outcome of the Joint Panel Review and future regulatory permitting and approvals decisions by a number of regulatory agencies. In addition, there remains considerable uncertainty as to if and when the Mackenzie Gas Project may in fact proceed. Currently the earliest projections for the possible start of construction of the project suggest the year 2015. However, a number of other critical factors, including economic, market and strategic priority considerations, could potentially result in further delays to the implementation of the Mackenzie Gas Project.

At this time it is more likely that the proposed Inuvik to Tuktoyaktuk Highway will be constructed and be in full operation well before construction of the Mackenzie Gas Project proceeds. On this basis, it is assumed that the one location where the future Mackenzie Gas Project pipeline (Storm Hills Lateral) may interact with the highway would be in the vicinity of KM 26 of the highway. At this location it is understood that the pipeline, when constructed, will be buried and would have to be installed beneath what would then be the existing highway, most likely using horizontal drilling technology. Using this technique, the highway would remain undisturbed and vehicles could continue to use the highway in an unimpeded manner.

The development of the highway may facilitate access to the portion of the buried Mackenzie gas pipeline that would pass under the highway, but with the application of the planned mitigation measures for the Mackenzie Gas Project, there would be no interactions or opportunity for a potentially significant cumulative environmental effect to occur.

12.3.2.2 Parsons Lake Gas Field Associated Infrastructure and Gathering Pipeline

The Parsons Lake gas field, currently operated by ConocoPhillips, is located about 55 km southwest of Tuktoyaktuk and 70 km north of Inuvik (Figure 12.3-1). The Parsons Lake gas field was discovered in 1972 and defined by two-dimensional (2-D) seismic and other study programs between 1959 and 2001. A major three dimensional (3-D) seismic program was conducted over the Parsons Lake gas field in winter 2001-2002. Between 1971 and 1986, 19 wells were drilled. The Parsons Lake significant discovery licences were granted in 1987. Based on the most recent interpretations of the exploration data obtained, the proponents estimate that the Parsons Lake field could contain about 2.3 Tcf of recoverable raw natural gas and NGLs (ConocoPhillips 2004a and 2004b).

The main production facilities at the Parsons Lake field will be located on two main gravel pads, the most northerly and larger of the two near the northeast shore of Parsons Lake. The north pad, which will accommodate the gas conditioning facility, camp, fuel storage, and other associated infrastructure, is proposed to be built first. The connection to the Mackenzie Gas gathering system will also be located at the north pad. The second, smaller well pad will be constructed about five or six years later and will be located about 14 km from the north pad at a location south of Parsons Lake. An elevated two-phase flow line will transport natural gas from the south pad to the north pad's gas conditioning facility (ConocoPhillips 2004a and 2004b).

The Parsons Lake gathering pipeline (Parsons Lake lateral) will originate from the gas conditioning facility located on the north pad and will head south around Parsons Lake. From there, the buried lateral will continue southwest between West Hans Lake and East Hans Lake to the Storm Hills Junction (Figure 12.3-1). The Parsons Lake lateral will be approximately 27 km long and centered in a 30 m wide ROW. At its nearest point, the lateral will be located approximately 1.8 km to the west of the Inuvik to Tuktoyaktuk Highway project.

Similar to the status of the rest of the Mackenzie Gas Project, the Parsons Lake gas field component of the overall project is continuing to wait for the outcome of the Joint Panel Review and future regulatory permitting and approvals decisions by a number of regulatory agencies. As indicated earlier, there also remains considerable uncertainty as to if and when the Mackenzie Gas Project may proceed. Currently the earliest projections for the possible start of construction of the overall project suggest the year 2015. However, a number of other critical factors, including economic, market and strategic priority considerations, could potentially result in further delays to the implementation of the entire Mackenzie Gas Project, including the Parsons Lake gas field component of the overall project.

At this time it is more likely that the proposed Inuvik to Tuktoyaktuk Highway will be constructed and be in full operation well before construction of the Parsons Lake gas field component of the overall Mackenzie Gas Project proceeds.

Assuming that this will be the case, it would seem likely that the highway would be used for the two-way transportation of workers and consumables from Tuktoyaktuk and Inuvik to the Parsons Lake gas field project. Possible use of the highway for the transportation of large modules to Parsons Lake from the Tuktoyaktuk harbour area would likely also be considered.

