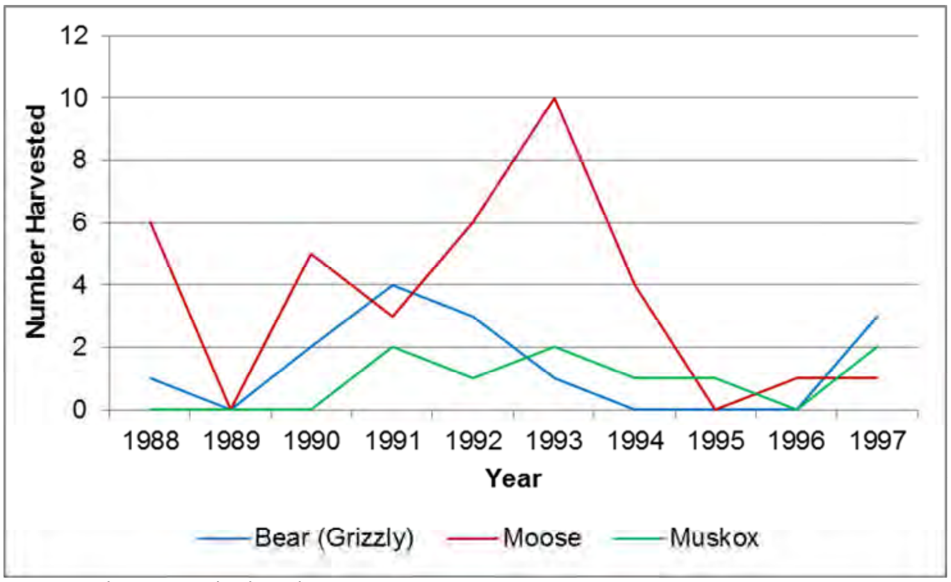
Tuktoyaktuk

The numbers of grizzly bear, moose and muskox harvested in the Tuktoyaktuk area have fluctuated over time for (Figure 3.2.8-5), from six or fewer of each species per year to a high of 10 moose in 1993.

Muskoxen are typically harvested between April 1 and May 31 within the Tuktoyaktuk Planning Area (Community of Tuktoyaktuk et al. 2000).



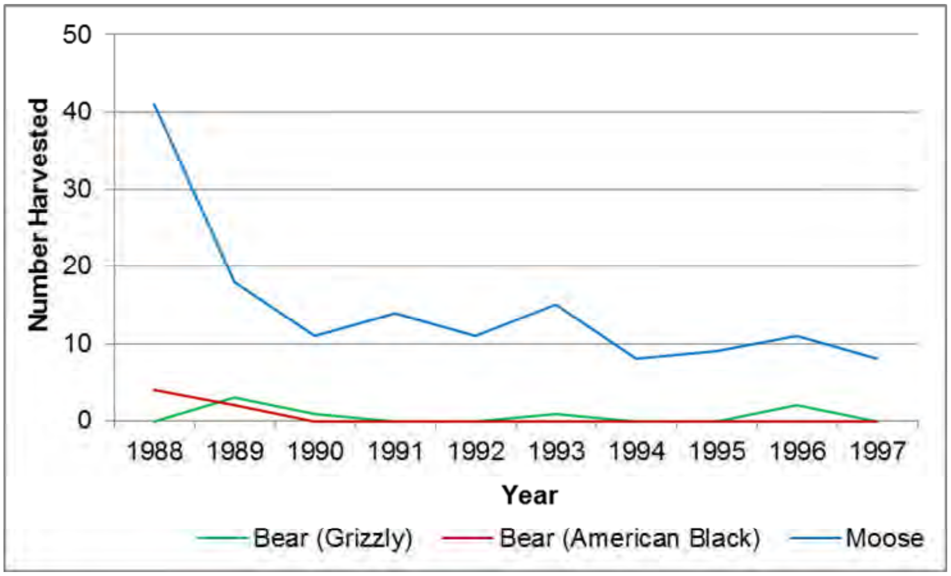
Source: Joint Secretariat (2003)

Figure 3.2.8-5
Estimated Annual Big-game Harvest, Per Species, Tuktoyaktuk, 1988-1997

More recent big-game harvest estimates for the ISR region were not available.

Inuvik

Moose hunting typically occurs between February 1 to March 31 and August 1 to 31 each year in the Inuvik Planning Area (Community of Inuvik et al. 2000). As indicated in Figure 3.2.8-6, between 1988 and 1997 the Inuvialuit annual moose harvest near Inuvik declined from 41 in 1988 to 8 in 1997. The sharpest decline followed the 1988 hunting season of 41 moose to 18 moose the following year. Between 1989 and 1997 the moose harvest near Inuvik fluctuated from 8 to 15 animals.



Source: Joint Secretariat (2003)

Figure 3.2.8-6
Estimated Annual Big-game Harvest, Per Species, Inuvik, 1988-1997

As indicated in Figure 3.2.8-6, based on the Inuvialuit Harvest Study (Joint Secretariat 2003) the Inuvialuit from Inuvik harvested seven grizzly bears between 1988 and 1997, including four that were harvested in 1989. No grizzly bears were harvested in the Inuvik area during the years 1988, 1991, 1992, 1994, 1995, or 1997. However, GNWT ENR records indicate the grizzly bear harvests recorded in the study were biased low. More recent data indicate that between July 2005 and June 2010, one grizzly bear was harvested (GNWT ENR 2010h).

Near Inuvik, it is estimated that less than five black bears were harvested during 1988 and 1989 (Figure 3.2.8-6).

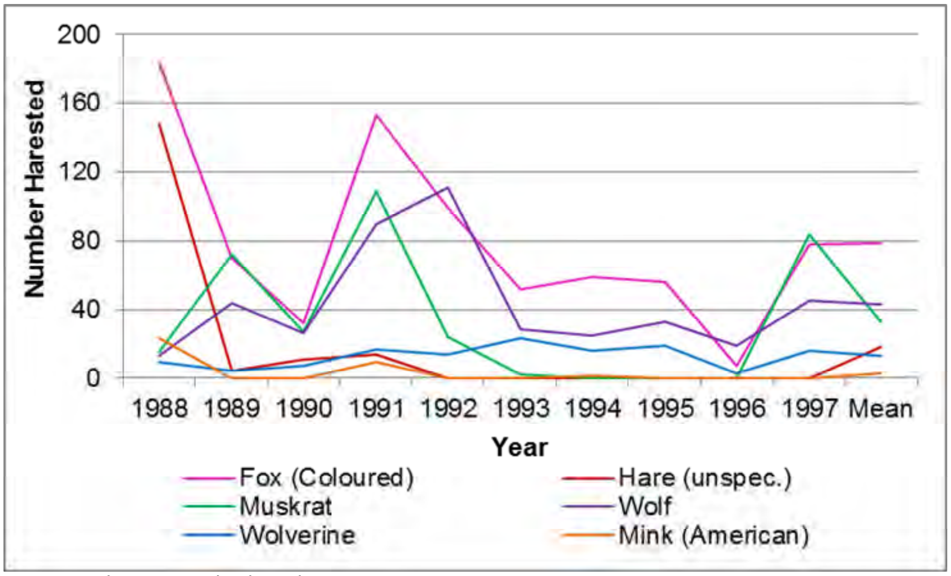
<u>Furbearers and Small Mammals</u>

Active trapping by the Inuvialuit near Inuvik has also been in decline. High-value, furbearing species trapped in the region include fox, American mink, hare, wolf (also classified as big-game), marten, wolverine and muskrat. Hare are also considered an important food source (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Tuktoyaktuk

Active trapping by the Inuvialuit near Tuktoyaktuk has fluctuated over the period from 1988 to 1997 (Figure 3.2.8-7). In the Tuktoyaktuk Planning Area, furbearers are typically harvested between January 1 to April 15 and November 1 to December 15 of each year (Community of Tuktoyaktuk et al. 2000). Muskrat are harvested between March 5 and May 31 each year (Community of Tuktoyaktuk et al. 2000).

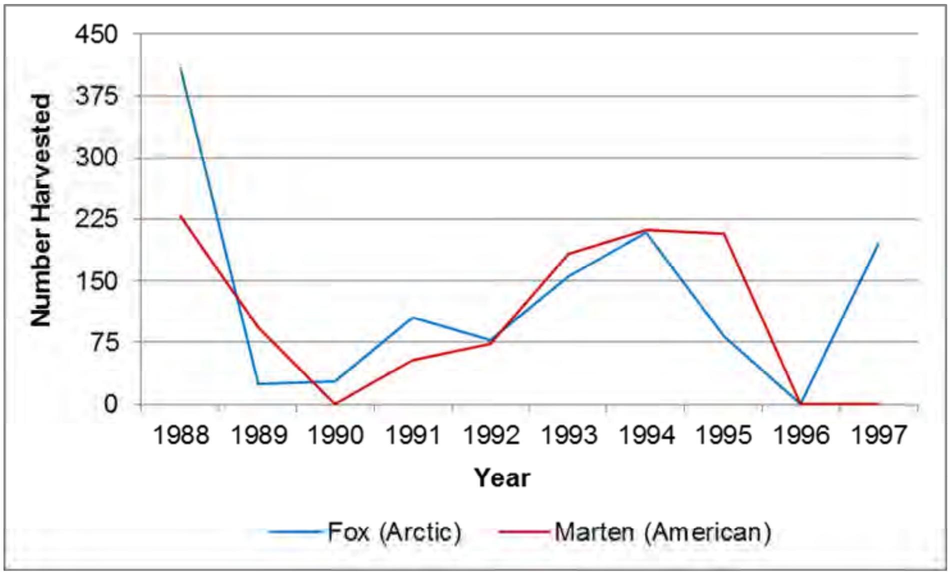
As indicated in Figure 3.2.8-7, mink and hare harvest rates have decreased between 1988 and 1997. Other species have generally fluctuated over this time period (Figures 3.2.8-7 and 3.2.8-8 (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-7
Estimated Annual Furbearers/ Small Mammals Harvest, Per Species, Tuktoyaktuk, 1988-1997

The number of Arctic fox and marten harvested near Tuktoyaktuk fell substantially between 1988 and 1990 and then rose steadily again until 1996 (Figure 3.2.8-8).

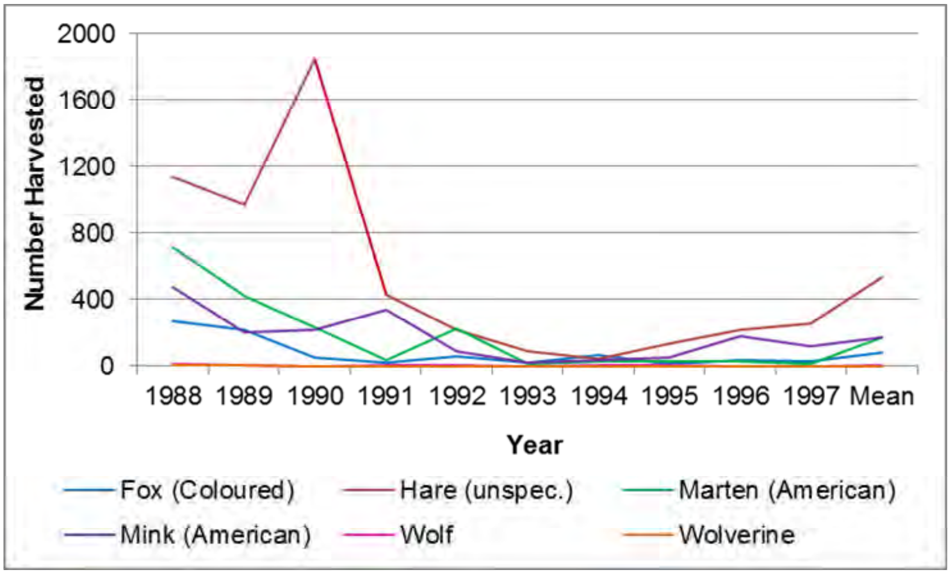


Source: Joint Secretariat (2003)

Figure 3.2.8-8
Estimated Annual Furbearers/ Small Mammals Harvest, Per Species, Tuktoyaktuk, 1988-1997

Inuvik

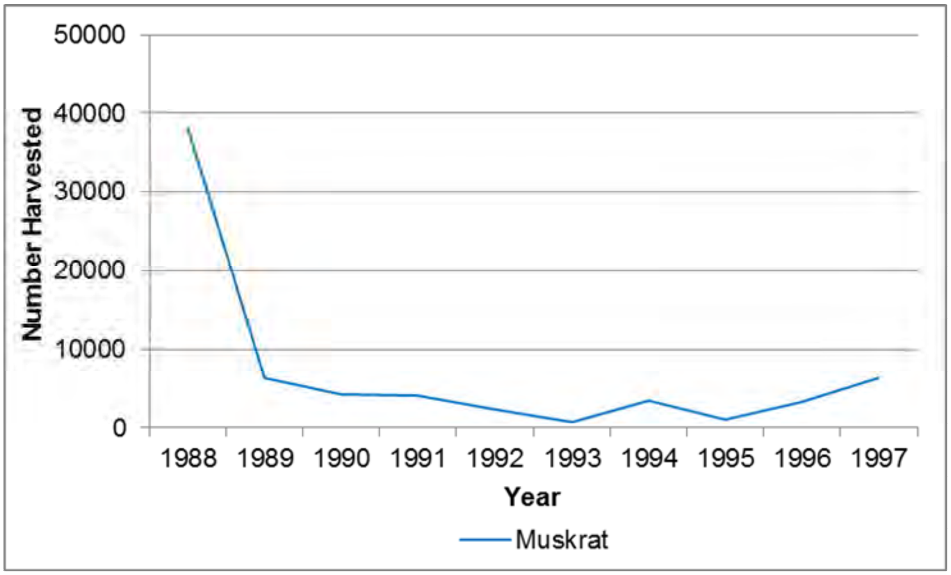
In the Inuvik area, furbearers are typically harvested between January 1 to May 15 and November 1 to December 31 of each year (Community of Inuvik et al. 2000). Muskrat are harvested from March 5 to June 15 each year (Community of Inuvik et al. 2000). As shown in Figures 3.2.8-9 and 3.2.8-10, harvest rates have decreased between 1988 and 1997. An exception is the hare harvest in 1990, which increased sharply in 1990. Wolf and wolverine were the least harvested each year (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-9
Estimated Annual Furbearers / Small Mammals Harvest, Per Species, Inuvik, 1988-1997

Muskrat harvesting has declined between 1988 and 1997, and the sharpest decline was from 1988 (38,136 animals) to 1989 (6,305 animals) (Figure 3.2.8-10). Between 1989 and 1997 the muskrat harvest fluctuated from a low 698 in 1993 to 6,314 in 1997. Figure 3.2.8-11 shows the winter harvesting areas for wolverine.



Source: Joint Secretariat (2003)

Figure 3.2.8-10
Estimated Annual Muskrat Harvest, Inuvik, 1988-1997

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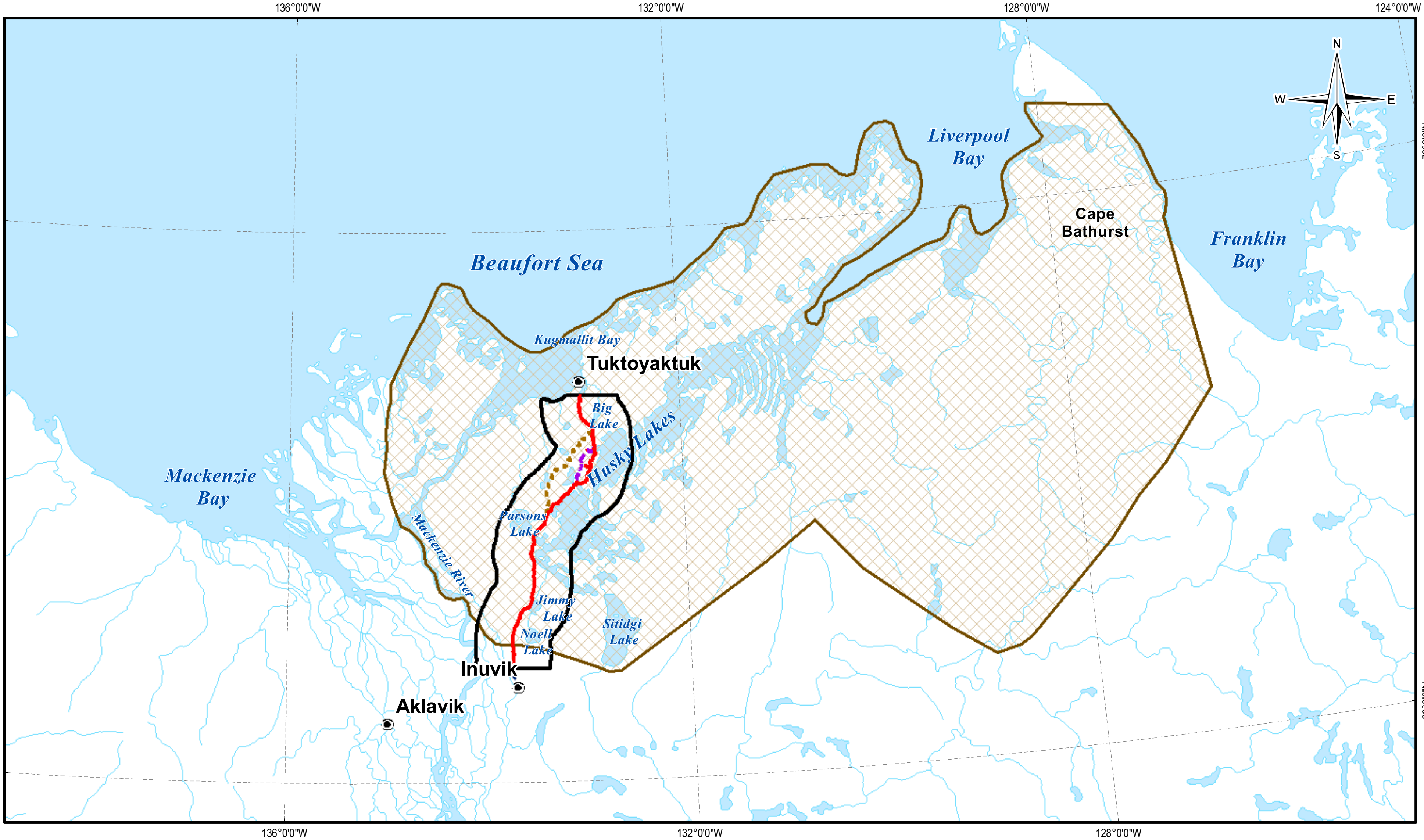


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 314C-Winter Wolverine Harvesting Area
- Watercourse
- Waterbody

NOTES

Base data source: National Atlas
Wolverine Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

ISSUED FOR USE

Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map012_Trad_WolverineHarv.mxd

Town of Inuvik · Northwest Territories · KIGGIAK - EBA

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Wolverine Harvesting Areas Winter

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

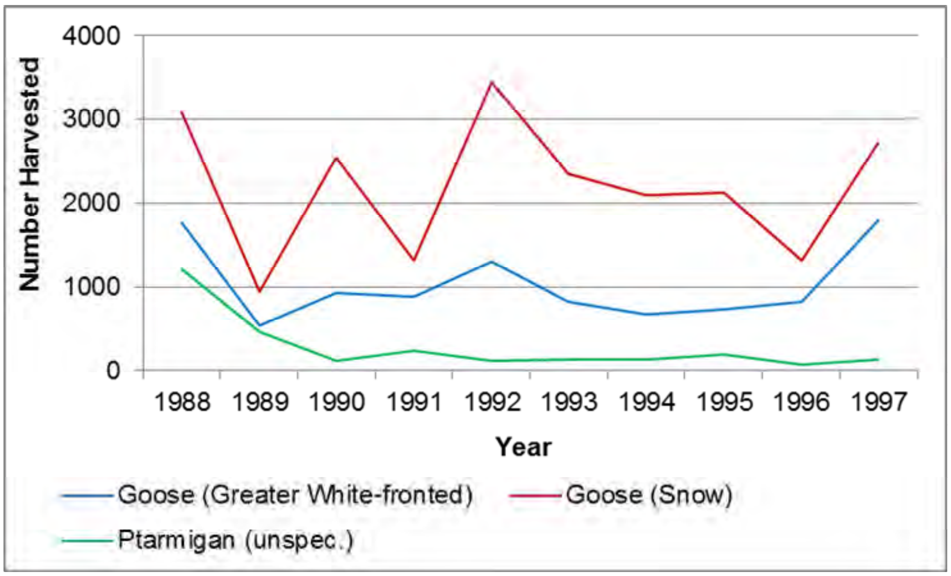
Figure 3.2.8-11

Waterfowl

Waterfowl are an important food source for the Inuvialuit during the spring and fall and the down from these birds is traditionally used in pillows and quilts (Community of Inuvik et al. 2008). Figure 3.2.8-13 shows the spring, summer and fall goose harvesting areas.

Tuktoyaktuk

Birds are harvested in the Tuktoyaktuk Planning Area from May 1 to June 30 and August 1 to September 30 each year (Community of Tuktoyaktuk et al. 2000). As shown in Figure 3.2.8-12, the annual harvest rates of the greater white-fronted goose, snow goose and ptarmigan near Tuktoyaktuk have fluctuated considerably between 1988 and 1997 (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-12
Estimated Annual Bird Harvest (Goose and Ptarmigan), Tuktoyaktuk, 1988-1997

As shown in Figure 3.2.8-14, the annual harvest rates of eider and mallard ducks near Tuktoyaktuk have fluctuated considerably between 1988 and 1997 (Joint Secretariat 2003). According to the available records, no mallards were harvested near Tuktoyaktuk between 1993 and 1997.

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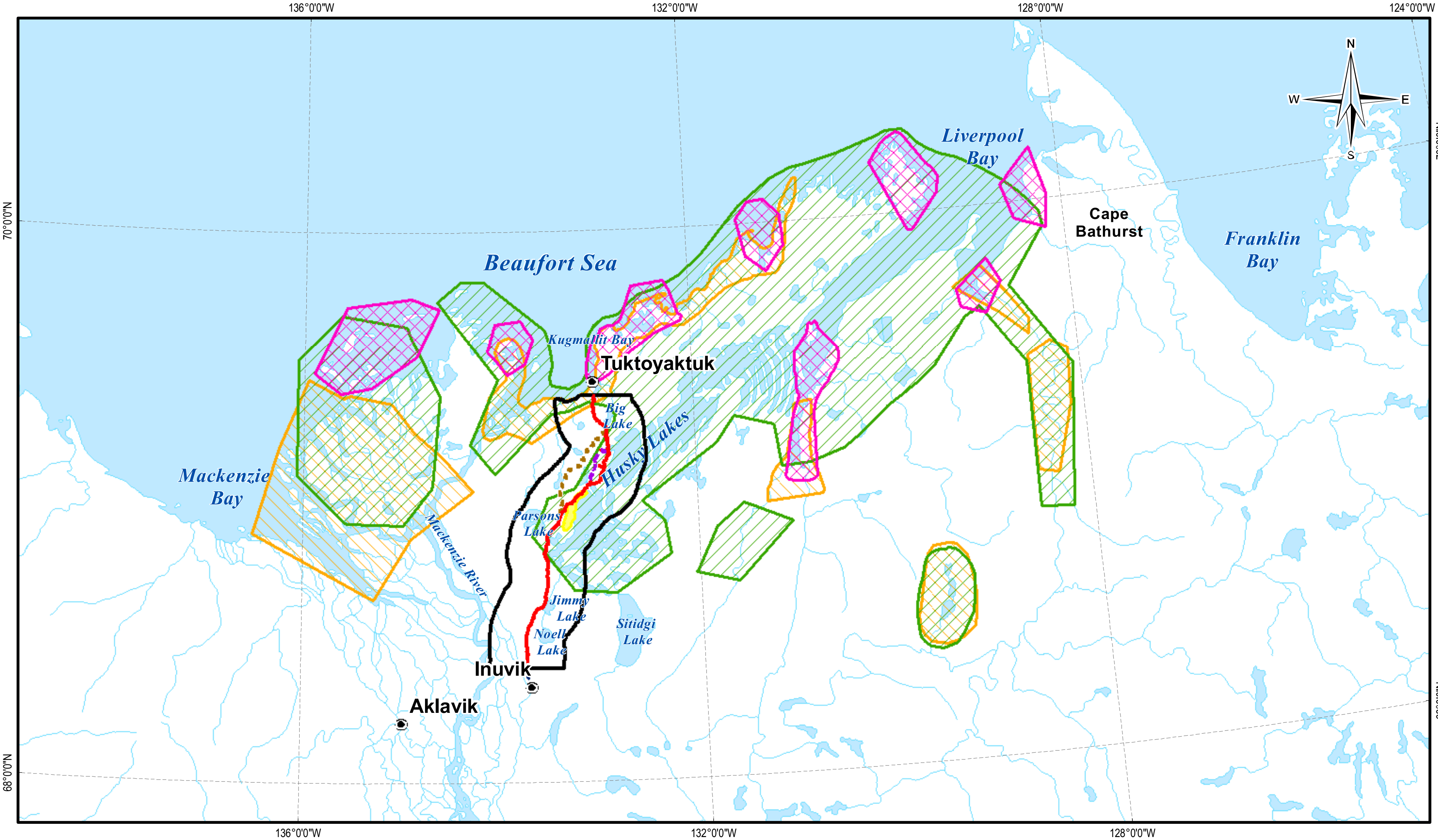


LEGEND

- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- Regional Study Area (15 km buffer)
- 304C-Spring Goose Harvesting Area
- 308C-Summer Goose Harvesting Area
- 312C-Fall Goose Harvesting Area
- Area Where Geese Congregate
- Watercourse
- Waterbody

NOTES

Base data source: National Atlas
Goose Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008
Area of Geese Congregation: Community Consultation, October 2009

ISSUED FOR USE

Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map010_Trad_GooseHarv.mxd

Town of Inuvik — Northwest Territories — KIGGIAK - EBA

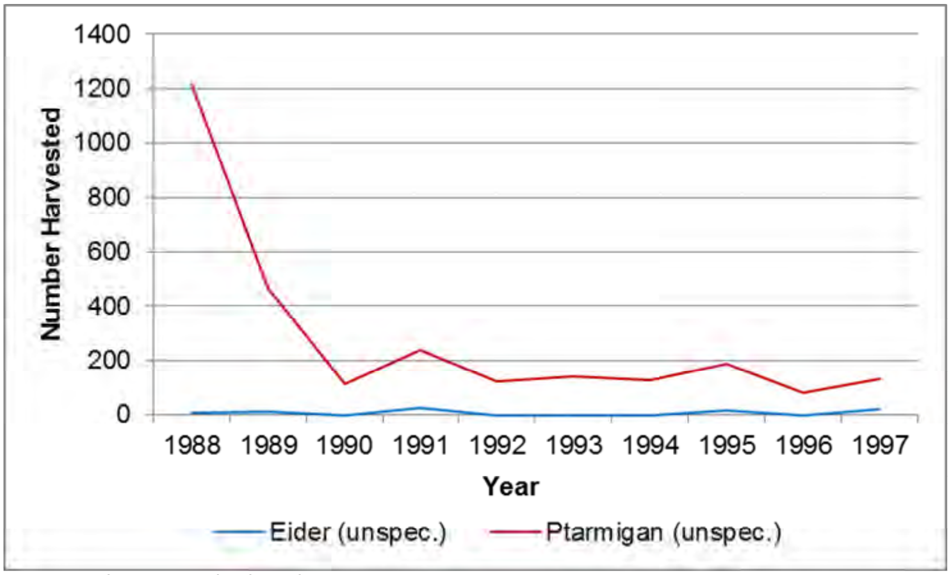
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Goose Harvesting Areas Spring, Summer, Fall

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Figure 3.2.8-13

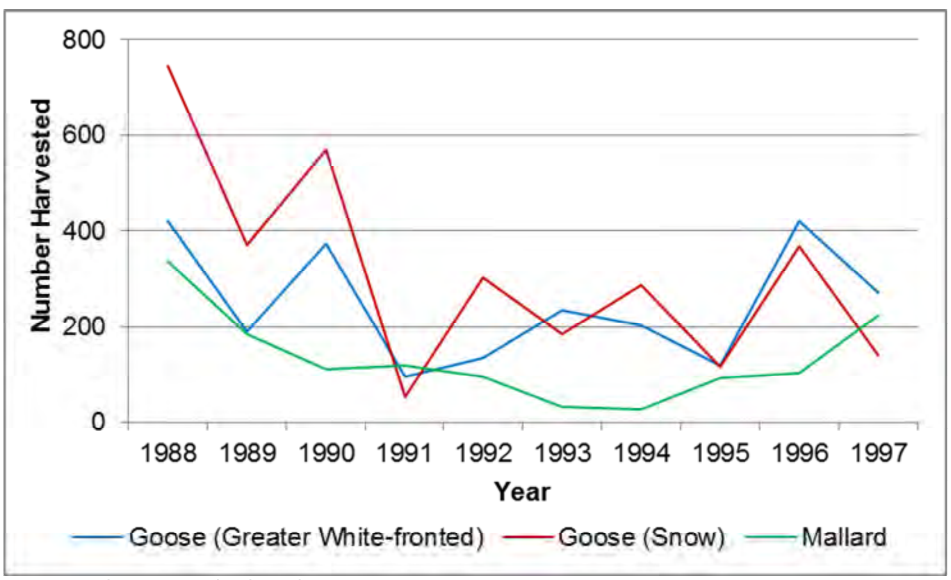


Source: Joint Secretariat (2003)

Figure 3.2.8-14
Estimated Annual Bird Harvest (Eider and Mallard), Tuktoyaktuk, 1988-1997

Inuvik

As shown in Figure 3.2.8-15, the annual harvest rate of the greater white-fronted goose, snow goose and mallard near Inuvik have fluctuated considerably between 1988 and 1997 (Joint Secretariat 2003). Overall, harvest numbers declined between 1988 and 1995 but increased in 1996 and 1997. The harvesting seasons for birds in the Inuvik Planning Area are May 1 to June 30 and September 1 to 30 (Community of Inuvik et al. 2000).



Source: Joint Secretariat (2003)

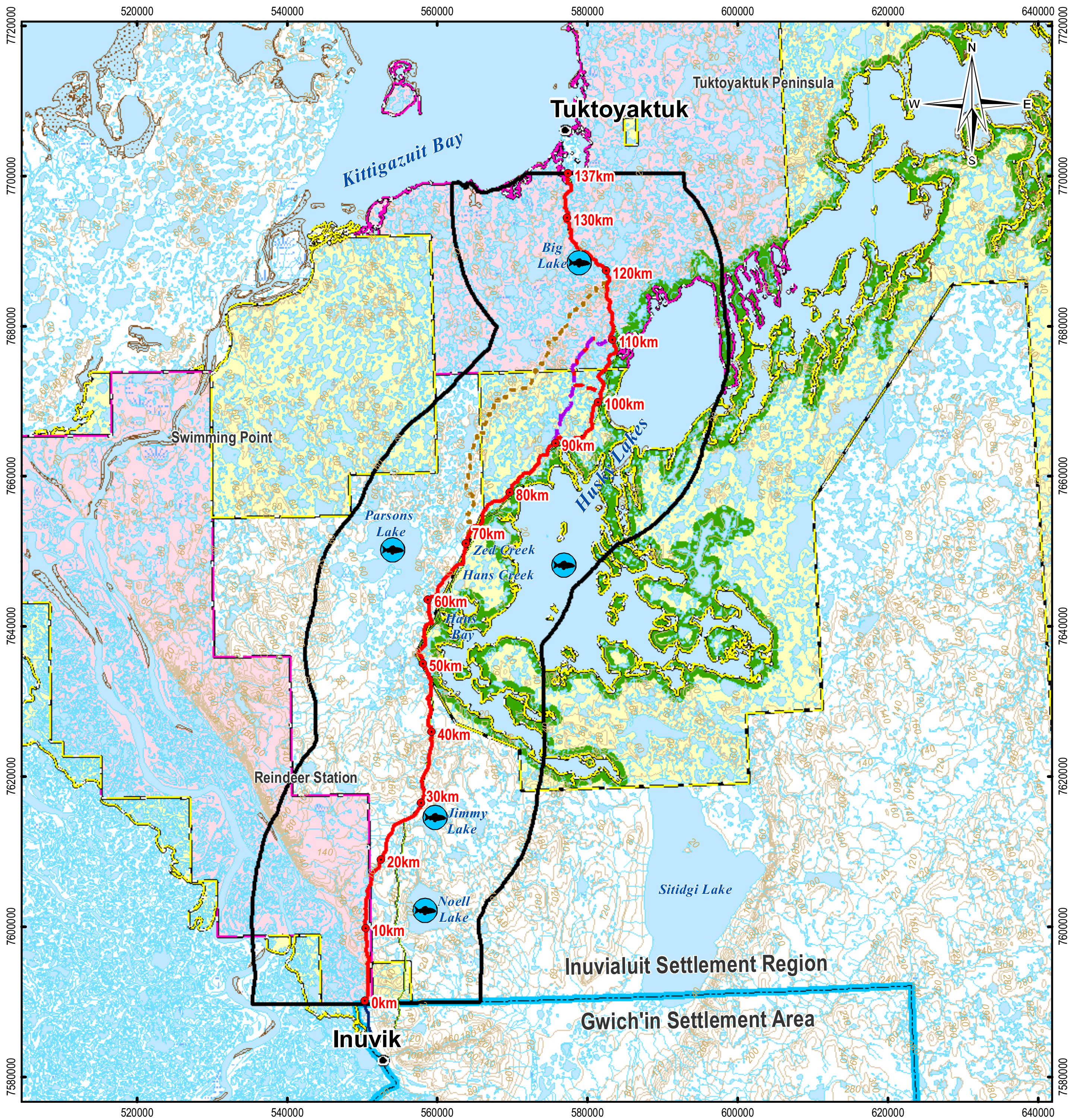
Figure 3.2.8-15
Estimated Annual Bird Harvest (Goose and Mallard), Inuvik, 1988-1997

Fish

Fish are an important food source for the Inuvialuit. The main fish-bearing lakes along the proposed Highway alignment are shown in Figure 3.2.8-16 while fish harvesting areas are shown in Figure 3.2.8-17. Fish-bearing lakes were identified by Rescan (1999a) and IOL et al. (2004), while the fish harvesting areas are identified in the Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2008).

Tuktoyaktuk

Fish species harvested near Tuktoyaktuk between 1988 and 1997 included inconnu, northern pike, lake trout, burbot, lake whitefish, broad whitefish and cisco. In general, the number of cisco harvested near Tuktoyaktuk declined significantly over the reported timeframe. Inconnu harvesting increased sharply in 1991, and declined again in 1992. Between 1988 and 1990, there was a considerable increase in the number of unspecified whitefish harvested from 1988; this may be attributed to the absence of data reported for broad and lake whitefish during that period. As shown in Figures 3.2.8-18 and 3.2.8-19, all other species showed minor fluctuations in the number harvested.



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LEGEND

- Fish Bearing / Ilkaasuat
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Fish Bearing Lakes Along the Proposed Alignment

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:750,000
10 5 0 10 20
Kilometres

FILE NO.
V23201322_EIS_Map007_Fish_FishLake.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 2, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.2.8-16

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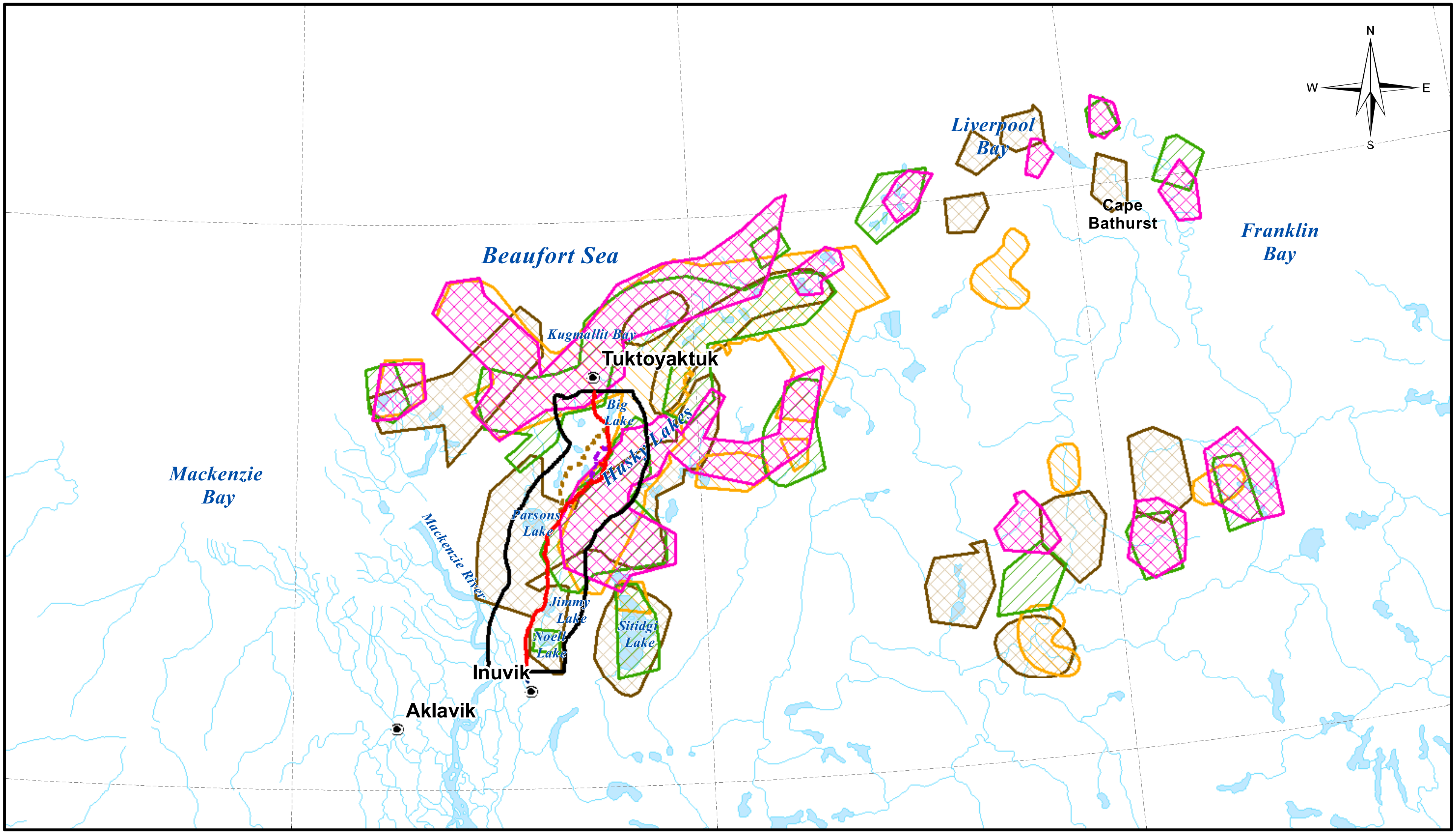


LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 307C-Summer Fishing Harvesting Area
- 305C-Spring Fishing Harvesting Area
- 310C-Fall Fishing Harvesting Area
- 316C-Winter Fishing Harvesting Area
- Watercourse
- Waterbody

NOTES
Base data source: National Atlas
Fishing Harvest Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

ISSUED FOR USE

Scale: 1:2,250,000
20 10 0 20 40 60 80
Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map009_Trad_FishHarv.mxd

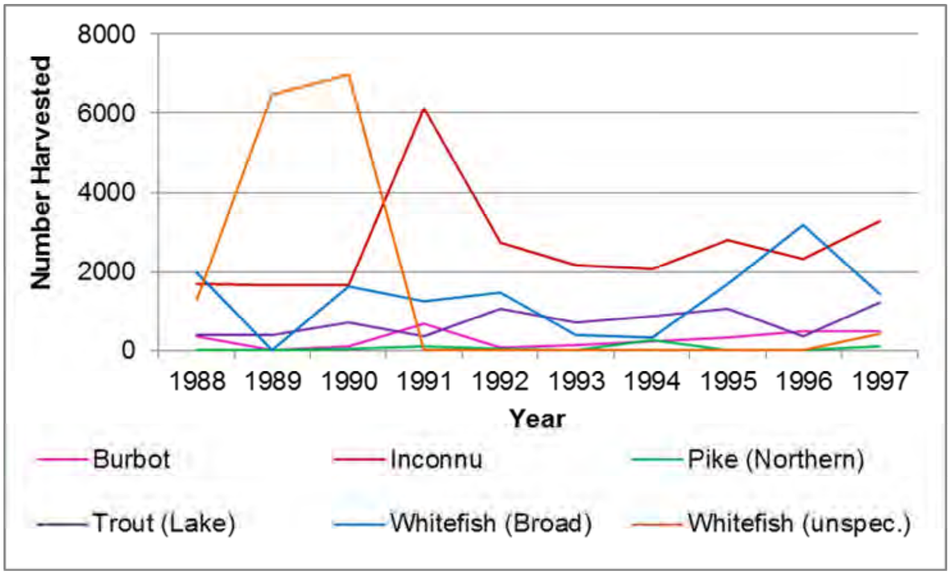
Northwest Territories
Town of Inuvik
KIGGIAK - EBA

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Fish Harvesting Areas Spring, Summer, Fall, Winter

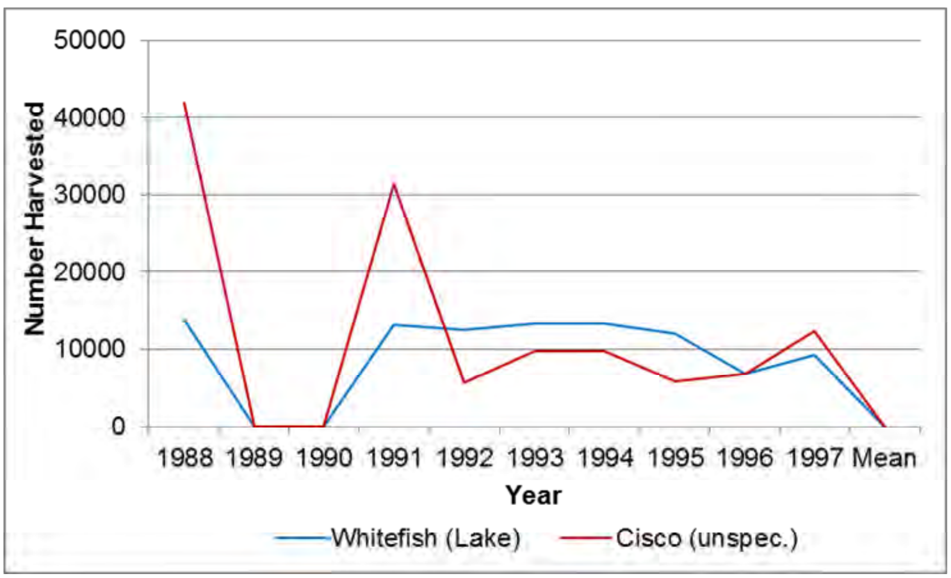
PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0
OFFICE	DATE		
EBA-VANC	May 2, 2011		

Figure 3.2.8-17



Source: Joint Secretariat (2003)

Figure 3.2.8-18
Estimated Annual Fish Harvest, Per Species, Tuktoyaktuk, 1988-1997

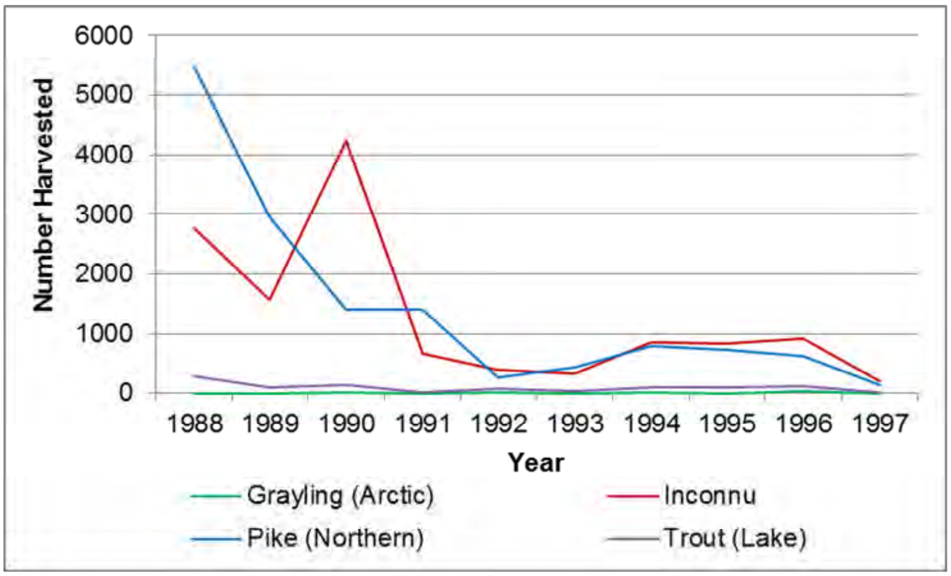


Source: Joint Secretariat (2003)

Figure 3.2.8-19
Estimated Annual Fish Harvest, Per Species, Tuktoyaktuk, 1988-1997

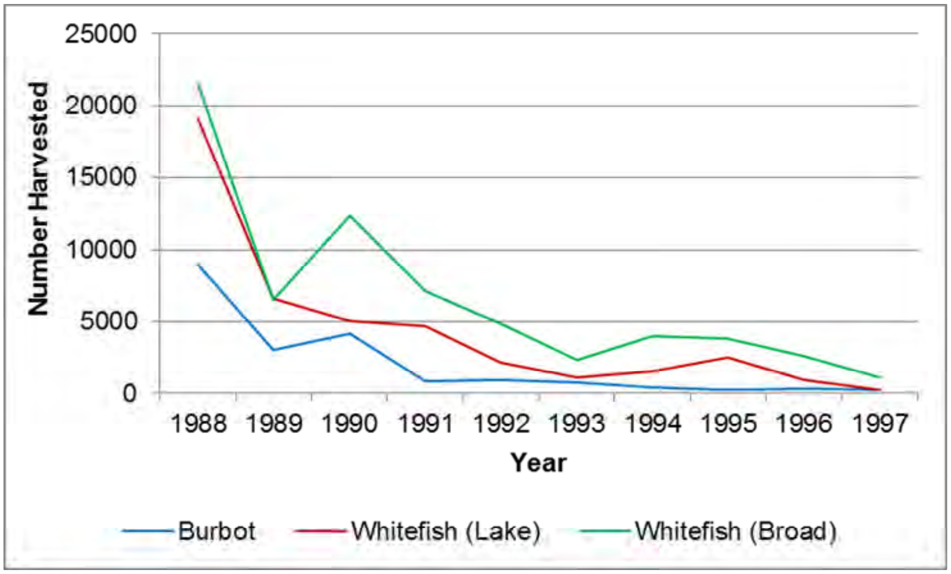
Inuvik

Fish species harvested near Inuvik between 1988 and 1997 included Arctic grayling, inconnu, northern pike, lake trout, burbot, lake whitefish and broad whitefish. In general, the harvest of all fish species near Inuvik declined over the reported time period. As shown in Figures 3.2.8-20 and 3.2.8-21, the greatest reductions in fish harvest occurred in broad whitefish, from 21,557 in 1988 to 1,149 in 1997; lake whitefish, from 19,094 in 1988 to 261 in 1997; and burbot, from 8,772 in 1988 to 216 in 1997. The 1990 harvest year had a considerable increase in the harvest of broad whitefish, burbot, and inconnu from the previous year (1989) before further declines were recorded from 1991 onward (Joint Secretariat 2003).