In addition, it could be anticipated that the provision of year-round overland highway access would likely reduce the need for extended-season storage of various critical consumables, including fuel, drilling and production supplies, etc. at the Parsons Lake facility. The existence of the highway may also influence future industry decisions regarding the need for and nature of an airstrip to support the Parsons Lake gas field project.

Such possible uses of the highway in support of the Parsons Lake gas field project would increase the overall use of the highway by oil industry vehicles and equipment for periods of time. The timing of use and traffic controls that would need to be implemented to permit the safe transit of specific equipment (e.g., large modules) and supplies would need to be developed and implemented. However, since the Inuvik to Tuktoyaktuk Highway will be a low volume traffic highway, such possible activities are expected to be manageable and are not likely to create a significant issue for the other users of the highway.

In addition, the year-round access provided by the highway may trigger future refinements to the Parsons Lake gas field project that may present environmental benefits. These could include potentially reduced on-site fuel and consumables storage needs and associated reductions in project footprint size and aggregate borrow requirements for infrastructure pad construction.

As a result, it is anticipated that the future existence of the Inuvik to Tuktoyaktuk Highway prior to the implementation of the Parsons Lake gas field project may provide operational and environmental advantages for the development of the Parsons Lake gas field project, but is not expected to contribute to a potentially negative cumulative environmental effect.

12.3.2.3 Tuktoyaktuk Harbour Project

During the October 2009 community consultations, a question was raised about the possible development of Tuktoyaktuk Harbour and how that might impact the development and operation of the proposed Inuvik to Tuktoyaktuk Highway. The harbour at Tuktoyaktuk is the only existing natural and active port along the Canadian Beaufort Sea coastline. Historically it has served as the primary base for offshore oil and gas exploration in the 1970s and 1980s when the oil and gas exploration companies were active in the area.

With the recent renewed interest in Beaufort Sea exploration and the possible development of the Mackenzie Gas Project, Tuktoyaktuk Harbour may again play an important role as an offshore logistics and service centre for the oil and gas industry.

In late 2005, as part of the ongoing Joint Review Panel (JRP) process, the proponents submitted updated information for the Parsons Lake gas field development. A potential option, not previously proposed, was for sea-lift transport of large modules on barges to Tuktoyaktuk Harbour following existing shipping lanes (IOL 2006).

The potential option to bring modules for the Parsons Lake gas field through the Beaufort Sea to Tuktoyaktuk is currently under study by ConocoPhillips. The option involves shipping process modules weighing up to 1,000 t on Series 240 or 400 barges from an offshore assembly location to Tuktoyaktuk, provided that the barges could be brought into Tuktoyaktuk Harbour without the need for dredging. If this was not possible, the modules would be transferred at Kuparuk or Prudhoe Bay, Alaska onto Series 1500 barges, which will accommodate loads of the weight and size of the proposed modules. Series 1500 barges are regularly used by Northern Transportation Company Limited (NTCL) for re-supplying Tuktoyaktuk (IOL 2006).

To date no formal proposal for the development of Tuktoyaktuk Harbour has been put forward. Nevertheless, assuming that Tuktoyaktuk Harbour is used in the future to accommodate further offshore exploration activities and/or the development of the Mackenzie Gas Project, and in particular the Parsons Lake gas field, it would seem likely that the highway would be used to provide overland logistics and transportation access to the Parsons Lake gas project.

The specific nature of possible uses of the Tuktoyaktuk Harbour and Highway in support of the Parsons Lake gas project cannot be defined with certainty at this time. However, it would seem likely that if the highway was in operation, it would be used for the two-way transportation of workers and consumables from Tuktoyaktuk and Inuvik to the Parsons Lake gas project. Possible use of the highway for the transportation of the large modules from Tuktoyaktuk Harbour to Parsons Lake would likely also be considered.

Such possible uses of the Tuktoyaktuk Harbour and the Highway in support of the Parsons Lake gas field project would increase the overall use of the highway by oil industry vehicles and equipment for periods of time. The timing of use and traffic controls that would need to be implemented to permit the safe transit of specific equipment (e.g. large modules) and supplies would need to be developed and implemented. However, since the Inuvik to Tuktoyaktuk Highway will be a low volume traffic highway, such possible activities are expected to be manageable and are not likely to create a significant issue for the other users of the highway.