Source: Joint Secretariat (2003)

Figure 3.2.8-20
Estimated Annual Fish Harvest, Per Species, Inuvik, 1988-1997



Source: Joint Secretariat (2003)

Figure 3.2.8-21
Estimated Annual Fish Harvest, Per Species, Inuvik, 1988-1997

Berries

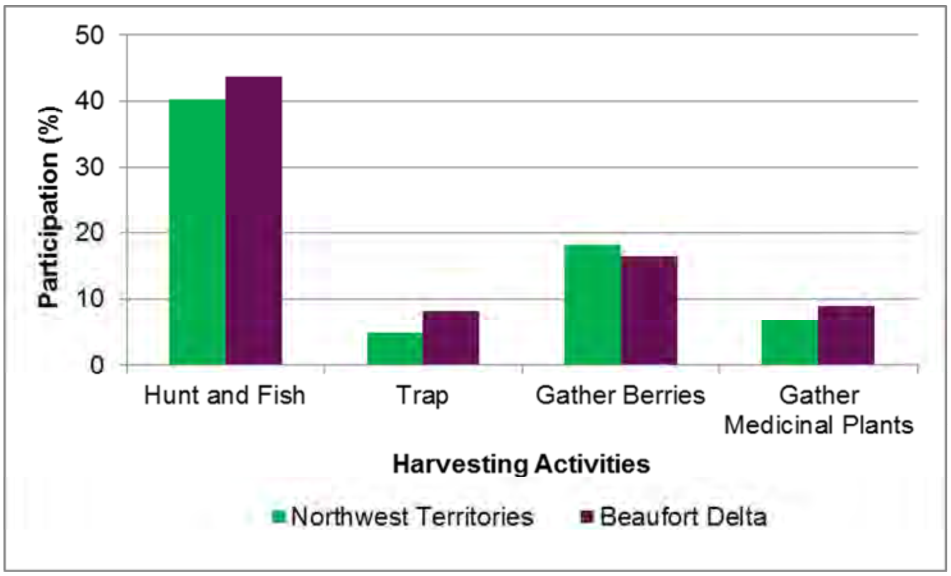
Berry (asiat) picking is an important summer activity (IOL et al. 2004; Kiggiak-EBA 2008). Key berry species include blueberry (*Vaccinium uliginosum* ssp. *alpinum* and ssp. *Microphylum*), or asivit, and salmonberry or cloudberry (*Rubus chamaemorus*), or aqpik. During the October 2009 consultation sessions held for the proposed Inuvik to Tuktoyaktuk Highway, a number of participants in both communities identified berry picking as an important summer family activity. The participants also indicated that the proposed Highway will help families to access new berry picking areas along the route that they cannot reach now. Several participants in the October 2009 consultation sessions at Tuktoyaktuk indicated that during the summer of 2009, some families drove on the completed section of the Tuktoyaktuk to Source 177 Access Road to pick berries along the right of way.

3.2.8.3 Participation in Harvesting Activities for Household Food Supply

The Inuit Health Survey 2007-2008 (Egeland 2010) shows that there is an active hunter in more than half of the households in the ISR. In particular, 70% of households with children have an active hunter. The majority of households in the ISR obtained their country foods directly from hunting themselves or from other family members. Country food is also obtained from friends, the community freezer, purchased at the store, or received from the hunters and trappers committee (Egeland 2010).

In 2002 the GNWT conducted an employment and harvesting survey to gather information about individuals involved in the NWT and Beaufort-Delta region in harvesting activities such as hunting, trapping, fishing, gathering berries, and gatherings plants for medicinal purposes. Information was also collected regarding the consumption of harvested meat and fish (GNWT Bureau of Statistics 2002).

The survey shows that of the people aged 15 years and older in the Beaufort-Delta region and the NWT, hunting and fishing had the greatest percentage of participation (Figure 3.2.8-22). Gathering berries was the only harvesting activity where the NWT's average participation exceeded that of the Beaufort-Delta (GNWT Bureau of Statistics 2002).



Source: GNWT Bureau of Statistics (2002)

Figure 3.2.8-22
Percent of Persons 15 Years of Age & Older Involved in Harvesting Activities, 2002

The survey participant responses were categorized according to gender, age range, and ethnicity (Table 3.2.8-4). Table 3.2.8-4 indicates that the majority of hunting, trapping and fishing activities was conducted by males, while the majority of gathering activities (berries and plants) were conducted by females.

Participation by age group seemed relatively dependent on the type of activity. Most trappers were 40 years and older, while hunters and fishers were active in all age groups. Berry gathering was primarily conducted by those aged 40 years and older, while plant gathering was primarily done by those aged 60 years and older.

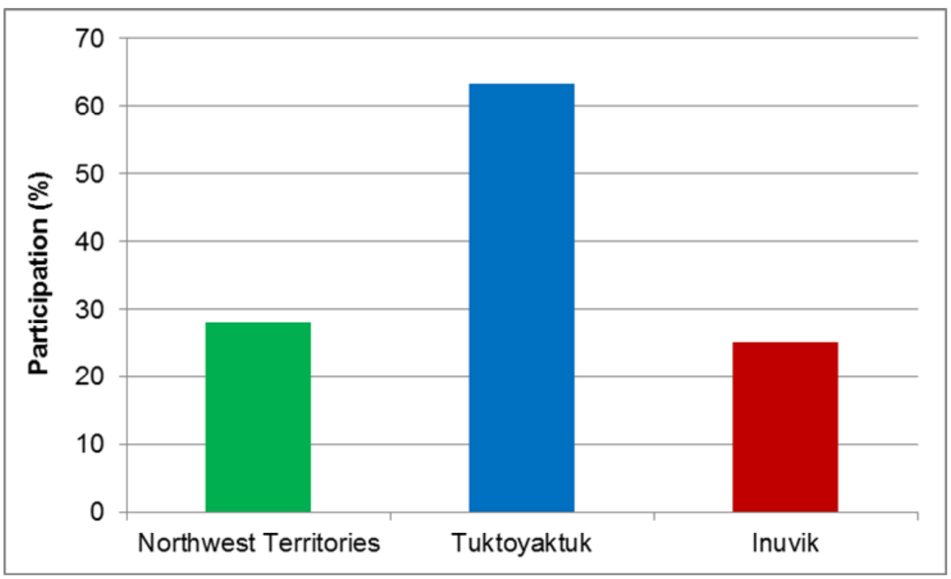
Aboriginal participation in harvesting activities exceeded that of non-Aboriginals (GNWT Bureau of Statistics 2002).

TABLE 3.2.8-4: PERCENT OF PERSONS INVOLVED IN HARVESTING ACTIVITIES, BY SELECTED CHARACTERISTICS FOR THE NWT, 2002

	Trapped	Hunted or Fished	Gathered Berries	Gathered Plants
Persons 15 Yrs. & Older	5.0	40.2	18.2	6.8
Males	7.6	51.4	12.8	5.7
Females	2.2	27.9	24.4	7.9
15-24 Years	4.0	34.6	12.9	3.9
25-39 Years	4.7	40.8	16.9	5.2
40-59 Years	5.1	46.1	22.1	7.3
60 Years & Over	8.3	31.6	23.8	16.6
Aboriginal	9.9	44.9	23.6	13.0
Males	15.4	58.3	16.6	10.7
Females	4.3	30.7	30.9	15.5
Non-Aboriginal	0.7	36.5	13.2	1.3
Males	1.1	46.2	9.4	1.7
Females	0.3	25.4	17.9	1.0

Source: GNWT Bureau of Statistics (2002)

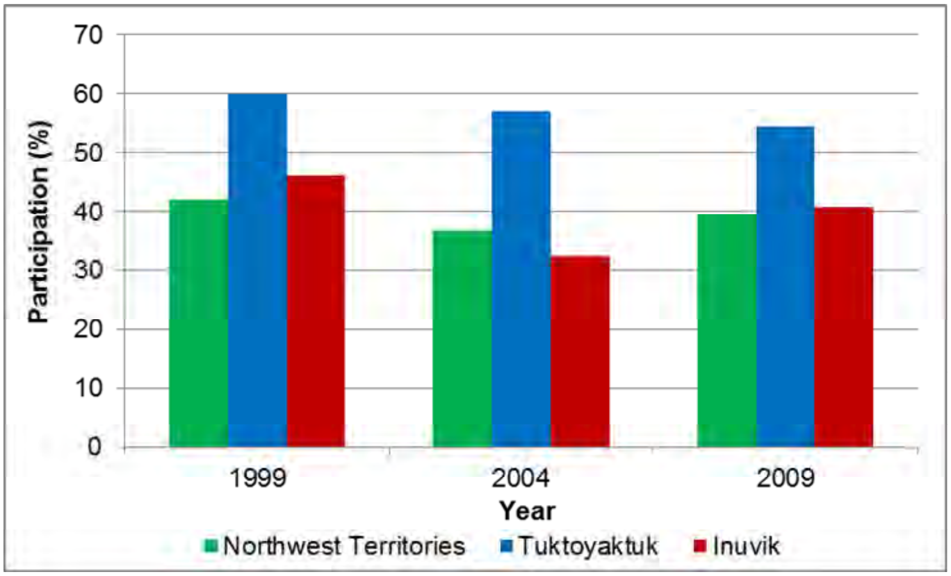
Figure 3.2.8-23 shows the percent of households that obtained half or more of meat and fish consumed by hunting and fishing in 2008. Tuktoyaktuk has the greatest percent participation.



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.8-23
Percent of Households that Obtained Half or More of Meat and Fish Consumed by Hunting and Fishing, 2008

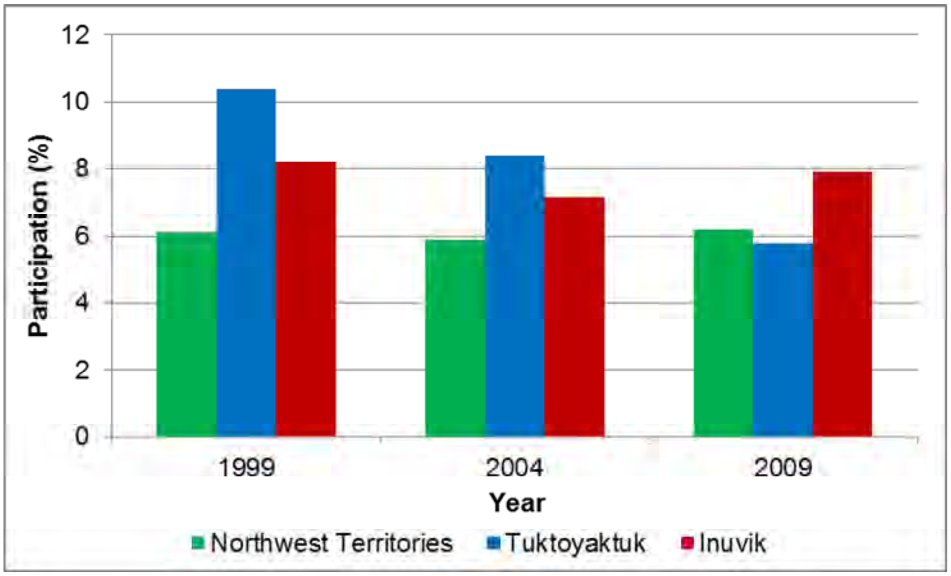
From 1999 to 2009 the percent of the population in Tuktoyaktuk, Inuvik and the NWT participating in hunting and fishing activities has decreased (Figure 3.2.8-24).



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.8-24
Persons 15 and Over Who Hunted or Fished in Previous Years, 1999-2009

Figure 3.2.8-25 shows the percent participation of persons 15 years of age and older who trapped between 1999 and 2009. There are no consistent trends that occur between Tuktoyaktuk, Inuvik, and the NWT.



Source: GNWT Bureau of Statistics (2010g)

Figure 3.2.8-25
Persons 15 and Over Who Trapped in Previous Years, 1999-2009

3.2.8.4 Encroachments and Restrictions of Harvesting Activities

Encroachments

Although there are few, if any, encroachments on current harvesting activities in the region, the recent approval of the Mackenzie Gas Project may change that. If constructed, the Mackenzie Gas facilities and pipelines would encroach upon harvesting areas within the Inuvialuit Settlement Region. Potential infrastructure includes the Parsons Lake Production Facilities and the Storm Hills Pigging Facility (NEB 2010). Project lead Imperial Oil Resources Ventures Limited has until the end of 2013 to indicate whether the Mackenzie Gas Project will be constructed in the near term.

Restrictions

Harvesting restrictions are a management tool implemented by co-management boards and the GNWT. As of 2010, harvesting restrictions are in place for certain wildlife species in the NWT including barren-ground caribou and grizzly bears.

Due to a decline in the barren-ground caribou population, barren-ground caribou hunting was closed to all hunters, including Inuvialuit beneficiaries, from July 1, 2006 to present in Area I/BC/07 (which includes the area of the proposed Highway). In Area I/BC/08, located to the north and east of Tuktoyaktuk, hunting for the Tuktoyaktuk Peninsula Herd is still permitted between June 16 and March 31. However, this area is closed for hunting from April 1 to June 15 to allow the Cape Bathurst caribou herd to migrate back to their calving grounds along the coast.

The Inuvialuit have exclusive harvesting rights to grizzly bear within the Inuvialuit Settlement Region. In 1987 the Tuktoyaktuk HTC expressed concern about over-harvesting of grizzly bears (Community of Tuktoyaktuk et al. 2000). The organization suggested that a quota be established, and the process of implementing a quota began (IDRC ND).

3.2.8.5 Harvesting Rights

The *Inuvialuit Final Agreement* provides the Inuvialuit with preferential harvesting rights to wildlife in the Western Arctic Region, subject to general laws such as public safety and conservation. Inuvialuit harvesting rights include:

- The preferential right to harvest all species of wildlife, except migratory non-game birds and migratory insectivorous birds, for subsistence usage throughout the Western Arctic Region;
- The exclusive right to harvest furbearers, including black and grizzly bears, throughout the ISR;
- The exclusive right to harvest polar bear and muskox throughout the ISR; and
- The exclusive right to harvest game on Inuvialuit lands and if, agreed upon, other areas (IRC 1987).

Fish are not considered "game" they are not included under the IFA exclusive harvest rights for Inuvialuit (Inuvialuit Regional Corporation 1987).

As well, the *Gwich'in Comprehensive Land Claim Agreement* (1992) provides the Gwich'in with certain harvesting rights to wildlife in the Western Arctic Region. In particular, according to Section 27.2.3, the Gwich'in have the right to harvest those species of wildlife which they have traditionally harvested within those areas of the Western Arctic Region which have been traditionally used by the Gwich'in to harvest wildlife.

3.2.8.6 Trapping, Outfitting and Related Area Use

Outfitting and trapping activities and related use areas are discussed in Section 3.2.9.2 of this report.

3.2.9 Land Use

The Tuktoyaktuk Peninsula, the Mackenzie Delta, and the Husky Lakes area have been occupied for several thousand years by the Inuvialuit, with recent in-migration by settlers from Europe and other countries of origin. There are several areas with traditional land use significance, and areas that are specially managed. Due to the rich natural resources in the area, industrial, transportation, and recreational land uses are prevalent and/or proposed for the future. The Inuvialuit continue to harvest and use many of the available natural resources, such as wildlife, waterfowl, fish, and berries.

Information regarding land uses along the proposed alignment of the Inuvik to Tuktoyaktuk Highway has been drawn from a number of sources. In October 2009 and January 2010, consultations and discussions were held with Elders, hunters and trappers, and community residents for this Project, as described in Section 1.6.2. In addition, information gathered during the consultation process for the Tuktoyaktuk to Source 177 Access Road Project Description Screening Report (Kiggiak-EBA 2008) was reviewed and incorporated. Further traditional knowledge information was collected from the Proposed Inuvik to Tuktoyaktuk Road Environmental/ Socioeconomic Baseline Report (Rescan 1999a). Other key sources of information include the Tuktoyaktuk Community Conservation Plan (TCCP) (Community of Tuktoyaktuk et al. 2008) and the Inuvik Inuvialuit Community Conservation Plan (IICCP) (Community of Inuvik et al. 2008).

Information from the Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2008) and the Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008) are summarized in the following sections. Specific references from these reports are designated with a site number and land management category (e.g. 722C) as per the community conservation plan designation.

Representatives from each community organization, including the Tuktoyaktuk Hunters and Trappers Committee (HTC), Inuvik HTC, Tuktoyaktuk and Inuvik Community Corporations, Elders, and other community representatives coordinated development of the original TCCP and IICCP in 1993. In 2000 and 2008, updated editions were prepared by the Tuktoyaktuk HTC, Inuvik Inuvialuit HTC, the newly established Community Conservation Plan Working Group, the Wildlife Management Advisory Council (NWT), and staff from the Joint Secretariat.

3.2.9.1 Historic/Traditional Land Use

Tuktoyaktuk Peninsula

Tuktoyaktuk is located on a peninsula extending into Kugmallit Bay, east of the Mackenzie River Delta, on the Beaufort Sea coast. The name in Inuvialuktun means "resembling a caribou". It was formerly called Port Brabant, and the present name is commonly abbreviated to "Tuk". Tuktoyaktuk is located 122 km (76 mi.) by air or 177 km (110 mi.) by river northeast of Inuvik. In 1934, the Hudson's Bay Company chose this site as an alternative to Herschel Island and as the most suitable harbour in the region for shipping freight shipped down the Mackenzie River for distribution to Arctic coastal communities (Community of Tuktoyaktuk et al. 2008).

For generations, the Inuvialuit have inhabited the coastline from the United States (Alaska)-Canada border to Cape Bathurst. The primary land use patterns of the Inuvialuit in the Tuktoyaktuk region have centered on the Tuktoyaktuk-Kitigaaryuit area. Prior to 1890, the Inuvialuit had minimal contact with Europeans or others and lived a traditional harvesting lifestyle. This changed with the arrival of the American and European whaling ships at Herschel Island in 1890.

The influence of whalers and the spread of various diseases dramatically affected the local population and disrupted previous traditional subsistence patterns. The large settlement at Kitigaaryuit was abandoned just after the turn of the century. The previous local groupings of Inuvialuit became blurred as intermingling of the local Inuvialuit population occurred with whalers and Alaskan Inupiat who had come into the region with the whalers. With the collapse of the whaling economy around 1910, the region suffered a major economic downturn. Many of the whalers remained in the region and established trading and fur posts.

The expansion of trapping areas in the 1920s was attributed to high fur prices and an increase in boat ownership. During the 1950s, the decline of fur prices and the beginning of DEW Line construction at Tuktoyaktuk caused a shift in land use from the surrounding areas into the community, resulting in a temporary contraction of the areas used for hunting and trapping. However, with the introduction of the snowmachine, the Inuvialuit have again moved into these areas (Community of Tuktoyaktuk et al. 2008).

Exploration for petroleum began in the late 1950s, and by the 1970s and 1980s, increased industrial activity created major economic changes in the region. The continued decline in the fur market and the availability of employment with industry shifted large numbers of people into a wage based economy. The decline of oil and gas exploration activity in the early 1990s created a high level of regional unemployment. This continued until the early 2000s with the return of petroleum exploration, and ended again by 2010. Guided sports hunting in the winter and other forms of tourism during the summer have provided employment for a few people. The potential for tourism in the region remains strong due to the location of Tuktoyaktuk on the Beaufort Sea coast and its proximity to Inuvik and access to the south (Community of Tuktoyaktuk et al. 2008).

The majority (75%) of households continue to supplement their wage earnings by deriving a portion of their food from hunting and fishing. Wage employment generally limits the time available to travel to weekends and holidays. This increases the residents' dependence on hunting/fishing areas that are located close to the community, within 100 km (Community of Tuktoyaktuk et al. 2008).A profile of Tuktoyaktuk's population, demographics and community services is provided in Section 3.2.1.

Inuvik

Inuvik is located on the East Channel of the Mackenzie River Delta. It lies at the treeline and is located 97 km south of the Mackenzie Bay on the Beaufort Sea. The name "Inuvik" means "living place".

The Inuvik town site was first surveyed in 1955 and a permanent settlement was established in 1958 when, due to yearly flooding and erosion, the federal government moved its regional offices from Aklavik to the present site of Inuvik. It was originally intended that all government services and employees, as well as the local population would be relocated from Aklavik to the new Town of Inuvik. However, many of the Inuvialuit and Gwich'in residents decided to remain in Aklavik and the settlement continues to exist today. The Mackenzie Hotel, Recreation Hall, Polaris Theatre, RCMP Building and several small houses (known as "512s" due to their 512 sq. ft size) were some of the first buildings to be built in Inuvik, but many of the residents remained living in tents by the river until public housing was completed (Community of Inuvik et al. 2000).

Most of the Inuvialuit that moved to Inuvik were from the Mackenzie Delta region, but many had family ties with other settlements around the delta and even Alaska. John Keevik was the last elected Inuvialuit Chief for the Mackenzie Delta in approximately 1953, well before any land claim was proposed (Community of Inuvik et al. 2000).

The Canadian Armed Forces moved to Inuvik and left in 1986, when satellite communication replaced the need for a staffed base (Community of Inuvik et al. 2000). During the 1960s, people remember turning on their radios for the first time to listen to Wally Firth and Nellie Cournoyea for messages and announcements (Community of Inuvik et al. 2000).

Like Tuktoyaktuk, Inuvik also benefited from oil and gas exploration and despite the boom-bust cycle of activity referred to earlier, the community remains the local headquarters for industry companies exploring in the region, both onshore and offshore.

Inuvik is the regional government centre and transportation and recreation hub for the Mackenzie Delta region. The airport, government services, recreational programs and hospitality industry attract residents from neighbouring communities and tourists. A profile of Inuvik's population, demographics and community services is provided in Section 3.2.1.

The Inuvialuit traditionally hunted and fished in the region where Inuvik is now situated. Historically, trapping muskrat, fox and other furbearers created employment and prosperity in the area but has declined significantly as a result of lower fur prices. Most Inuvialuit do not trap as regularly or as extensively as in the past but some still trap occasionally on weekends and in the spring for muskrats on the Delta. Subsistence harvesting of animals and plants remains important to the Inuvialuit community (Community of Inuvik et al. 2000).

3.2.9.2 Current Land Uses

Existing land uses are identified in Figure 3.2.9-1 and are described below.

Traditional Use/ Special Harvesting Areas

There are several areas in the vicinity of the proposed Primary 2009 Route that are used for traditional or harvesting purposes or have special interest or values between Inuvik and Tuktoyaktuk.

Gungi – also spelled 'gunny', roughly translated means "bottom of the bay." During the consultations held in Tuktoyaktuk on November 21, 2008 for the proposed access road to Source 177 (Kiggiak-EBA 2008), many residents indicated that the area to the south of Tuktoyaktuk, including the Gungi area at the south end of Tuktoyaktuk Harbour and further south towards Big Lake (Ilkaasuat), is used regularly during the summer months for picnicking and berry picking. The residents indicated that a road would allow them to carry on these activities more easily in the future.

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. The lakes provide spawning habitat for herring and lake trout. The Tuktoyaktuk Community Conservation Plan (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). Information for the harvest locations of key species is found in Section 3.2.8.

Fishing Areas – Big Lake (Ilkaasuat or "fishing area") was identified as a popular fishing area for lake trout and pike. Residents stated that a road would allow easier access to this fishing area (Kiggiak-EBA 2008; Rescan 1999a). In 1999, residents from Tuktoyaktuk suggested that people do not fish along the proposed route, but they do fish further to the east, so the Highway would not affect their fishing areas. Inuvik residents identified Husky Lakes as important fishing areas, and were concerned that traffic and industrial activity associated with the Highway may negatively affect the lakes. They suggested that the Highway be moved further away from the lakes. This request was accommodated in the alternative routing options. Fish lakes include Jimmy Lake, Noell Lake, and Parsons Lake. Further information about the fish harvesting area located near the proposed Highway is found in Section 3.2.8.

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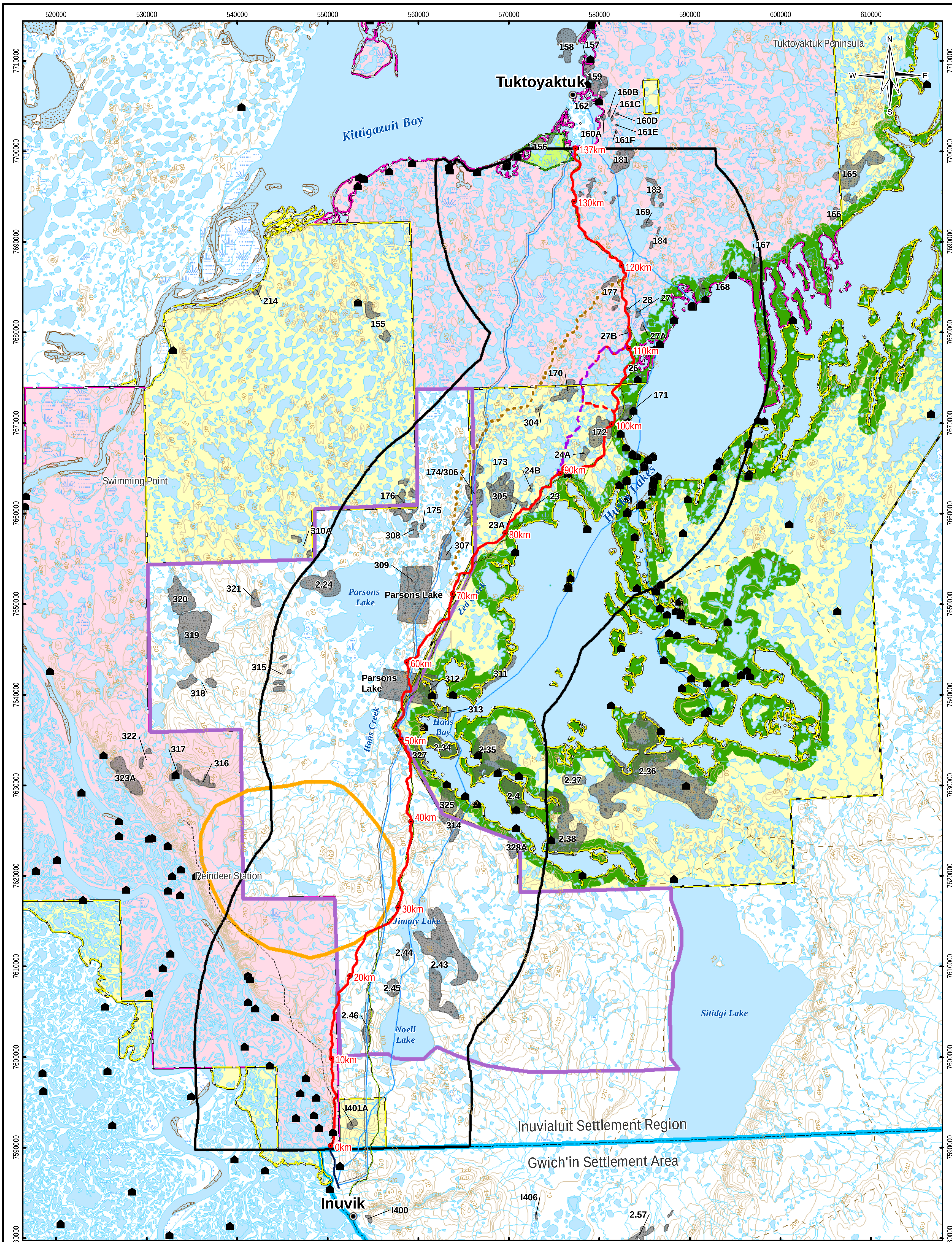

LEGEND

- Residential Leases
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Approximate Winter Reindeer Range
- Approximate Allotment B
- Borrow Sources
- Husky Lakes 1000m Setback
- Former Powerline
- Ikhil Gas Pipeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

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

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Existing Land Uses

PROJECTION: UTM Zone 8
DATUM: NAD83

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

FILE NO.: V23201322_EIS_Map016_Dev_ExistLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE: EBA-VANC
DATE: May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.2.9-1

Hunting and Trapping Areas – during consultations, Tuktoyaktuk residents stated that there is limited hunting from Inuvik to Husky Lakes, but that hunting usually occurs around Parsons Lake. It was further stated that the proposed Highway would be good for hunters and trappers. According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), only wolves and wolverines are harvested in the area of the proposed Highway.

Specific areas related to current wildlife, waterfowl and fish harvesting are identified in the Harvesting Section (Section 3.2.8).

Traditional and Historical Cultural Areas - according to the Tuktoyaktuk Community Conservation Plan (Community of Tuktoyaktuk et al. 2008), traditional and historical cultural areas are identified in areas east of Husky Lakes (Map 15), not in the vicinity of the proposed Highway.

According to the Inuvik Inuvialuit Community Conservation Plan (Community of Inuvik et al. 2008), traditional Inuvialuit camps and cultural sites have been identified but are not available to the public on maps.

Traditional Trails

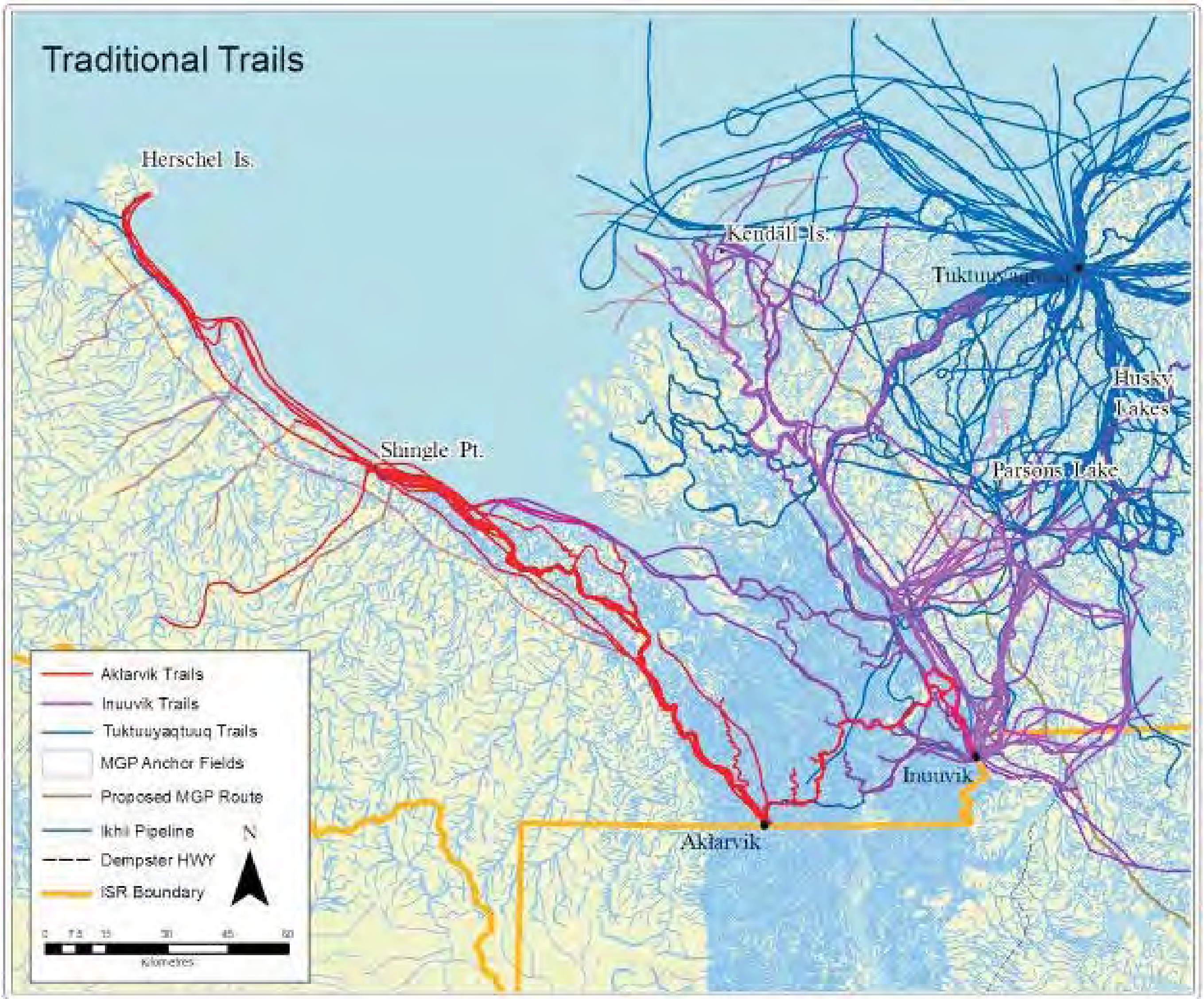
Since the introduction of snowmachines, winter access trails are developed each winter as needed that allow residents of Tuktoyaktuk and Inuvik to pursue recreational, hunting, trapping and other activities on the Tuktoyaktuk Peninsula and in the Mackenzie Delta, including in the general area of the proposed Highway. Several routes that are established every winter are the traditional routes from Tuktoyaktuk and Inuvik to the Husky Lakes area (Figures 3.2.9-1 and 3.2.9-2). The October 2009 consultations sessions confirmed that many families have and continue to use the traditional winter routes to the Husky Lakes.

Seasonal and Permanent Camp Areas

According to ILA records, there are currently 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 (Figure 3.2.9-1).

According to the Tuktoyaktuk CCP (Community of Tuktoyaktuk et al. 2008), there are approximately 25 recreational, educational and trapping cabins located throughout the area. Locations of residential leases are identified in Figure 3.2.9-1; locations of cabins are identified in Figure 3.2.9-3 (ICC et al. 2006).

Specific types of cabin use, such as individual, recreational and commercial use is not available.



NOTES

1. Source: Figure 20. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Traditional Trails

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	March 15, 2011

Figure 3.2.9-2

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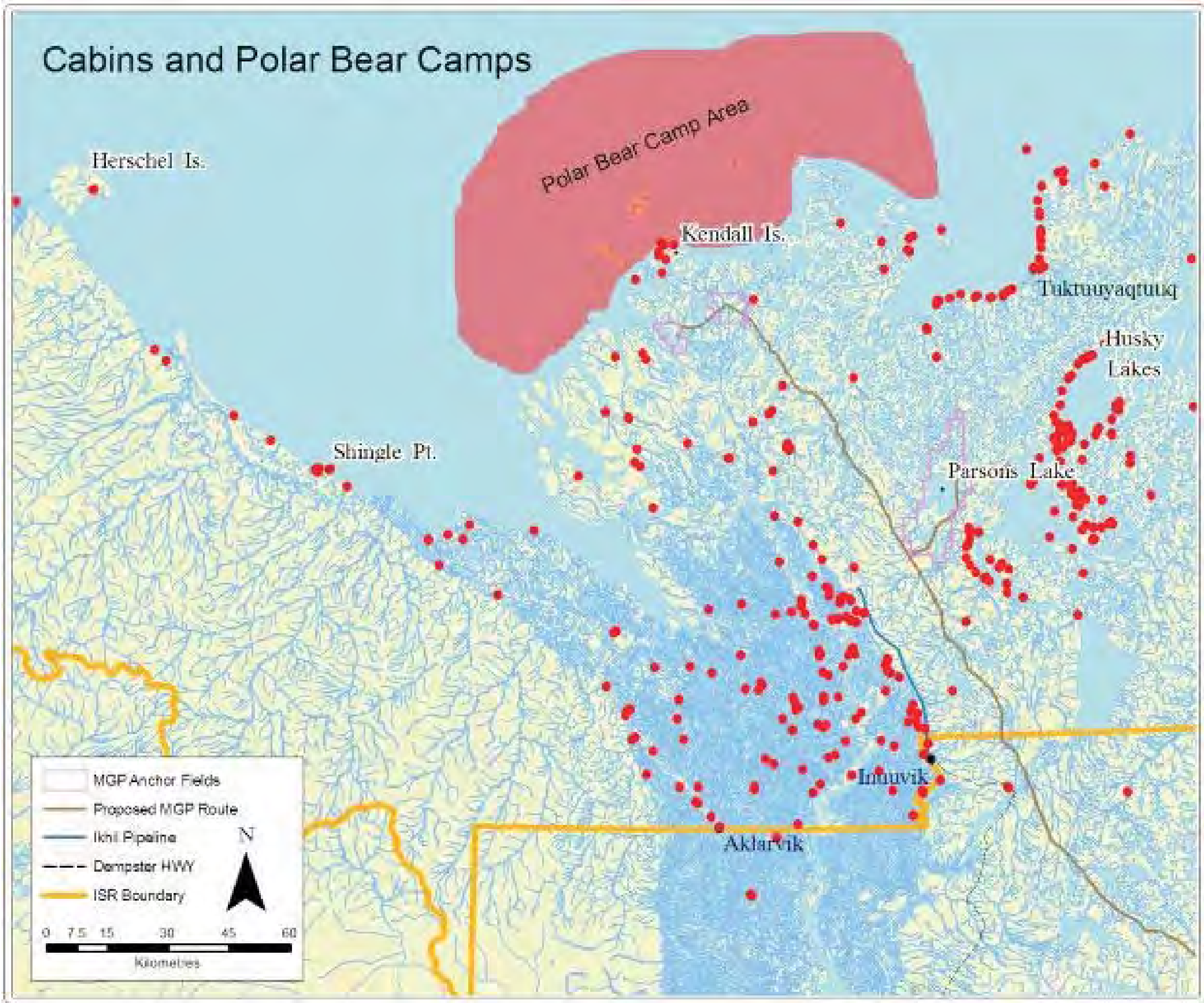

NOTES

1. Source: Figure 9. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Cabins and Polar Bear Camps

PROJECT NO.	DWN	CKD	REV	
V23201322	SL	TS	0	**Figure 3.2.9-3**
OFFICE	DATE			
EBA-VANC	March 15, 2011			

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Parks and Recreation Areas / Protected Areas

Pingo Canadian Landmark (728E) - The area around Tuktoyaktuk has the greatest concentration of pingos. In particular, the Ibyuk Pingo is 50 m (164 ft) tall, and is approximately 1,000 years old. The Landmark is located approximately 4 km (2.4 mi) southwest of Tuktoyaktuk, covering a total of 16.4 km^2 (6.3 mi^2).

This area is protected under the *Canada National Parks Act* and *Western Arctic (Inuvialuit) Claims Settlement Act*. The proposed Highway is not located in this area (Community of Tuktoyaktuk et al. 2008).

Transportation Corridors

Tuktoyaktuk to Source 177 Access Road - A 19 km access road from Tuktoyaktuk to a nearby granular source was completed in 2010. The road 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.

Winter Road - Every year a winter road is constructed between Inuvik and Tuktoyaktuk. This transportation link allows residents and businesses to transport people and goods between communities. According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), the winter road allows Tuktoyaktuk residents to access cheaper goods in Inuvik and to conduct banking in Inuvik.

According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), the winter road is not used for harvesting as people typically use their snowmachines for harvesting.

Winter Access Trails - As noted above, snowmachine trails are developed each winter as needed for recreational, hunting, trapping and other activities in the region including the general area of the proposed Highway. Several routes that become established every winter are the traditional routes from Tuktoyaktuk and Inuvik to the Husky Lakes area (Figure 3.2.9-1).

The consultations sessions held in October 2009 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) power line right-of-way (ROW) that extended from Inuvik to Tuktoyaktuk (Figure 3.2.9-1).

Summer Access Trails - According to Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011), the Husky Lakes is not accessed much during summer months.

Granular Resources

Information regarding the material resources available in the Regional Study Area is located in Section 2.6. Before any removal of sand or gravel from Inuvialuit lands, a license must be obtained from the Inuvialuit Land Administration. The IFA contains various conditions on rights, fees and royalties payable (INAC 1997).

Industrial Zones

There are no areas designated specifically for industrial development within the non-municipal areas of the ISR. According to the Mackenzie Delta-Beaufort Sea Regional Land Use Planning Commission, the land classification system was developed to "contribute to conservation of important resource areas without necessarily formal legal designation… their intent is not to foreclose economic development in the region… rather, classifying the lands defines the conditions under which conservation and utilization can be assured" (MD-BSRLUPC 1991). Therefore, there are no specific industrial zones; rather, land uses may be proposed within areas that allow for that type of land use (e.g., Management Categories A to E).

The Town of Inuvik has zones for light industrial and heavy industrial development (Town of Inuvik 2008).

3.2.9.3 Land Use Designations

Land Management Categories

According to the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans, the proposed Highway alignment passes through several special management areas. In general, the Highway is located in the areas with Management Categories "B", "C" and "E" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Management Category "B" means that the "lands and waters where there are cultural or renewable resources of some significance and sensitivity but where terms and conditions associated with permits and leases shall assure the conservation of these resources" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Management Category "C" means that the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Management Category "E" means that the "lands and waters where cultural or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

Figure 3.2.9-4 shows the all-site designations in the Inuvik Planning Area in relation to the proposed Highway. The all-site designations for the Tuktoyaktuk Planning Area are similar to the Inuvik Planning Area, in the Project RSA.

Areas of High Conservation Value/ Ecological Sensitivity or Importance

The special management areas that the proposed Highway is located in, or in the vicinity of, are described below, and are shown on Figure 3.2.9-5.

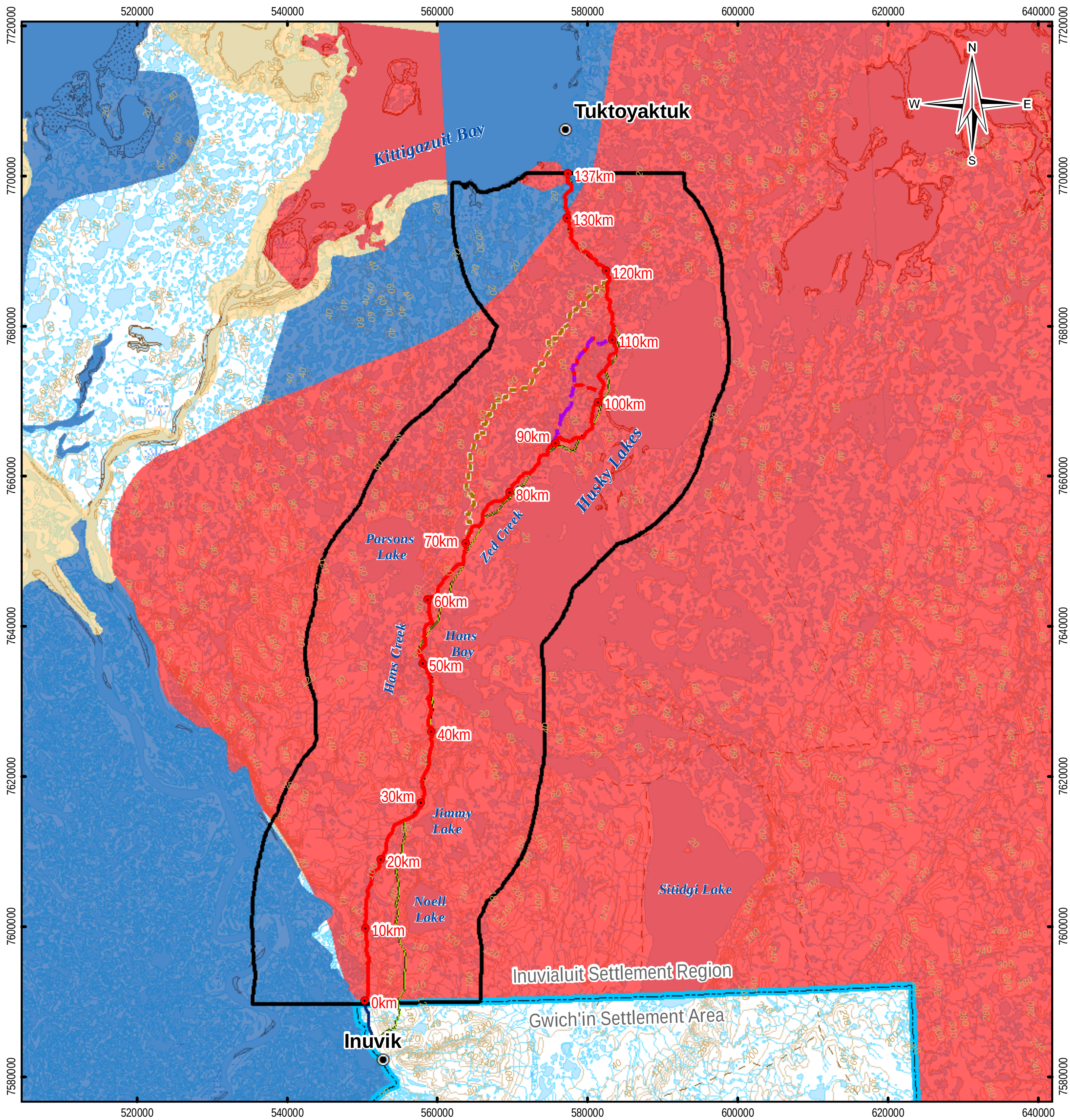
Critical Grizzly Bear Denning Areas (322C) - Grizzly bears make their dens over an expansive area between October and May each year. The proposed Highway is located within this area.