As a result, the possible future development of the Tuktoyaktuk Harbour is not expected to contribute to a potentially negative cumulative environmental effect.

12.3.2.4 Husky Lakes Development

The Husky Lakes Special Management Area (Site No. 705D) is located adjacent to a portion of the proposed alignment of the Inuvik to Tuktoyaktuk Highway. In accordance with anticipated revisions to the Husky Lakes Criteria and associated Management Plan and specific directions received from the ILA, the alignment of the proposed Highway has been re-routed to the extent possible to maintain a minimum setback of at least 1 km from the Husky Lakes Special Management Area.

As confirmed during the October 2009 and January 2010 community consultations and previous consultations for the Tuktoyaktuk to Source 177 Access Road project, the project proponents understand fully that the Husky Lakes area is considered by the residents of Tuktoyaktuk and Inuvik to be very important for year-round hunting, trapping, fishing, and recreation and for seasonal berry picking.

As stated in the EIRB's Husky Lakes Criteria (EIRB 2002), the Husky Lakes area is considered by many as one of the best places to hunt and fish in the Inuvialuit Settlement Region. It is an area with abundant plant and animal life, frequented by campers, local hunters and trappers, and visiting sports hunters and fishers. Many go there to relax and enjoy the experience the Husky Lakes area provides.

The Husky Lakes also provide spawning habitat for herring and lake trout. The TCCP (Community of Tuktoyaktuk et al. 2000) reported that fish harvesting has been typically concentrated in the upper parts of Husky Lakes around Saunatuk, Zieman Cabin and Stanley Cabin. Community of Tuktoyaktuk et al. (2000) also suggests that harvesting use has been more limited to the west of Husky Lakes (including the vicinity of the Inuvik to Tuktoyaktuk Highway alignment).

According to ILA records, there are currently about 118 registered leases located throughout the Husky Lakes area with the heaviest concentrations of cabins present in the narrows northwest of Five Hundred Lakes and to a lesser extent around Whale Point and Portage Point at the southern limit of Husky Lakes (see Figure 7.5-1).

The Husky Lakes Integrated Management Planning Study, completed in 2001, suggested that the area was already under pressure and that the local people were concerned about the deterioration of the "specialness" of Husky Lakes due to increased garbage and crowding of Husky Lakes related to the increasing number of cabins and residential leases (Hoyt 2001). At that time there was already a concern that land use activities may affect the traditional ways of life. As reported in Hoyt (2001), the region was considered to be vital to the community as a place where families could spend time together and pass on the skills and culture of the Inuvialuit.

During the October 2009 community consultation sessions, some people expressed concerns about the proposed Highway being too close to the Husky Lakes area. The main concern was that a highway near the Husky Lakes could result in more people coming into the area and this could subsequently lead to the development of additional cabins, docks, over harvesting, the generation of more garbage, etc. Other people were of the view that the highway should still be built because it would make it easier for them to get to the Husky Lakes and concerns such as those raised should be managed to ensure that such potential problems would not occur. It was also noted by some people that the relative proximity of the highway would make it easier for people to transport garbage back to their home communities for more appropriate disposal in established landfill facilities.

During the January 2010 community consultations, community members expressed general satisfaction that the Project Team had employed all reasonable mitigation measures to address the concerns of the community members. In particular, the community members were generally pleased with the Project's efforts to keep the proposed Highway alignment beyond the 1 km setback recommended by the ILA and the latest version of the Husky Lakes Management Plan.

Representatives of the ILA confirmed that the Hunters and Trappers Committees, the Elders, the Community Corporations, resource management agencies, co-management bodies, the ILA and the proponents of the Inuvik to Tuktoyaktuk Highway should work together to develop the necessary management tools to minimize the potential for such concerns to be realized.

13.0 SPILL CONTINGENCY PLAN

For the construction of the Inuvik to Tuktoyaktuk Highway, the successful prime contractors will be responsible for the preparation and implementation of the appropriate project-specific spill contingency and emergency response plan covering their areas of operation.

The key strategy will be to prevent accidents from occurring through education and enforcement. With the application and implementation of the preventative and mitigation measures as outlined, no significant fuel, chemical or other product spills are expected to occur.

A typical example of a suitable spill response plan is provided in Appendix C. The development of site-specific plans will be undertaken in the future after the prime construction contractors have been selected.