Caribou Hills (702B) - The Caribou Hills management area is in the middle of the Mackenzie Delta, with a unique transition zone between alluvial taiga and low tundra habitats. It has a unique successional plant life and is an important subsistence berry picking and harvesting area. A portion of the proposed Highway is located within the Caribou Hills area.

Fish Lakes and Rivers (704C) - The northern portion of the proposed Highway is located within Fish Lakes and Rivers management area which includes the rivers and lakes along the shoreline west of Tuktoyaktuk, inland to their headwaters, as well as Parsons and Yaya Lakes. These lakes and rivers are important fish habitat and important historical and current subsistence harvest areas used by the residents of Tuktoyaktuk and Inuvik. The proposed Highway is located within this area.

Husky Lakes (705E) - The Husky Lakes management area is adjacent to a portion of the proposed route of the Inuvik to Tuktoyaktuk Highway. The Husky Lakes and the area surrounding the lakes provide important historical and current subsistence fishing, trapping, hunting and berry picking areas. There are approximately 25 recreational, educational and trapping cabins located throughout the area. The Lakes are an important spawning area for Pacific herring, lake trout and beluga (Community of Tuktoyaktuk et al. 2008).

The Husky Lakes area is considered by the residents of Tuktoyaktuk and Inuvik to be very important for year-round hunting, trapping, fishing, and recreational use and for seasonal berry picking. The lakes provide spawning habitat for herring and lake trout. The TCCP (Community of Tuktoyaktuk et al. 2008) 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 has been more limited to the west of Husky Lakes (including the vicinity of the Highway alignment).



LEGEND

Site Designation

- Management Category "B"
- Management Category "C"
- Management Category "D"
- Management Category "E"
- Gwich'in / Inuvialuit Boundary
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES

Base data source: NTS 1:250,000
Site Designations: Joint Secretariat, Inuvik CCP November 2008

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

All Site Designations in the Inuvik Planning Area

PROJECTION: UTM Zone 8	DATUM: NAD83

Scale: 1:750,000

10 5 0 10 20
Kilometres

FILE NO. V23201322_EIS_Map056_SiteDesignations.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 17, 2011

Town of Inuvik
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Figure 3.2.9-4

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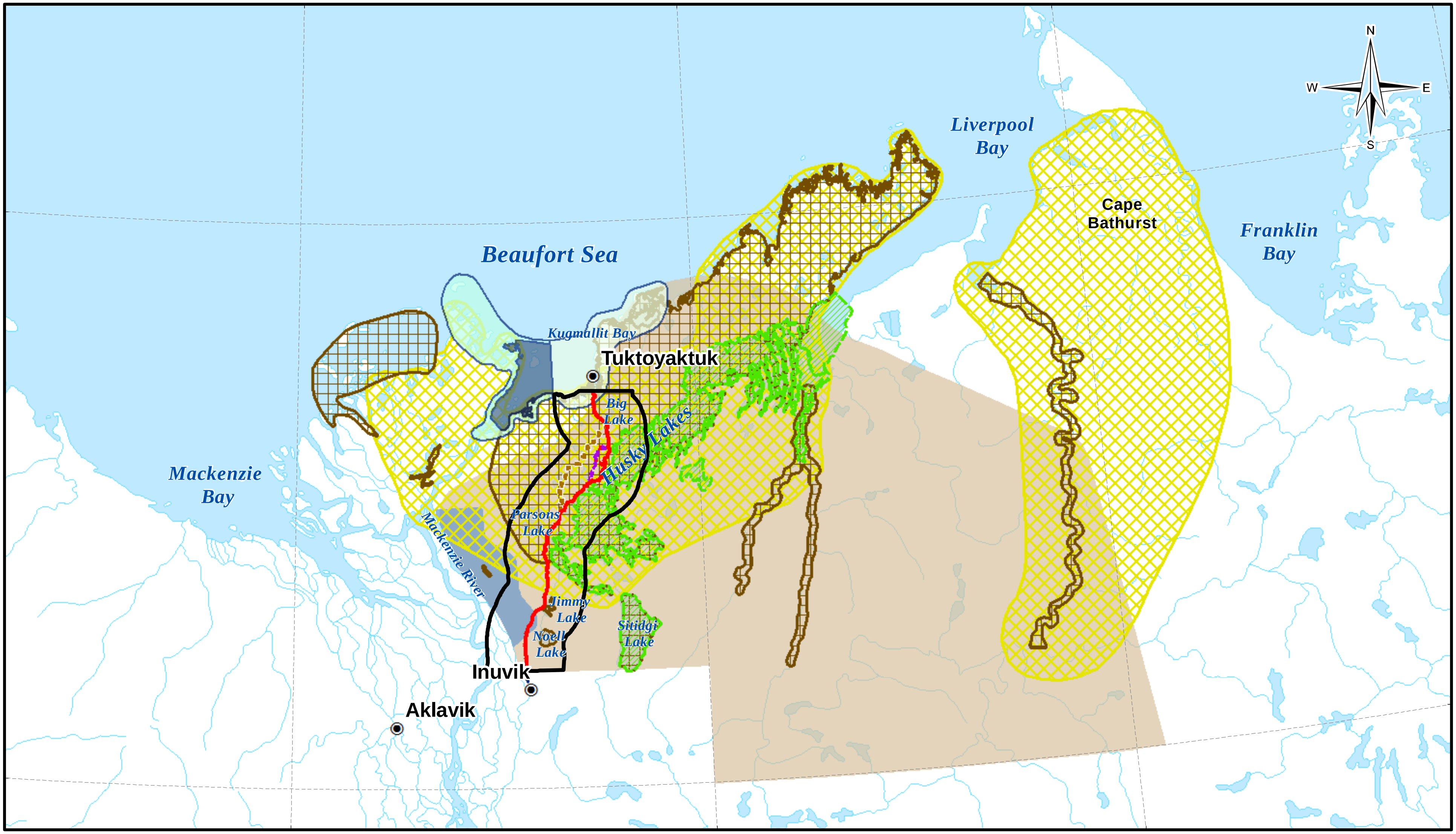

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- 322C-Grizzly Bear Denning Areas
- 701E-Bluenose-West Winter Range
- 702B-Caribou Hills
- 704C-Fish Lakes and Rivers
- 705E-Husky Lakes
- 728E-Pingo Canadian Landmark
- 714C-Kugmallit Bay
- 714D-Kugmallit Bay
- 714E-Kugmallit Bay
- Watercourse
- Waterbody

NOTES

Base data source: National Atlas

Management Areas: Joint Secretariat, Tuktoyaktuk CCP April 2008

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Scale: 1:2,250,000

20 10 0 20 40 60 80

Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD83

FILE NO.
V23201322_EIS_Map028_SpecialMngt.mxd

Town of Inuvik · Northwest Territories · KIGGIAK - EBA

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Special Management Areas

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 17, 2011

Figure 3.2.9-5

The Husky Lakes Integrated Management Planning Study completed in 2001 suggested that the area was already under pressure and that local people were concerned about the deterioration of the "specialness" of Husky Lakes due to increased garbage and crowding from increasing numbers of cabins and residential leases (Hoyt 2001). At that time, there was concern that land use activities could 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.

The EIRB (2009) prepared a draft guidance document for proposed developments in the Husky Lakes Area entitled "Criteria for Establishing Environmental Standards and Criteria for Evaluating a Developer's Standard of Performance in the Husky Lakes Area (Area Number 2, Annex D, *Inuvialuit Final Agreement*)". This document is a draft update from the version adopted in 2002.

In accordance with the anticipated revisions to the Husky Lakes criteria and the direction provided by the ILA, the initial Primary 2009 Route was re-routed to maintain a minimum setback of 1 km from the boundary of the Husky Lakes Special Management Area, with the exception of one area of encroachment. Alternative alignments have since been developed that do not encroach upon this setback.

This Environmental Impact Statement outlines the methods that will be employed to conform to EIRB's criteria for establishing environmental standards. EIRB's draft criteria are:

Traditional and Beneficiary Usage - Developments shall not produce air conditions, vibrations, noise levels, or any other disturbance that interfere with beneficiaries' use of the Husky Lakes Area.

Development Footprint - Developments shall be carried out so that the area occupied by the project site is no larger than necessary. Ideally, after final remediation, there will remain no evidence of environmental disturbance in and about the development site.

Land-Use Conflicts - Developments shall avoid conflicts with community and beneficiary use of the land. Traditional land use activities will have priority over development activities.

Archaeological and Heritage Resources - Developer must take all reasonable steps to identify, locate and protect known and unknown heritage resources in the Husky Lakes Area.

Flora - Developments will be carried out in such a manner that plants are preserved and undisturbed to the greatest extent possible. Reasonable efforts must be taken to identify and protect areas of rare, at risk, and traditional use plants in the Husky Lakes Area

Water Quality - Developments in the Husky Lakes Area must not result in any adverse impact to the ambient hydrological regime taking into consideration seasonal variations.

Air Quality - Air emissions resulting from a development in the Husky Lakes Area must meet the most current Canadian and Northwest Territories air quality standards.

Soils - Developments must proceed in such a manner that the native soils and any imported project materials (e.g. aggregate, rock, crushed stone) are used in the most appropriate manner to minimize soil degradation and not significantly affect other lands, waterbodies, or marine areas. Every effort shall be made to preserve native soils.

Sediments - Developments must not disturb benthic soils and organic/inorganic materials in any manner that would adversely impact the water quality and/or quantity of that waterbody or feeding/receiving waters beyond seasonal variations.

Kugmallit Bay (714C) - The area managed under category 'C' consists of the eastern portion of Kugmallit Bay. Whales concentrate in these shallow, warm, brackish and highly turbid waters to calve, rear calves, moult and/or socialize. The area is an important historical and current beluga whale subsistence harvesting area from June 15 to August 15.

Creek Crossings – According to the Tuktoyaktuk and Inuvik HTCs, the proposed Highway crosses several creeks where fishing has taken place. These include Jimmy Creek, Trail Creek, Hans Creek and Zed Creek. Further information regarding creeks along the proposed Highway alignment is available in Section 3.1.7.

Caribou Protection Measures

Caribou are protected from harvesting by hunting restrictions. The proposed Highway alignment is located within Area I/BC/07, which is currently closed to barren-ground caribou hunting due to declining caribou populations.

Caribou Feeding Areas - According to the Tuktoyaktuk Elders traditional knowledge interviews conducted in 1999, the main feeding area for caribou is along the shore of Husky Lakes. They said the caribou migrate along the shore of the lake, and not on higher ground (where the proposed Highway is) as there is not much food available at the higher elevation. Several Elders stated that the proposed 1999 alignment would not affect caribou (Rescan 1999a). More information about caribou related to harvesting is found in Section 3.2.8.

Bluenose-West Caribou Herd Winter Range (701E) - This area provides important winter habitat for the Bluenose-West caribou herd, which are valued for year-round subsistence harvest. The proposed Highway is located within the Bluenose-West caribou's winter range.

3.2.9.4 Valued Locations and Attributes

Aesthetic Locations

Areas with aesthetic values were not identified during consultation or in the Tuktoyaktuk or Inuvik Inuvialuit Community Conservation Plans.

Special Interest or Valued Locations

Culturally Significant Sites – According to Tuktoyaktuk residents, and supported by historical and archaeological records, the area around Husky Lakes was subject to intermittent, violent conflict between Dene and Inuvialuit individuals and groups.

Saunatuk, although well removed from the proposed alignment of the Inuvik to Tuktoyaktuk Highway, is a particularly important and culturally significant site. It is located on a long sandspit that separates the second Husky Lake from the third Husky Lake. Archaeological work conducted at the site validates the traditional stories of violent conflict between the Dene and the Inuvialuit. More information about the heritage resources in the area is available in Section 3.2.10.

3.2.9.5 Past and Present Non-Traditional Land Uses

The land between Inuvik and Tuktoyaktuk is currently used for a variety of purposes, which are described in this section, as shown on Figure 3.2.9-1.

Ikhil Gas Development and Pipeline Project

The Ikhil Gas Development and Pipeline Project is located approximately 50 km north of Inuvik in the Caribou Hills. It consist of two producing gas wells, associated feeder lines, a small gas processing plant and a 50 km long, 168.3 mm diameter buried gas pipeline. The pipeline extends south to a pressure regulation and metering facility near the Northwest Territories Power Corporation power plant in Inuvik. The project was developed during the period 1997 to 1999 and is expected to be in service for the foreseeable future.

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.

Former Northern Canada Power Commission (NCPC) Power Line

In 1972, a 144 km wooden pole power (transmission) line (69 kV) was constructed by the NCPC from Inuvik to Tuktoyaktuk, the only line of its type in the world north of the Arctic Circle (NTPC 2009b). The route of this former power line is shown in Figure 3.2.9-1.

Due to high maintenance costs, this line was abandoned and salvaged in the late 1980s. The former power line ROW was used as a winter trail between Tuktoyaktuk and Inuvik and also helped harvesters on the land to determine their location (G. Colton, NTPC, pers. comm. 2009). Today little physical evidence remains of the former NCPC power line.

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 Highway, has been seismic exploration. For example, in the 41,105 ha Parsons Lake Study Area defined for the Mackenzie Gas Project, approximately 1.5% of that area had been subjected to seismic lines and associated activities (IOL et al. 2004). 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 seismic programs.

Oil and Gas Well Sites

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

3.2.9.6 Proposed Future Land Uses

Figure 3.2.9-6 identifies the locations of known proposed future projects that may be developed in the region.

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 40 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 proposed project would see development of three onshore natural gas fields (anchor gas fields) in the Mackenzie Delta and the transportation of natural gas and natural gas liquids (NGLs) by pipeline to southern markets (Figure 3.2.9-6).

The project recently received approval from the National Energy Board and the federal cabinet. The Mackenzie Gas Project partners have until December 31, 2013 to decide whether they will go ahead with the construction of the $16.2-billion project.

Parsons Lake Gas Field Associated Infrastructure and Gathering Pipeline

The Parsons Lake gas field, owed by ConocoPhillips, is located about 55 km southwest of Tuktoyaktuk and 70 km north of Inuvik (Figure 3.2.9-6). The production facilities at the Parsons Lake field will be located on two gravel pads, the most northerly and larger of which will be 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 2004).

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 3.2.9-6).

Tuktoyaktuk Harbour Project

The harbour at Tuktoyaktuk is the only existing natural and active port along the Canadian Beaufort Sea coastline. It has served as the primary base for offshore oil and gas exploration in the 1970s and 1980s. 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.

Currently, the Tuktoyaktuk harbour can only be used by vessels with a draft of 13 feet (4 m) or less. Drillships, ice breakers and supply boats with a draft deeper than 13 feet cannot enter the harbour. With the projected melting of summer ice in the Northwest Passage, the expected increase in global marine traffic through the north and anticipated Beaufort Sea oil and gas exploration and possible development, there could be a need for a harbour for deeper draft vessels. Both government and industry have expressed an interest in developing the Tuktoyaktuk harbour to support deeper draft vessels and proposals for such potential development may be forthcoming.

The option to bring modules for the Parsons Lake gas field through the Beaufort Sea to Tuktoyaktuk is currently under study by ConocoPhillips. To date no formal proposal for the development of Tuktoyaktuk harbour has been put forward.

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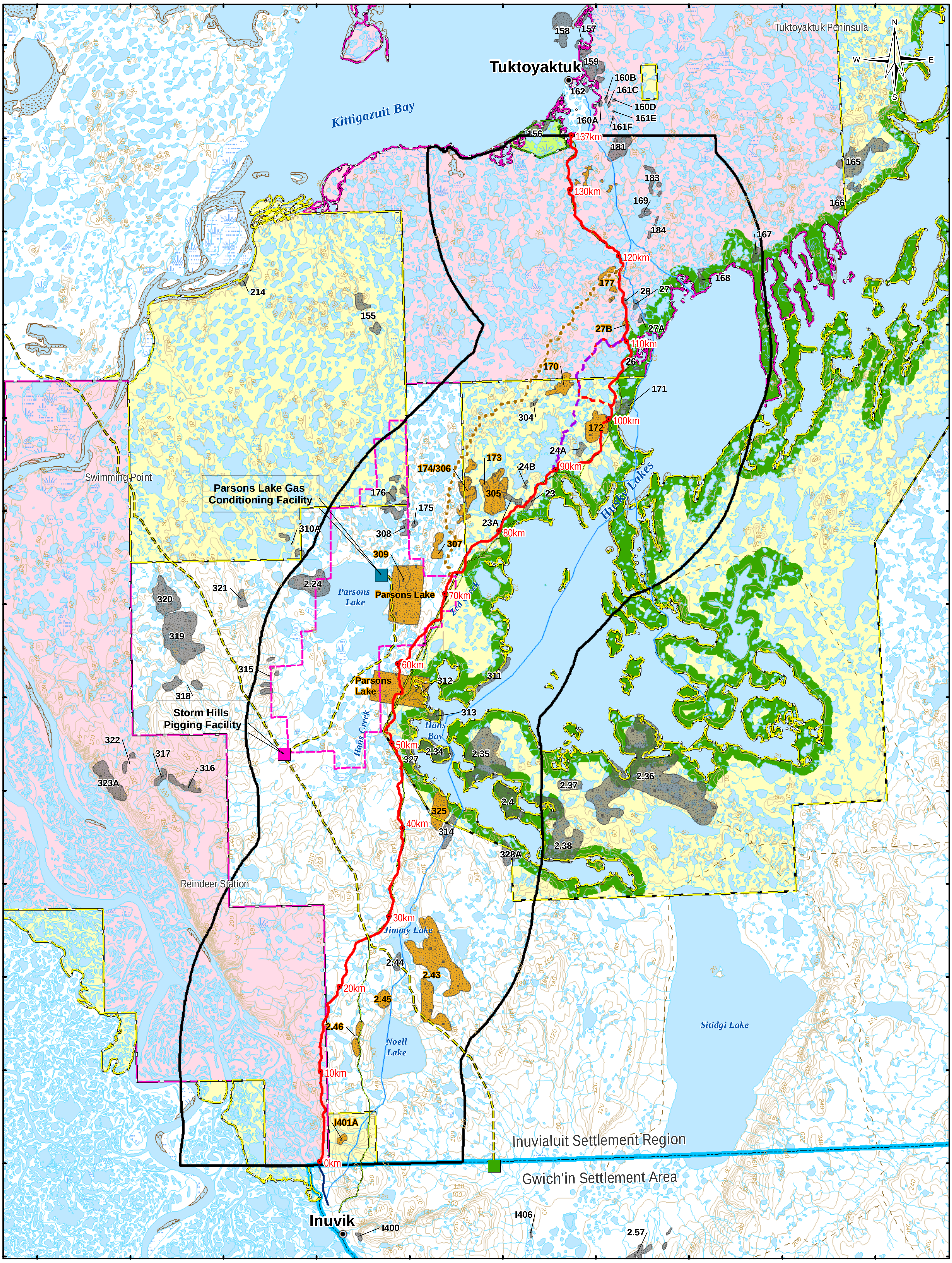

LEGEND

- Facility Site
- Gas Conditioning Facility
- Pigging Facility Site
- Route of Gathering Pipelines
- Significant Discovery Licence Area
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration
Mackenzie Gas Project 2004

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Proposed Future Land Uses

PROJECTION	DATUM
UTM Zone 8	NAD83

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

FILE NO.
V23201322_EIS_Map017_CE_PropLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Figure 3.2.9-6

3.2.10 Archaeological Resources

Archaeological resources are non-renewable and finite. They are important sources of historical knowledge and cultural identity. They are considered of value to local communities, scientists and the Governments of the Northwest Territories and Canada. Consequently, they are protected by legislation. It is illegal to disturb an archaeological site, burial or artifact, and no land use activity is permitted within 30 m of a known monument or known or suspected archaeological site or burial ground.

According to the *Northwest Territories Archaeological Sites Regulations*, archaeological artifacts are defined as any tangible evidence of human activity that is more than 50 years old, in respect of which an unbroken chain of possession cannot be demonstrated. An archaeological site is defined as a site where an archaeological artifact is found.

The following summary is based on research of available archaeological documentary data as well as the preliminary field reconnaissance of the proposed Highway alignment conducted in September, 2009. Sources that were consulted include: archaeological site inventory records held by the Northwest Territories government, early fur trader/explorer accounts, ethnographic/anthropological studies, and reports on past archaeological studies. The methods employed to assess archaeological potential along the proposed alignments is detailed in Section 3.2.10.3. Traditional knowledge studies and pertinent palaeogeological and paleoenvironmental information were incorporated to form a detailed knowledge base in order to assess the potential for archaeological resources.

3.2.10.1 Human History Summary

Prehistory

Unlike many other coastal areas of the Arctic, the low lying nature of the terrain in the Mackenzie Delta region has resulted in land subsidence and coastal erosion that is thought to have obliterated many of the earliest archaeological sites. Northwest Microblade tradition (as old as 6,000 years) has been recognized by the presence of distinctive burins, blades and microblades at sites in the Mackenzie Valley, eastern Mackenzie Delta and as far north as Cape Bathurst (Morrison 1987). This is said to represent seasonal northward movement of interior people over the arctic coastal plain to hunt caribou and muskox (Le Blanc 1994). This group predates and possibly overlaps Paleoeskimo sites, represented by Pre-Dorset or Arctic Small Tool tradition (ASTt). The ASTt began an extremely rapid expansion from western Alaska eastward across the Canadian Arctic about 4,500 years ago. The Paleoeskimo period is sparsely represented in the Mackenzie region, probably mainly due to severe coastal erosion. The sites that are known suggest a regionally distinct variant with western influences (Betts 2008). An early regional variant of the Arctic Small Tool tradition called the Inuvik Phase, dating to 4,300 to 3,400 years ago, has been suggested (Pilon 1994a) for the southeastern portion of the Mackenzie region. ASTt is characterized by microblades and burins with specific characteristics and small, very finely worked bifaces.

Dorset culture expanded across the High and Eastern Arctic from Foxe Basin about 3,000 years ago. Dorset sites have not been identified in the Mackenzie region. It is speculated that due to the warm climate of this period, southern Aboriginal groups expanded north to near the arctic coast, particularly in the forested Delta area, and prevented Dorset people from exploiting the mainland (McGhee 1978).

Approximately 1,000 years ago, another series of rapid eastward migrations from northwestern Alaska began. This was Thule, a culture focused on whaling. Work in Alaska resulted in the definition of a regionally distinct Western Thule culture characterized by multiple room houses built of wood, curvilinear stamped pottery, Thule Type 2 harpoons, and arrowheads with knobbed tangs (Betts 2008). Most researchers now recognize an early and a late Thule period (Betts 2008). The term Neoeskimo (also known as Siglit) is typically applied to cultural remains in the Western Arctic dating between 1,500 and 150 years ago. It includes western Thule, the earliest group, and Mackenzie Inuit, thought to have derived from Thule. Mackenzie Inuit, dated to between 600 and 150 years ago, are associated with the appearance of large whaling villages on the East channel of the Mackenzie River and along the coast east and west of the mouth of the river. Their lifestyles are detailed below. Current Inuvialuit residents of the Mackenzie Delta are considered to have descended from remnants of the Mackenzie Inuit following their decimation by disease and Alaskan Inupiat who migrated to the Delta in early historic times (Betts 2008).

Historic Period

Alexander Mackenzie in 1789 travelled up the Mackenzie River's East Channel on his return journey from the mouth of the river but had no contact with Aboriginal people. A number of subsequent explorers recorded ethnographic details of their encounters with Mackenzie Inuit and later Delta residents:

- 1826 - John Richardson, part of John Franklin's second polar expedition, explored and mapped the East Channel of the Mackenzie River and the arctic coastline to the east (Franklin 1828).
- Late 1860s - missionary Emile Petitot (1887) worked in the Mackenzie region.
- 1906-1912 - the Stefansson-Anderson Arctic Expedition travelled from Alaska to Coronation Gulf; the expedition wintered in the Delta the first year (Stefansson 1919).
- 1913-1918 - the Canadian Arctic expedition was led by V. Stefansson, accompanied by ethnographer Diamond Jenness (1991).
- 1924 - the western team of the Fifth Thule expedition was led by Dr. Knut Rasmussen who made notes and ethnological collections from western Inuit groups (Mathiassen 1930; Rasmussen 1942).

Direct trading for European goods began in earnest in 1889 when whalers came into the Mackenzie Delta-Beaufort sea area (Bockstoce 1986). They frequently traded with the Inuit from their ships, and later established a post on Herschel Island. Whaling in the Beaufort Sea ceased in 1907, but various independent trading posts continued. In 1912, the Hudson

Bay Company opened a trading post at Kittigazuit, a former focal point for Mackenzie Inuit. This post operated until 1934 when the Hudson's Bay Company moved to Tuktoyaktuk (Usher 1971). Several independent traders continued operations at Kittigazuit until 1940.

Inuvialuit Ethnography

Prior to the 1890s, the Mackenzie Inuit were perhaps the most numerous Inuit in Canada. They were culturally most closely related to the Inupiat of Alaska (Morrison and Arnold 1994). Their range extended east and west along the coast from the Delta and south to the head of the Delta and some distance south of Husky (also called Eskimo) Lakes (Stefansson 1919). The rich resource base of the Mackenzie region, anchored by beluga whale, caribou, muskox and fish, permitted the Mackenzie Inuit to develop a semi-sedentary lifestyle.

Historically, the Mackenzie Inuit were reportedly clustered into at least five more or less distinct territorial groups. Each group was centred on a resource focal point that provided sufficient resources for the establishment of a seasonally permanent village. There may have been two or three additional subgroups that had disappeared prior to the arrival of European and Canadian explorers; one of those was Imaryungmiut ("Eskimo Lake people") who inhabited the Husky Lakes area and focused on caribou hunting and fishing (Betts 2008). After that group's disappearance, this territory was exploited by the Kitigaaryungmiut who seasonally utilized the entire area from the lower Tuktoyaktuk Peninsula to the southern Husky Lakes and were probably among the Mackenzie Inuit who annually went as far south along the Mackenzie drainage system as Arctic Red River to trade with the Dene. Trade with Alaskan Inuit was conducted at Barter Island. The Kitigaaryungmiut main winter village, Kittigazuit, located at the mouth of the East Channel served as a summer beluga whale hunting station and winter gathering locale from which sealing and fishing was carried out. They were also reported to make occasional boat trips some 200 miles further up the Mackenzie River to obtain slate from a quarry near the Ramparts (McGhee 1974).

The following subsistence cycle summary is based mainly on Stefansson (1919). During dark winter months, people were relatively sedentary in the larger coastal villages, subsisting on dried or frozen whale, fish and caribou meat and conducting shorter hunting and trapping trips. In June, people dispersed in small family groups inland to hunt and fish at the larger lakes. From late July through August, moderate sized groups of people gathered at whaling camps. These gatherings were usually at the winter villages, but whale hunting also occurred in the Husky Lakes. Stefansson (1919) identified a winter and summer camp location at the southern narrows of Husky Lakes (not identified archaeologically to date). Focus was on caribou hunting in September and October when the animals were well fed and the hides were in prime condition. Cooperative hunting activities commonly included whaling, weir fishing, caribou drives and floe-edge sealing.

Food was generally stored in permafrost pits although raised platforms were also recorded. Fish was eaten raw or frozen, or dried and sometimes partly smoked. Meat was usually stored directly in the pits although some may have been dried. Fats and oils of sea mammals accompanied most meals and sometimes food was preserved in oil. According to Stefansson's informants, the Mackenzie Inuit ate much less raw food than their Alaskan neighbors (Stefansson 1919). Various berries were used, as well as edible roots of young willow and knotweed.

The vast quantities of driftwood available in the Mackenzie Delta meant that, contrary to most of the arctic, people living in the Delta region used wood for construction as well as fuel. The commonly used winter house was a semi-subterranean structure built of wood, often with whalebone, and covered with sod; multiple chambers were connected to a large central area. Such a structure would have been shared by two or more families. Snowhouses were used only when travelling and generally were built for one nuclear family. Skin covered tents were used on summer hunting trips. Winter travel was by dog team and sled. Water travel in summer was by larger whale skin covered boats called umiaks, and the smaller kayaks were used for sea mammal hunts.

Tools comprised more wood components than elsewhere in the Arctic. Most implements were composed of combinations of wood, bone, antler and stone. Harpoon shafts and fish hooks were made of bone. Wooden bows and arrows were used. Projectile points, endblades and knives were made of chipped or polished chert or slate. Labrets, beads and various ornaments were made of polished steatite, antler or ivory. Cooking pots of steatite were traded from the east (Smith 1984).

Burial usually involved placing the body, wrapped in skins, on a low hill and covering it with driftwood. Personal possessions were placed in, near or on top of the grave.

3.2.10.2 Previous Archaeological Studies

A considerable amount of archaeological research has been conducted in certain areas of the Mackenzie Delta-Tuktoyaktuk Peninsula region. Many of the early explorers commented on seeing old camps or graves as they travelled through the region (Franklin and Richardson 1824; Franklin 1828). The first excavations were conducted as part of ethnoarchaeological research during two arctic expeditions: in 1911 by Stefansson and in 1914 by Jenness.

Beginning in the 1950s, several archaeological research projects were aimed at elucidating the early culture history of the Mackenzie region, for example, MacNeish in 1954 and McGhee in 1974. These studies comprised both surveys and excavations conducted at sites on the Mackenzie River and adjacent coastlines. They studied the prehistoric cultural relationships between the Mackenzie Delta and Alaska. Robert McGhee spent several years excavating at Kittigazuit and a nearby smaller site, and developed a preliminary cultural synthesis for the Mackenzie Inuit (McGhee 1974).

Most archaeological investigations since the 1980s related to Mackenzie oil and gas projects (Cinq-Mars and Pilon 1991; Pilon 1994b; Hanna 2002; Clarke et al. 2004). These studies again included both surveys and excavations and provided a substantial body of data relating to the early human history of the Mackenzie region. Two research projects of specific interest to this study are an archaeological survey and testing of several sites in the interior Tuktoyaktuk Peninsula (Swayze 1994), and survey and excavations conducted on limited portions of the Husky Lakes (Morrison and Swayze 1991; Morrison and Arnold 1994). In 2001, the Mackenzie Delta Heritage Resource Survey conducted revisits of 117 previously recorded site locations and found 70 more sites (Hanna 2002). In 2003, archaeological work associated with the Mackenzie Gas Project revisited/recorded 12 sites in the Inuvialuit portion of their study (Clarke et al. 2004). In 2009, an archaeological impact assessment was completed for Tuktoyaktuk to Source 177 Access Road; no sites were recorded (IMG-Golder Corporation 2009a).

Previous studies focused on specific areas, largely the coastal region, the Mackenzie Delta and River, and portions of the Husky Lakes. The latter includes essentially the entire present Project footprint, excluding the northern 19 km (Tuktoyaktuk to Source 177 Access Road). However, substantial portions of the region remain unexamined. In particular, the region south of the Husky Lakes and east of the Mackenzie River has not been subjected to any previous archaeological investigation.

Recorded Archaeological Resources

Given the limited areas previously subjected to archaeological surveys, the site inventory is quite significant, both in terms of numbers of sites and site remains. Within the general study region encompassing the area east of the Mackenzie River and west of the Husky Lakes and from the coast to the southern limits of the Project area, there are 103 previously recorded sites (Figure 3.2.10-1). Types of sites found in this region include: lithic scatters and quarry/workshops; stone features such as tent rings, caches and cairns; hearths and fire cracked rock concentrations; cabin remains and semi-subterranean house remains; cache pits; middens; graves; various types of wood features; and cut/worked wood remains. Excavated sites have revealed cultural deposits often to 30cm below surface and some remains are as deep as 60 cm. Dates from a number of sites confirmed the time periods represented range from Northwest Microblade tradition over 5000 years old and Paleoeskimo as old as 4,300 years ago, through Neoeskimo representations between 1,000 to 200 years old.

There are 12 previously recorded archaeological sites within 5 km of the proposed Highway route, four of which are within prospective gravel sources; one additional site is within a possible borrow source further from the route (Table 3.2.10-1; Figure 3.2.10-1). These sites typically represent Mackenzie Inuit occupations with some small components ascribed to the Paleoeskimo period. Most of these sites are small camps characterized by lithic, bone and artifact scatters, some with structural features such as tent rings, hearths, semi-subterranean house remains, middens and caches.

Artifacts that have been found at some of these sites include harpoon parts, projectile points of flaked stone, fish hooks, net sinkers, and pottery. The Cache site, on a large, unnamed lake along the western Alternative 2 (Upland Route), contains remains of several different occupation periods, from Paleoeskimo to Inuvialuit; remains include wood house remains, hearth, a range of artifacts and numerous animals remains, predominantly fish, waterfowl and caribou. One of the sites on Big Lake (Ilkaasuat) also revealed prehistoric pottery. These are the types of site features and artifacts that can be expected to be present within the Project Study Area.

TABLE 3.2.10-1: ARCHAEOLOGICAL SITES NEAR PROJECT COMPONENTS

Site	Location	Distance to Highway	Type	Features
NeTq-1	Husky Lakes	1.4km+b	tool making	scatter (lithic)
NeTq-2	S. Husky Lakes	borrow	trail	trail
NfTq-1	Husky Lakes	800m+b	campsite	bone scatter; tent ring (fire cracked rock)
NfTq-4	Parsons Lake	3.3km+b	camp	scatter (lithic); sub. house
NfTq-5	large unnamed lake	2.5km+b	tool making	lithic scatter
NgTo-2	Husky Lakes	2 km	isolated find	lithic flake
NgTq-1	large unnamed lake	150m	tool making, campsite	scatter (fire cracked rock), scatter (lithic)
NhTo-1	Sukunnuk Narrows	1.8km	campsite	bone scatter
NhTo-2	Husky Lakes	2.4km	campsite	scatter (bone)
NhTo-4	west of Husky Lakes	1.8km	tool making	scatter (lithic)
NhTp-1	large unnamed lake	4.8km	campsite	cache pits, house, midden, lithic remains, pottery
NhTp-2	Big Lake (Ilkaasuat)	1.5km	campsite	midden, bones, pottery
NhTp-6	Big Lake (Ilkaasuat)	4.5km	isolated find	harpoon frag/wood debris

Note: +b = in proposed borrow source

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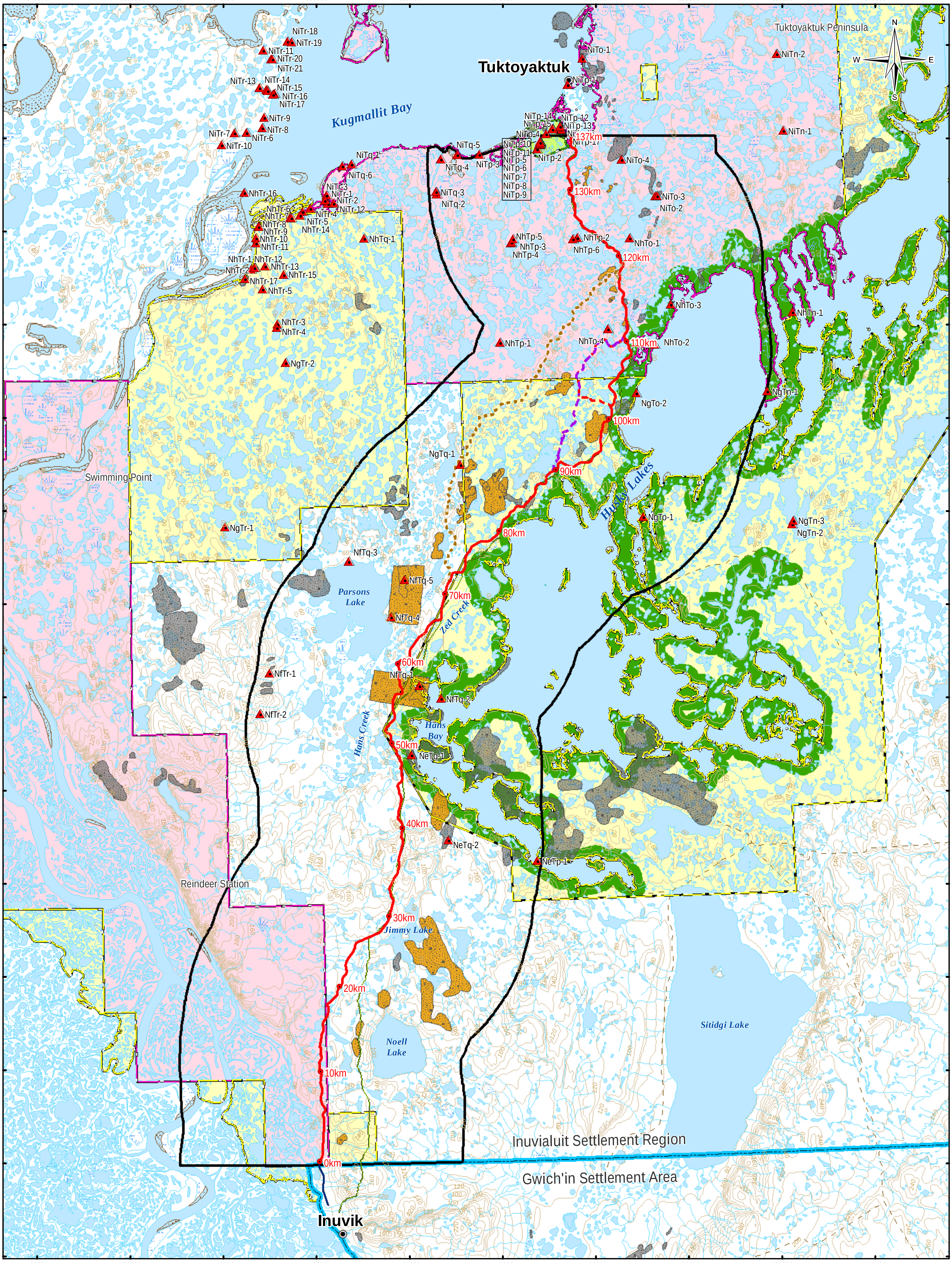

LEGEND

- Archaeological Sites
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)a Lands
- Inuvialuit 7(1)b Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

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

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Archaeological Sites Previously Recorded

PROJECTION	DATUM
UTM Zone 8	NAD83

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

FILE NO.
V23201322_EIS_Map001_Arch_Sites.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 3.2.10-1

3.2.10.3 Archaeological Overview Assessment

An archaeological overview assessment of the proposed Highway and selected borrow sources was completed in September 2009 by Ms. J. Bussey of Points West Heritage Consulting Ltd. (Kiggiak-EBA 2010a). The main goal was to assess the archaeological potential of terrain to be affected by this Project. The primary method used to rate archaeological potential was visual assessment of terrain by low and slow helicopter overflight following the proposed alignment using GPS coordinates. The route was shown on topographic maps at a scale of 1:25,000. The borrow sources were also overflown, but the boundaries were roughly approximated using topographic maps. Data gathered during the overview assessment were used to identify specific portions of Project components that will require ground reconnaissance surveys during the next phase of study.

The best potential terrain types include level and dry banks, terraces or benches along major streams or lakes. Areas with good potential include well defined, elevated landforms adjacent to larger waterbodies. Low lying expanses of tussock tundra or wet muskeg have limited potential for archaeological resources.

Findings

No previously recorded archaeological sites occur within the primary proposed Highway alignment, assuming a typical right-of-way width. The sections of the Highway route that are close to Husky Lakes and cross elevated, dry terrain (Photo 3.2.10-1) are judged to have good archaeological potential. Elevated terrain features such as moraines, knolls, pingos, esker remnants, and ridges (Photo 3.2.10-2) all have good potential. Major creek crossings are suggestive of good archaeological potential. These sections of the Highway route were roughly outlined on preliminary topographic maps (Figure 3.2.10-2 and 3.2.10-3). It is estimated that about one quarter of the route will require ground reconnaissance.

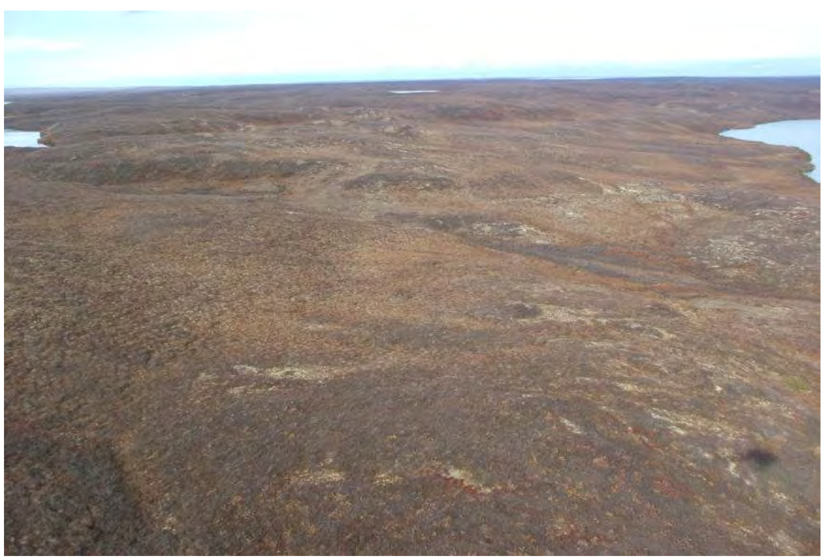

Photo 3.2.10-1
Terraces and benches along Husky Lakes suggestive of good archaeological potential

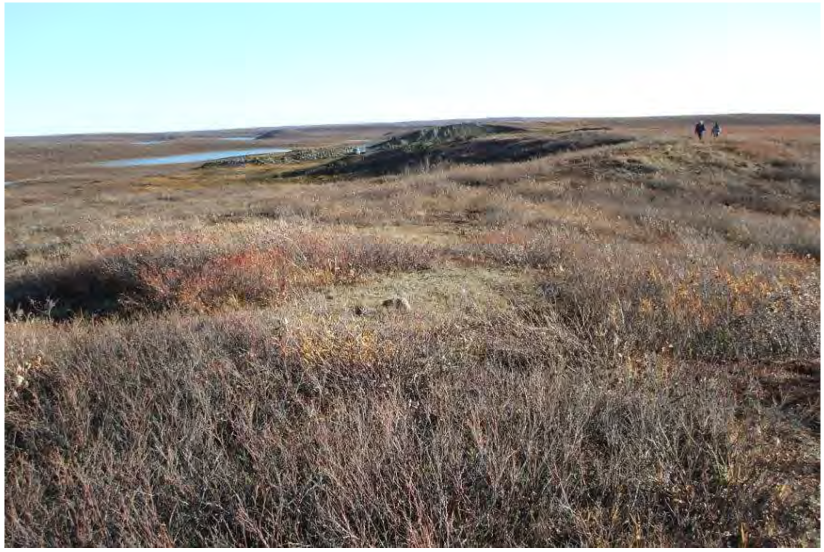

Photo 3.2.10-2
Checking surface exposures on a good potential ridge to be used as a borrow source

Borrow sources were not assessed south of Hans Creek in September 2009 as they had not yet been identified at that time, as well as the time limitations during the September 2009 field investigation. One site is located within or immediately adjacent to Borrow Area 19, and several more may fall within borrow sources that were not assessed. All of the proposed borrow sources that were examined are situated on elevated terrain features that include sections suggestive of good archaeological potential; therefore, ground reconnaissance will be necessary in most of the sources.

Areas with the best potential terrain types include level and dry banks, terraces or benches along major streams or lakes, particularly along Husky Lakes, in close proximity to the Mackenzie drainage system, Zed Creek and Hans Creek; however, any well-defined, elevated landforms adjacent to larger waterbodies have good potential. Low-lying expanses of tussock tundra or wet muskeg have limited potential for archaeological resources. A few such areas will be sampled during ground reconnaissance to ensure that all types of terrain are considered.