14.0 OTHER ENVIRONMENTAL ASSESSMENTS

From the 1970s to present, all-weather transportation infrastructure has been contemplated and studied approximately once every ten years. Prior to this Project Description Report and the Project Description Report for Screening the Tuktoyaktuk to Source 177 Access Road (Kiggiak-EBA 2008), the most recent environmental and socio-economic assessment to evaluate an all-weather alignment between Inuvik and Tuktoyaktuk was the *Proposed Inuvik to Tuktoyaktuk Road: Environmental/Socioeconomic Baseline Report* (Rescan 1999). In addition to the transportation-oriented environmental assessments, petroleum exploration in the Mackenzie Delta and Beaufort Sea region has generated substantial volumes of information on the environmental aspects of potential industrial developments and related activities.

Relevant to the assessment of the effects of a Highway's linear corridor, petroleum industry environmental assessment efforts, particularly the *Environmental Impact Statement for the Mackenzie Gas Project* (IOL et al. 2004), has amassed substantial additional biophysical baseline data, as well as socio-economic, cultural, and consultation inputs from the residents of Inuvik and Tuktoyaktuk. Prominent in this assessment are the Parsons Lake project, the ConocoPhillips natural gas anchor field and the gathering system that would connect it to the pipeline that will transport gas down the Mackenzie Valley to southern markets. Petroleum industry environmental assessments are considered relevant to this transportation project, and have been cited as appropriate.

Several environmental assessments have been prepared for review by the EISC for land-based oil and gas seismic and drilling exploration in the Delta area from the late 1990s to the present day. These include MGM Energy Corp.'s seismic and drilling programs, Chevron et al. drilling programs, and Petro Canada's seismic and drilling programs on the Tuktoyaktuk Peninsula. In addition, in 1997, the Ikhil Pipeline Project was reviewed by the EISC and an environmental screening of this project was also performed by the NEB as mandated under CEAA. In the offshore, Devon Canada Corporation, GX Technology

Corporation, Imperial Oil Resources Ventures Ltd., and British Petroleum plc have completed assessments and on-going data collection for marine geophysical exploration projects, most thorough of which was the Devon Beaufort Sea Exploration Drilling Program - Comprehensive Study Report (Devon 2004).

Additionally, government departments have stepped up the pace of collecting suitable background data for characterizing and monitoring the natural environment in Canada's north. These data sources comprise a significant amount of information and lessons learned from previous industrial and non-industrial development and related activities in northern environs.

15.0 CLOSURE

As evidenced by decades of planning, investigation, and consultation, the completion of the proposed Inuvik to Tuktoyaktuk Highway has been a long standing goal of the Town of Inuvik, the Hamlet of Tuktoyaktuk, and the residents of the Inuvialuit Settlement Region. It has also been a major policy objective of the Government of the Northwest Territories.

From the regional perspective, the Highway will result in a dramatic decrease in the cost of living in Tuktoyaktuk and other benefits for Inuvik. It will improve residents' access to healthcare professionals and educational opportunities. The Highway will support year-round social and recreational opportunities and will enable family and community interactions that are currently limited to the winter months when the ice road is open. From a national perspective, completing the Highway and connecting Canada from Coast to Coast to Coast will address Canada's goal of establishing a year round transportation link to the Arctic coastline. The proposed all-weather infrastructure will be integral to protecting Canadian sovereignty in the Arctic and providing diverse economic development opportunities for the future.

The Inuvik to Tuktoyaktuk Highway PDR demonstrates the viability and importance of the Highway. It describes how the anticipated effects of the Highway are manageable. This finding is derived from the scientific and engineering assessments conducted for this PDR and from the knowledge shared and views expressed by the communities of Inuvik and Tuktoyaktuk. Consultations revealed a general satisfaction with the approach and proposals contained within the PDR.

Based on consultation with the environmental screening and regulatory authorities, community organizations, and residents, the Project Partners have a high degree of confidence that that the proposed Highway can proceed efficiently through the regulatory process to permitting, construction, and responsible longterm operation and maintenance.

We trust this Project Description Report provides the information required for the Environmental Impact Screening Committee and Federal agencies to successfully complete their screening review of the proposed Inuvik to Tuktoyaktuk Highway project.

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