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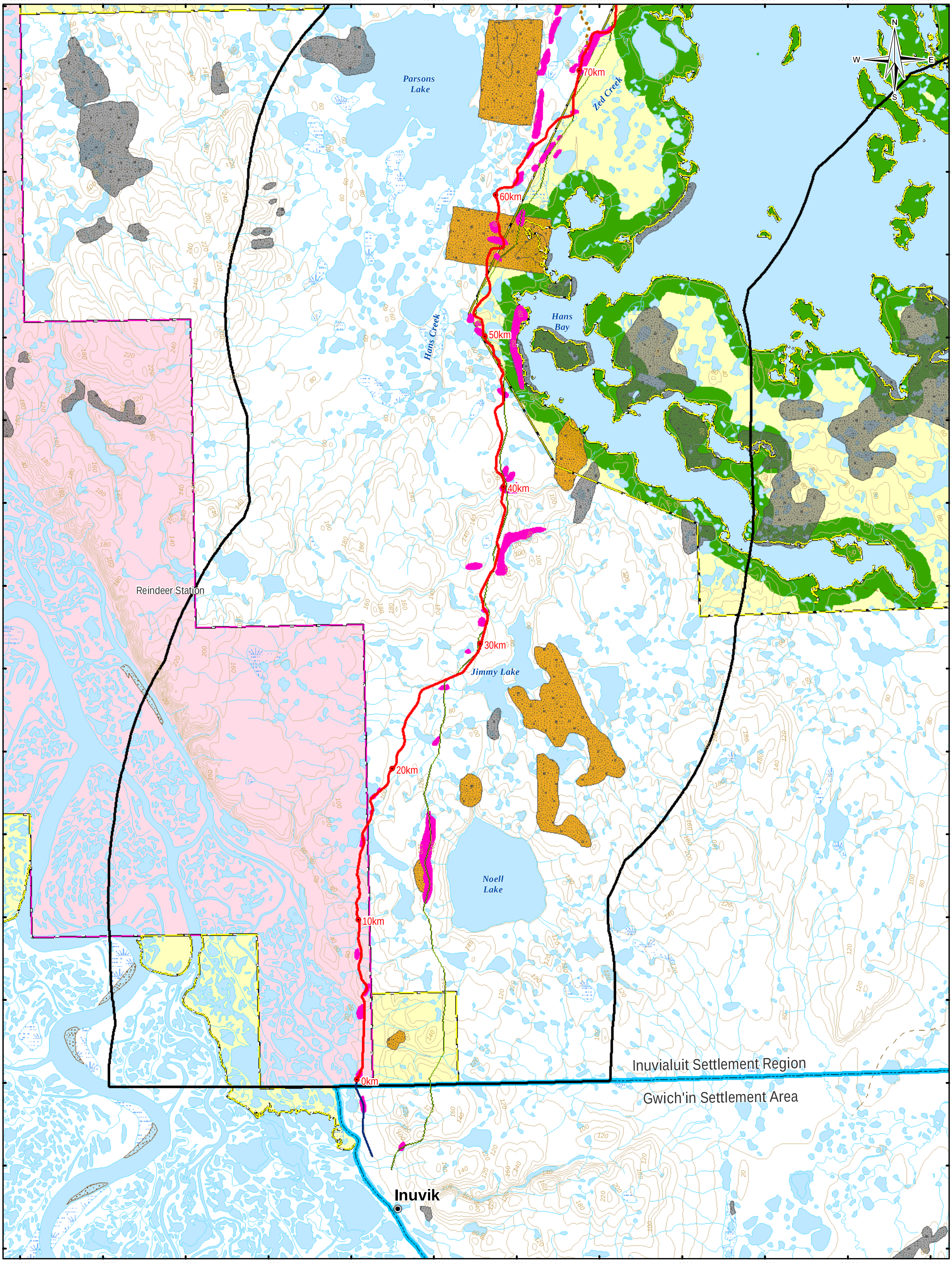

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Archaeological Potential Area
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

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

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Archaeological Potential Areas
(Map 1 of 2 - Southern Portion)

PROJECTION	DATUM
UTM Zone 8	NAD83

Scale: 1:225,000
Kilometres

FILE NO.
V23201322_EIS_Map002_Arch_Areas1.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
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Figure 3.2.10-2

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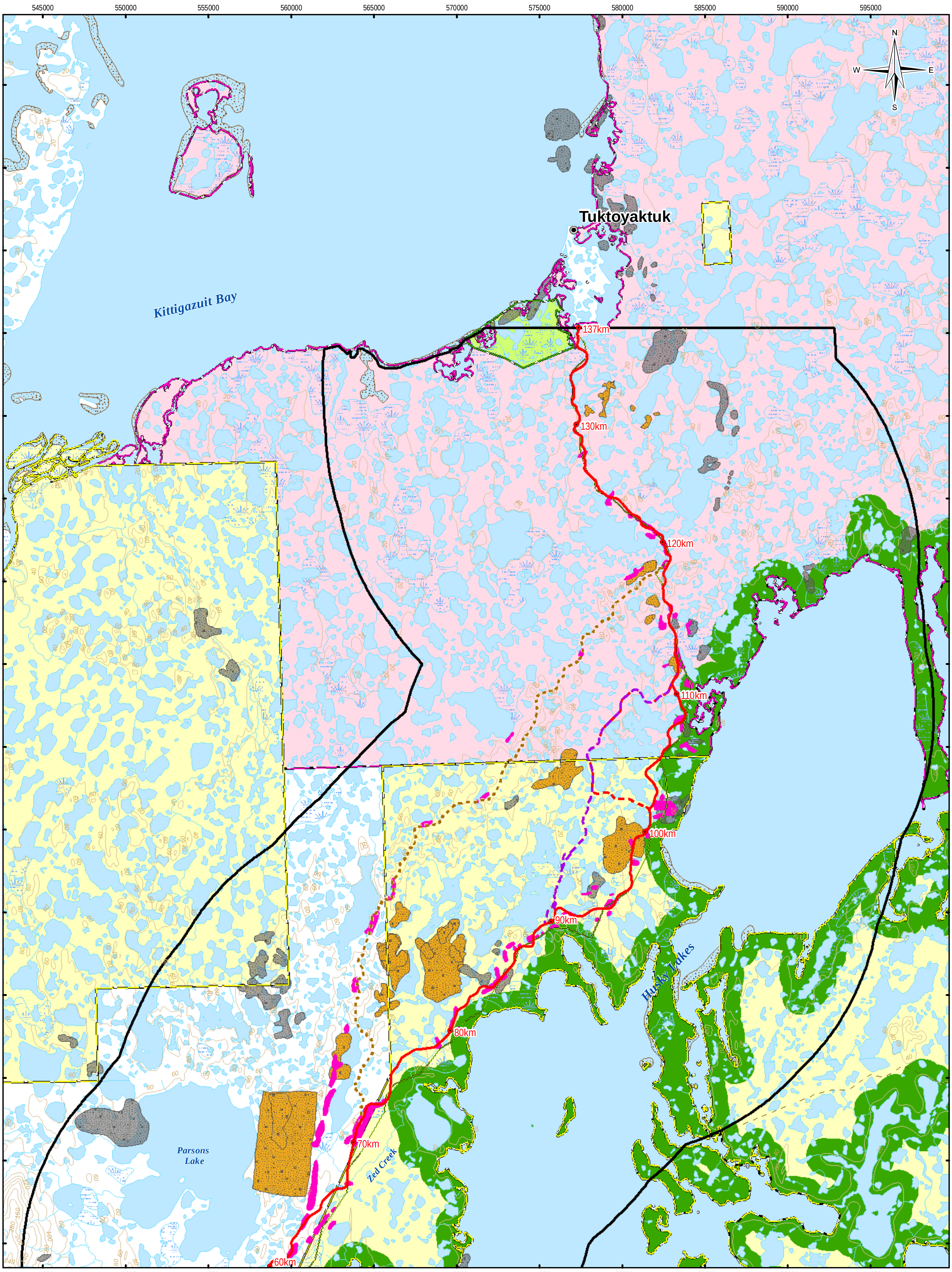

LEGEND

- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Archaeological Potential Area
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

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

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY
ENVIRONMENTAL IMPACT STATEMENT

Archaeological Potential Areas
(Map 2 of 2 - Northern Portion)

PROJECTION: UTM Zone 8	DATUM: NAD83

Scale: 1:225,000

2 1 0 2 4 6

Kilometres

FILE NO.: V23201322_EIS_Map003_Arch_Areas2.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
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Figure 3.2.10-3

Archaeological Expectations

The background research and visual assessment conducted of the areas in close proximity to the proposed Highway route and borrow sources provides the basis for some preliminary statements on expected archaeological resources.

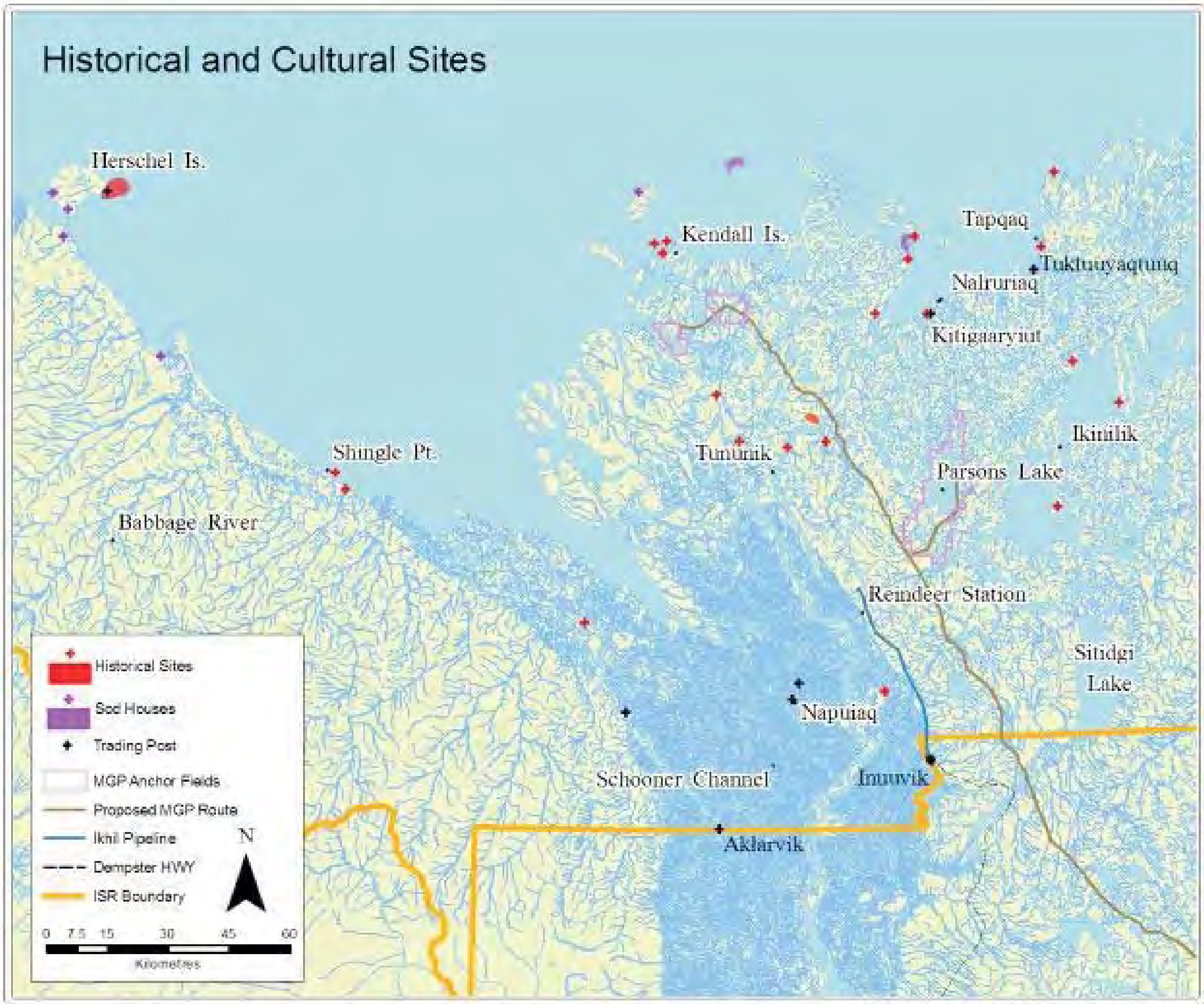
According to the Inuvialuit Settlement Region Traditional Knowledge Report (ICC et al. 2006), there are no historical sites, burial sites or cemeteries documented in the LSA (Figures 3.2.10-4 and 3.2.10-5).

Archaeological Site Locations

Archaeological sites on the Tuktoyaktuk Peninsula and in the Husky Lakes area have most often been recorded on outlet creeks at larger lakes and along the Husky Lakes shoreline. It should be emphasized that this distribution is likely at least partly due to the fact that the research strategies of past studies focused on examination of these high potential locations. Since those are high potential locations, sites can be expected on elevated ridges, hills and terraces adjacent to larger lakes and streams. Besides Husky Lakes, of particularly good potential would be Parsons Lake, the lake known locally as Big Lake (Ilkaasuat), Hans and Zed creeks, and elevated terrain close to channels of the Mackenzie drainage. Old sites have been found on pingos in northern Alaska (Lobdell 1986); therefore, such features are also considered to have archaeological potential.

Archaeological Site Types

Based on ethnographic research and known heritage sites, the types of heritage sites to be expected could include various types of structural remains, stone tools and flakes, a variety of bone and wood artifacts, and bone concentrations. Mounds could be semi-subterranean houses or middens, that is, refuse accumulations. Piles of driftwood could represent graves or house remains. Pits could have been used as caches for food or belongings. Rock piles could represent caches or cairns marking a particular location or feature.



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NOTES

1. Source: Figure 15. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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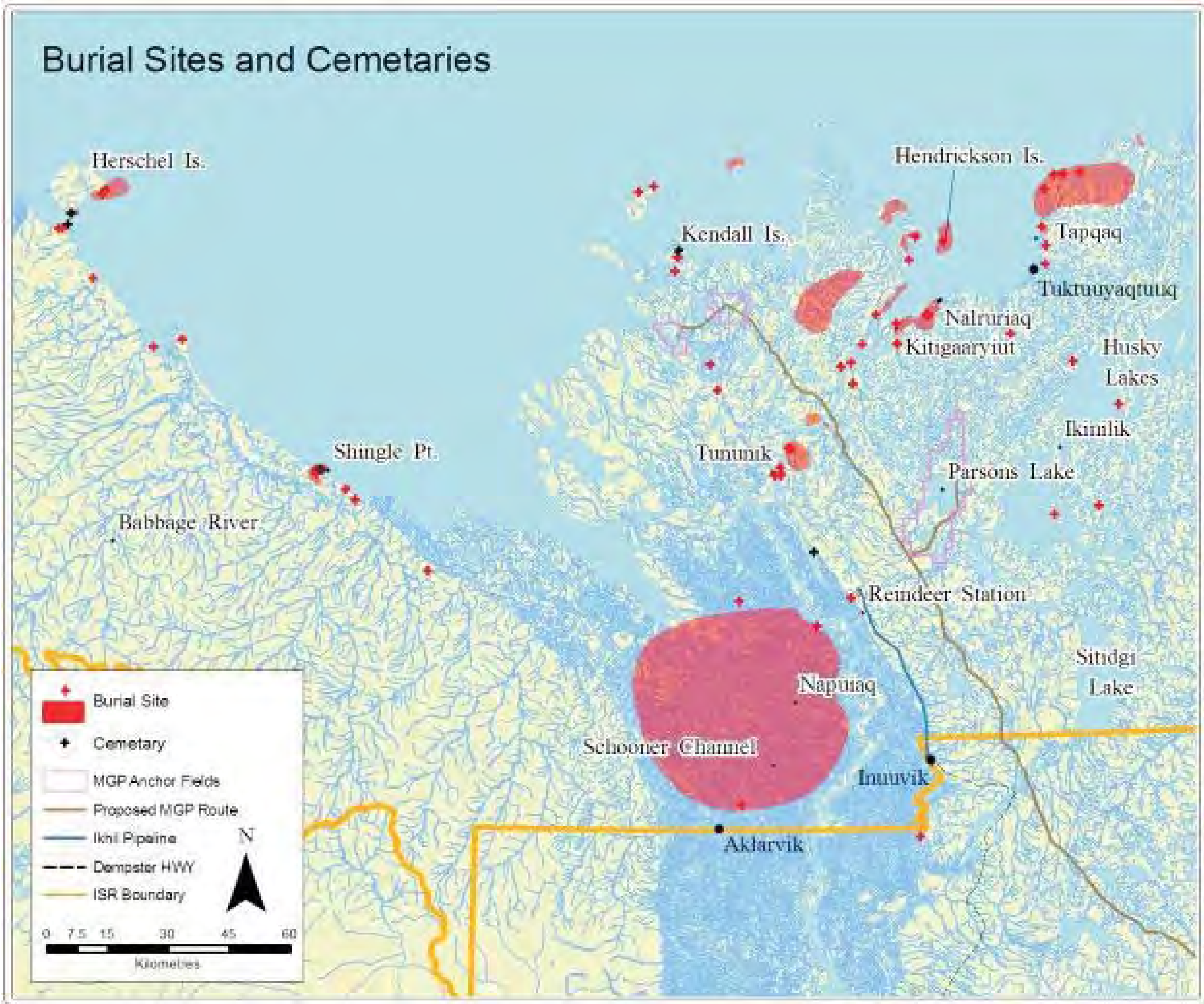
PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Historical and Cultural Sites

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0
OFFICE	DATE		
EBA-VANC	March 15, 2011		

Figure 3.2.10-4



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NOTES

1. Source: Figure 13. Inuvialuit Settlement Region Traditional Knowledge Report (Inuvik Community Corporation et al. 2006).

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PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Burial Sites and Cemeteries

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	March 15, 2011

Figure 3.2.10-5

4.0 IMPACT ASSESSMENT

This section identifies the potential effects of construction and operation of the Highway, proposed mitigation measures, and any residual effects following implementation of the mitigation measures.

The Developer is committed to constructing the proposed Inuvik to Tuktoyaktuk Highway, borrow sources, and associated winter access roads in a safe and environmentally responsible manner. The Developer is committed to incorporating existing information and building upon this knowledge base. Table 4-1, extracted from the EIRB (2010) Terms of Reference for this Project, identifies the goal statements which the Developer is working towards in the design of this Project.

TABLE 4-1: BIOLOGICAL, PHYSICAL, AND HUMAN ELEMENTS AND GOAL STATEMENTS

Element	Goal Statements
Migratory Birds and Habitat	Protect and avoid disturbance or destruction to migratory birds and their habitat throughout all phases of the proposed development.
Species at Risk	Avoid the loss, damage or destruction of species at risk and their critical habitat throughout all phases of the proposed development.
Wildlife and Wildlife Habitat	Protect all wildlife and wildlife habitat and minimize habitat losses throughout all phases of the proposed development.
Fish and Fish Habitat	Protect all fish and fish habitat and establish a "no-net-loss" of fish habitat throughout all phases of the proposed development.
Vegetation	Maintain the diversity of all vegetation communities throughout all phases of the proposed development.
Waterbodies and Wetlands	Conserve and minimize or avoid negative impacts to all waterbodies and wetlands throughout all phases of the proposed development.
Soil	Protect and sustain soils and minimize losses through erosion throughout all phases of the proposed development
Surface water and Groundwater	Protect or minimize impacts to all ground and surface water throughout all phases of the proposed development.
Permafrost	Protect and minimize impacts to permafrost throughout all phases of the proposed development.
Noise	Minimize anthropogenic noises throughout the duration of the proposed development.
Climate Change	Minimize contributions to climate change throughout all phases of the proposed development.
Air Quality	Minimize air pollution throughout all phases of the proposed development.
Navigation	Avoid impeding navigation throughout all phases of development.
Wildlife Harvesting	Conserve species used for wildlife harvesting throughout all phases of the proposed development.
Culture, Heritage and Archaeology	Preserve culture, heritage and archaeology throughout all phases of development.

TABLE 4-1: BIOLOGICAL, PHYSICAL, AND HUMAN ELEMENTS AND GOAL STATEMENTS	
Element	**Goal Statements**
Communities	Minimize or avoid negative impacts to local communities throughout all phases of the proposed development
Economy	Pursue economic development opportunities that do not adversely impact environmental, social, and cultural conditions/wellness
Human Health and Safety	Avoid negative impacts to human health and safety throughout all phases of development
Land Use	Protect important land use areas.
Participation Agreement (IBA) if required	Commitment from the Developer to participate (section 10 of the IFA.)
Migratory Birds and Habitat	Protect and avoid disturbance or destruction to migratory birds and their habitat throughout all phases of the proposed development.
Species at Risk	Avoid the loss, damage or destruction of species at risk and their critical habitat throughout all phases of the proposed development.
Wildlife and Wildlife Habitat	Protect all wildlife and wildlife habitat and minimize habitat losses throughout all phases of the proposed development.
Fish and Fish Habitat	Protect all fish and fish habitat and establish a "no-net-loss" of fish habitat throughout all phases of the proposed development.
Vegetation	Maintain the diversity of all vegetation communities throughout all phases of the proposed development.
Waterbodies and Wetlands	Conserve and minimize or avoid negative impacts to all waterbodies and wetlands throughout all phases of the proposed development.

The framework for environmental management of the Project will consist of regulatory and other management instruments that define environmental terms and conditions, including:

- EIRB 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);
- Conformance to resource management legislation and regulations including NWT Wildlife Act and Regulations, Migratory Birds Convention Act and Regulations, Migratory Birds Convention Act and Regulations, federal Species at Risk Act, and Species at Risk (NWT) Act;
- Conformance with health and safety legislation and regulations including Public Health Act, Workers Compensation Act, and Explosives Use Act; and
- HTCs, Renewable Resource Committees, and Co-Management Body directions.

Other components of the framework will include:

- Use of experienced, local construction contractors, where possible;
- Avoidance and protection of sensitive terrain and habitats;
- Avoidance of identified heritage and archaeological sites;
- A construction environmental management plan;
- Construction environmental and wildlife protection and monitoring plans;

In addition, the contractor(s) selected to construct the Highway will be required to have 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; and
- Site-specific spill contingency plans.

A copy of INAC's *Guidelines for Spill Contingency Planning*, with which the spill contingency plan will conform to, is provided in Appendix E. The development of site-specific plans will take place in the future upon award of contracts to the successful contractors. All plans must meet the minimum requirements set out in this EIS, the Project's environmental management plans, applicable guidelines, and the terms and conditions required under the regulatory process.

This section of the Environmental Impact Statement 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.

4.1 BIOPHYSICAL AND SOCIO-ECONOMIC ASSESSMENT METHODS

The biophysical and socio-economic assessment for the Inuvik to Tuktoyaktuk Highway has been prepared in general accordance with the EIRB's Terms of Reference (2010), to assist the EIRB, regulatory agencies, Inuvialuit and Gwich'in and other interested parties in understanding the anticipated biophysical and socio-economic consequences of the proposed Highway. As a result, this section of the EIS examines the predicted effects of the proposed Highway on the biophysical and human environment components in the proposed development area and the region. Potential cumulative effects on the biophysical and socio-economic environment are discussed in Section 5.0. Potential effects of accidents and malfunctions related to the Highway and associated activities are discussed in Section 4.4.

The impact assessment process employed for the proposed Highway followed a typical environmental impact assessment approach consistent with EIRB and Canadian environmental and socio-economic assessment guidelines and methodologies. The assessment involved project scoping, baseline condition identification, impact assessment and prediction, mitigation planning, evaluation of significance, and follow-up. Each phase is described in detail in the following paragraphs.

Project Scoping – Scoping involves the identification of key issues of concern and the more important biophysical and/or socio-economic components within the area of influence that may be affected by the proposed development. These components are commonly referred to as Valued Components (VCs). VCs are components of the natural and human world that are considered valuable by participants in a public review process (Beanlands and Duinker 1983). VCs need not be restricted to being of an environmental nature. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons (Hegmann et al. 1999).

Project scoping serves to focus the assessment on valued components. The development of appropriate temporal and spatial boundaries for the various biophysical and socio-economic components of concern is also part of the scoping process.

Baseline Conditions – This phase involves the characterization of the pre-disturbance or pre-development biophysical and socio-economic conditions (baseline) in the proposed development area and includes additional site-specific field investigations to address relevant data deficiencies. The type and level of information required is typically related to the type of issue or importance of an issue, the assessment boundaries, and the potential effects predicted to occur.

Impact Assessment and Prediction – Using the baseline data, an understanding of the proposed Highway and available mitigation measures to prevent or minimize impacts, standard assessment tools and professional judgement are employed to assess potential environmental and socio-economic effects (including residual and cumulative effects) associated with the construction and operation of the proposed development. As indicated in the EIRB's Terms of Reference (EIRB 2010), project Project-related effects are typically characterized for each Project phase in terms of criteria, such as:

- The reversibility of the effect;
- The duration of the effect;
- The confidence of the predicted effect, based on the available data;
- The geographic location and range of the effect and any affected groups/individuals; and
- The goal statements outlined in Table 4-1.

For socio-economic parameters, the capacity of potentially affected groups, responsible authorities and/or the developer to manage the effect is an additional criterion that is commonly considered. Additional criteria, typical of environmental assessments, have also been integrated into this assessment and are discussed further in Section 4.1.4.

Mitigation Planning – Appropriate biophysical and socio-economic management and mitigation measures, where applicable, are described and directly integrated into the assessment of the proposed development-related effects.

Evaluation of Consequence – To determine the level of consequence from a residual effect, the magnitude, duration, and location of the effect were the primary factors. Residual effects are those effects remaining after the application of appropriate mitigation measures on the biophysical and socio-economic components of concern.

Follow-up – Construction-related monitoring will be conducted during the construction phase to confirm the accuracy of biophysical predictions and to implement corrective actions if, and as may be, warranted. Follow-up monitoring, during operations, is expected to be led by NWT natural resource agencies, in cooperation with the joint management committees and the HTCs.

4.1.1 Project Scoping

The EIRB (2010) determined that the Scope of Project Components and Activities included those items included in the Project Description Report submitted in 2010 to the Environmental Impact Screening Committee. It was to consist of all the physical works and activities required to construct and operate the Highway between Inuvik and Tuktoyaktuk. Route alignment alternatives were also considered.

More specifically, the EIRB's Terms of Reference (2010) defined the Scope of Project Components and Activities to consist at minimum of the following physical works or activities that are anticipated to occur during the construction, operation and where relevant, modification, decommissioning and abandonment phases:

- All-season Highway from Inuvik to Tuktoyaktuk;
- Temporary winter road parallel to the all season Highway;
- Temporary winter road to access borrow sites;
- Borrow areas to support construction, operations and maintenance requirements;
- Construction equipment staging areas;
- Construction material storage;
- Construction staging areas;
- Maintenance areas;
- Excavation equipment storage areas;
- Culvert, bridge and other water course crossing structures;

- Other drainage and thermal erosion control structures;
- Winter road water course crossings;
- Fuel, oil and other bulk liquids storage areas;
- Equipment maintenance, refilling and refueling areas;
- Temporary construction camp facilities;
- On-going operations and maintenance of the all-weather Highway;
- Temporary electrical or other power supply;
- Wastewater management and treatment;
- Solid and other waste management;
- Water withdrawals;
- Management of excavation material, including stockpiles;
- Construction worksites, storage areas and staging areas;
- Maintenance activities;
- Handling and storage of petroleum products and hazardous materials;
- Handling, storage and use of explosives (if required);
- Personnel, material, liquids, fuel and equipment resupply;
- Vehicle movements and frequency during construction;
- Aircraft use and frequency during construction; and
- The types, numbers, locations and frequency of use of all equipment associated with the development and associated exerted ground pressures, and techniques used to reduce these ground pressures.

The scope of assessment also includes an examination of cumulative effects. Cumulative effects were to focus on other past, present and reasonably foreseeable future developments or human activities that may combine with the impacts of the proposed Highway to affect the same valued components. Such cumulative effects were to be assessed at a geographic and temporal scale appropriate to the particular valued component under consideration.

4.1.2 Valued Components

The assessment methods used to evaluate the potential biophysical and socio-economic effects of the proposed Highway on the local and regional study areas are Valued Ecosystem Components (VECs) or Valued Socio-economic Components (VSCs). VECs are defined as "the environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic, or aesthetic value" (Sadar 1994). VSCs are defined as "Cultural, social, economic or health aspects of the study population that, if affected by the project, would be of concern to local human populations or government regulators" (NEB 2011). The VECs and VSCs collectively are referred to as Valued Components (VCs). Effects are predicted for each VC, particularly as they relate to their role in the ecosystem and the value placed on the component by the Inuvialuit.

The selection of VCs for this EIS is based on a combination of the directions provided in the EIRB Terms of Reference (2010), the Developer's understanding of the biophysical or socio-economic components, traditional knowledge as specified in the CCPs, the *Inuvialuit Final Agreement*, the consultation results, and various other considerations.

Table 4.1.2-1 summarizes the Valued Components that are assessed in the EIS.

TABLE 4.1.2-1: SELECTED VALUED COMPONENTS

Impact Assessment	Valued Components
Biophysical Components	Noise
	Terrain, Geology, Soils and Permafrost
	Water Quality and Quantity
	Changes to Hydrological Regime
	Species at Risk and Species of Special Status including grizzly bear and wolverine Species of high importance subsistence for country foods including barren-ground caribou and moose Species of moderate to high values as furbearers Species rated as high importance to outfitters or tourism guides Migratory and breeding birds
	Fish Species of high importance to subsistence for country foods and fish habitat
Human Environment Components	Land and Resource Use by the Inuvialuit
	Areas of Special Ecological and Cultural Importance
	Land Designation Areas (as per IFA and CCPs)
	Tourism, Commercial and Public Recreational Use
	Heritage and Archaeological Sites

4.1.3 Study Boundaries

The Review Board determined that the Developer should determine the appropriate boundary for biophysical and socio-economic elements assessed (EIRB 2010). Evaluating the significance of each potential effect associated with the Highway requires that appropriate spatial and temporal boundaries (space and time limits of potential effects) be defined.

4.1.3.1 Spatial Boundaries

Local and regional spatial boundaries were determined for biophysical and socio-economic components based on their respective characteristics and anticipated interactions with Highway activities. The spatial boundaries were primarily based on the Project footprint and the zone of influence beyond which the effects of the Highway were expected to be non-detectable.

For the biophysical components, two main assessment areas were defined.

Project Footprint – the area directly under the Highway alignment and the area used during borrow source activities. The Project footprint, shown on Figure 4.1.3-1, covers approximately 383 ha along the Highway (using the Primary 2009 Route) and an estimated 30 ha for the borrow sources.

Local Study Area (LSA) - includes a 0.5 km buffer on either side of the proposed Highway alignment (based on the Primary 2009 Route), including the available borrow sites and the proposed all-season Highway. The total width of the buffer is 1 km. The LSA, shown in Figure 4.1.3-1, covers approximately 13,650 hectares.

Regional Study Area (RSA) – includes a 15 km buffer on either side of the proposed Highway (based on the Primary 2009 Route). The total width of the buffer is 30 km. The RSA, shown in Figure 4.1.3-1, covers approximately 376,959 hectares and incorporates the LSA and the Project footprint.

The geographic scope for assessing effects to the human environment includes potentially affected communities.

Human Environment Study Area – includes the communities of Inuvik and Tuktoyaktuk and the Inuvialuit that may be impacted by the proposed development.

4.1.3.2 Temporal Boundaries

The EIRB (2010) determined that the temporal boundaries should reflect the construction, operation, maintenance and, where relevant, decommissioning and reclamation of the sites affected by the development. The temporal boundaries also consider seasonal and annual variations related to the environmental components for all phases of the development, where appropriate. To determine the temporal boundary of assessment, the following items were taken into account:

- Duration of the construction period;
- Duration of the operational period;
- Design life of engineered structures; and
- Frequency and duration of natural events and human-induced environmental changes (EIRB 2010).

Depending on the activity, the temporal boundaries for the assessment are defined as:

- Short-term – occurs or lasts for short periods of time (i.e., hours, weeks, or months);
- Medium-term – occurs or lasts for the life of the Project; and
- Long-term – extends or lasts beyond the life of the Project.

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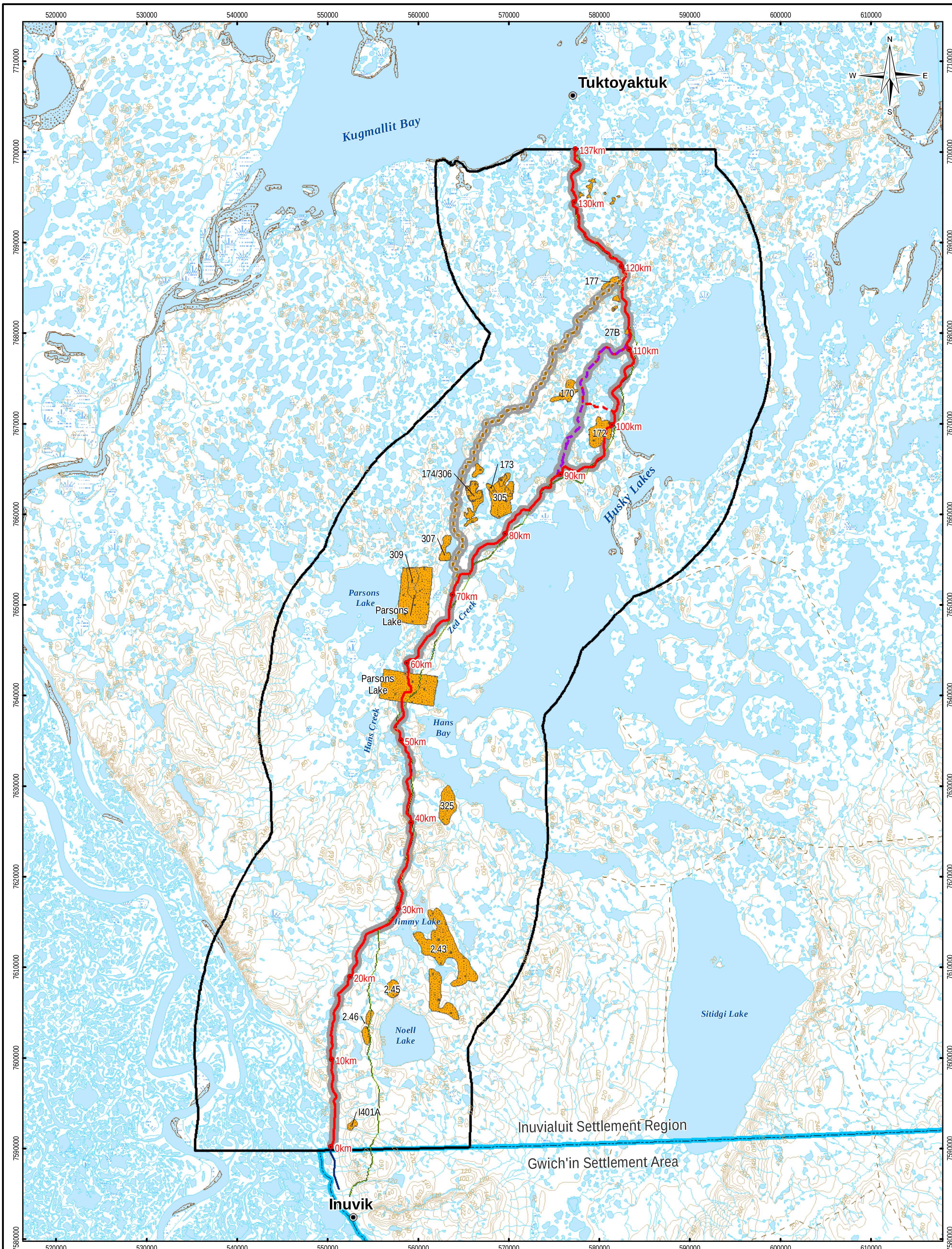

LEGEND

- Local Study Area (0.5 km buffer)
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources: Inuvialuit Land Administration

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Project Study Areas

PROJECTION	DATUM
UTM Zone 8	NAD83

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

FILE NO.
V23201322_EIS_Map032_StudyAreas.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Northwest Territories
Town of Inuvik
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Figure 4.1.3-1

4.1.3.3 Effects Assessment

Using the VCs as the primary focus for the analysis, the assessment of potential effects for each environmental component begins with a review of the main Project activities that could cause environmental disturbances during each of the three primary phases of activity (construction, operation and maintenance, and where relevant, decommissioning and reclamation) associated with the development of the Highway.

The evaluation of effects for each VC is addressed in terms of the type or nature of residual effects that remain after the application of appropriate environmental management and mitigation measures on the biophysical and socio-economic components of concern.

Potential residual effects are typically described in terms of a number of possible impact criteria. Table 4.1.4-1 provides the list of possible descriptors and their corresponding definitions used to assess the level of impact in the biophysical and human environments.

TABLE 4.1.4-1: EFFECTS ASSESSMENT AND CONSEQUENCE CRITERIA

Criterion	Descriptor	Definition
Magnitude	Negligible	• Effect will produce no detectable change from baseline conditions
	Low:	• Effect is within the range of baseline conditions or natural variation
	Moderate:	• Effect is at or slightly exceeds baseline conditions or the limits of natural variation
	High:	• Effect will produce a notable change beyond baseline conditions or the upper or lower limit of natural variation
Geographic Extent	Local	• Effect is confined to the LSA
	Regional	• Effect is confined to the RSA
	Beyond Regional	• Effect extends beyond the RSA
Duration	Short-term	• Effect occurs or lasts for short periods of time - hours, weeks, months
	Medium-term	• Effect occurs or lasts for the life of the Highway
	Long-term	• Effect extends or lasts beyond the life of the Highway
Frequency	Isolated	• Effect is confined to a discrete or specific period of time
	Sporadic	• Effect occurs on occasion and at irregular intervals
	Periodic	• Effect occurs intermittently but repeatedly during the life of the Project
	Continuous	• Effect will occur continually during the life of the Project
Reversibility	Reversible Short-term	• Effect can be reversed during the life of the Project
	Reversible Long-term	• Effect can be reversed within 100 years
	Irreversible	• Effect cannot be reversed

TABLE 4.1.4-1: EFFECTS ASSESSMENT AND CONSEQUENCE CRITERIA		
Criterion	**Descriptor**	**Definition**
Likelihood	Low	• Effect is unlikely but could occur
	Moderate	• Effect is likely but may not occur
	High	• Effect will occur
Consequence	Negligible	• Effect may result in a slight decline in condition of the VC in the study area for a very short duration but the VC should return to baseline conditions
	Low	• Effect may result in a slight decline in condition of the VC in the study area during the life of the Project. Research, monitoring, and/or recovery strategies would not normally be required
	Moderate	• Effect could result in a noticeable but stable change in the condition of the VC compared to baseline conditions which persists in the study area after Project closure and into the foreseeable future. **OR** • Effect could result in a noticeable change in the condition of the VC in that established guidelines or thresholds are exceeded but the VC should return to baseline conditions.
	High	• Effect results in notable changes to the condition of the VC.

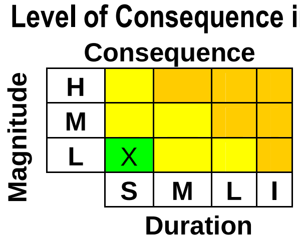
4.1.4 Assessing Level of Consequence

To determine the level of consequence from a residual effect, the magnitude, duration, and location of the effect were the primary factors. In the LSA, the highest consequence rating is moderate. Negligible consequences result from low magnitude and short duration; whereas moderate consequences result from low to high magnitude and medium-term to irreversible duration.

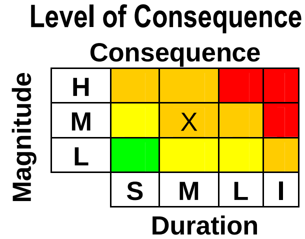
In the RSA, the highest consequence rating is high. Negligible consequences result from low magnitude and short duration; whereas high consequences result from moderate to high magnitude and long-term to irreversible duration.

Consequences are summarized in the following schematics, where the "X" identifies the level of consequence, based on the factors shown in Table 4.1.4-1. The magnitude levels are described as L (low), M (medium) and H (high), and the duration is described as S (short-term), M (medium-term), L (long-term), and I (irreversible).

Level of Consequence in the LSA



Level of Consequence in the RSA



4.2 BIOPHYSICAL COMPONENTS

4.2.1 Terrain, Geology, Soils and Permafrost

The terrain, geology, soils and permafrost baseline conditions along the alignment and in the general area of the Highway are described in detail in Section 2.0 and Section 3.0 of this EIS. The following few paragraphs provide a summary for convenience.

Terrain along the Highway varies from relatively dry upland and hummocky conditions, to wet, ice-rich lacustrine and thick organic conditions. This can be further categorized into four distinctive landforms; glacial moraine, glaciofluvial outwash, lacustrine and alluvial/colluvial deposits. Surface or exposed bedrock is not visible along the alignment as depth to bedrock in the Mackenzie Delta ranges from about 50 m near Inuvik to greater than 150 m near the seaward limit of the modern delta at Tuktoyaktuk.

The surficial geology and landforms along the Highway are primarily the result of glacial activity in the region. As a result, the route contains many seasonal watercourses, wet lowlands, peatlands and lakes, many of which are remnants of glacial outwash channels.

The Inuvik to Tuktoyaktuk Highway corridor is located entirely within the zone of continuous permafrost. The thickness of the active layer along the Highway 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. Common permafrost-related features in the vicinity of the Highway include ice-rich polygonal ground, retrogressive thaw-flow slides, thermokarst and peatland.

Terrain, geology, soils and permafrost are one Valued Component relative to the physical ground upon which the Highway will be built. This VC will be impacted due to both the Highway construction activities and the physical presence and operation of the Highway after it is built.

4.2.1.1 Potential Effects Due to Highway Construction Activities

Highway construction activities are described in detail in earlier sections of this EIS. In general the activities include:

- Development of winter access roads;
- Set up and operation of camps;
- Drilling for geotechnical investigation both along the alignment and in the borrow sources;
- Stripping of organic material from borrow sources;
- Removal of material from borrow sources;
- Hauling and placing of borrow material;
- Installation of bridges and culverts;
- Grading and compaction of constructed embankment; and
- Placement of surfacing gravel.

All of these activities require travel across the ground (as described by the terrain, geology, soils and permafrost) along the alignment and to borrow sources, or working in an area of open cut in a borrow source. The ground, as described above and in earlier sections of the EIS, is in its most vulnerable state in the spring and summer when the air/surface temperature is changing and the active layer is thawing. Travel over the ground with tract or wheeled equipment when it is in this vulnerable state will cause deformation to or shredding of the soil and vegetative surface, compaction of organic peatlands, pumping of water to the surface or collection of surface water in the deformation to form standing water. The effect would be a change in the air/surface temperature balance increasing the depth of the active layer and resulting in thaw slumps, melting of ice-rich soil, slope and soil instability, erosion and subsidence in the permafrost. Subsidence or the presence of new low lying areas or surface channels can also change the drainage and surface hydrology causing collection of water in future years in areas other than where the vehicles travelled creating similar negative effects beyond the area of immediate impact.

Construction will be managed such that travel across the ground, when in its most vulnerable state, does not occur. Such mitigative measures are further described in Table 4.2.1-1.

Extraction of construction materials from borrow sites requires removal of the organic layer and cutting into the ground. Cutting into the ground and removing material exposes the permafrost and ice-rich materials to thaw, creating similar negative effects described above. Development, working and restoration of borrow sources will be done with mitigative measures described in Table 4.2.1-1.

4.2.1.2 Potential Effects Due to the Physical Presence and Operation of the Highway

The ground (as described by the terrain, geology, soils and permafrost) could be affected by the physical presence and operation of the Highway (including embankment, bridges and culverts) after it is built.

As noted above, permafrost and ice-rich soils are highly sensitive to changes in the air/surface temperature balance. Even slight changes can cause an increase in the thickness of the active layer, instability, thaw settlement and subsidence due to loss of permafrost. The introduction of a material layer (the Highway embankment) to the surface could alter that air/surface temperature balance. The granular material will gain heat during warmer periods and if thin enough will transfer that heat to the surface of the natural ground. If the material layer or embankment is thick enough it will act as an insulating layer and the air/surface temperature balance will be maintained or improved.

The presence of the Highway could also affect the air/surface temperature balance in areas beyond the natural ground under the Highway. In the Mackenzie Delta snow normally blows and moves without drifts building along the natural ground particularly where there is little or low (short, stunted) tree cover. The air/surface temperature regime is maintained. Where the air/surface temperature regime is maintained, permafrost does not thaw and settlement does not occur. When the Highway is built, snow will build up on the sideslope and beyond the toe of the slope on the natural ground. This accumulation of snow insulates the permafrost, the air/surface temperature regime is impacted and the result is permafrost thaw and differential settlement.

The Highway also forms a barrier to movement of unchannelized surface water. Surface water can accumulate or pond along the toe of the embankment creating negative effects similar to those described above.

4.2.1.3 Spatial Boundaries

To mitigate the effects described above, Project design elements and measures will be initiated in the design and construction of the Highway to address the causes. The current approach to highway design and construction in permafrost regions is documented in the national guidelines entitled *Development and Management of Transportation Infrastructure in Permafrost Regions* published by the Transportation Association of Canada (TAC) in May 2010. The design parameters and construction techniques presented as mitigative measures in this section are based on experience in the area and the case studies and lessons learned as presented in the TAC guideline.

TABLE 4.2.1-1: SUMMARY OF MITIGATION MEASURES

Cause	Potential Effects	Mitigation Measures
Travel across the ground along the alignment or to borrow sources with tract or wheeled vehicles.	Change in drainage and surface hydrology, thaw slumps, melting of ice-rich ground, slope and soil instability, erosion and subsidence in the permafrost.	Access to and hauling from borrow sources during winter months. Construction of embankment during winter months. Summer activities such as grading and compaction of the embankment, and placing of surfacing materials only where the Highway can be accessed over embankment constructed the previous winter. Stockpiling surfacing material along the previously constructed embankment during the winter for use in the summer.
Cutting into the ground and removing material.	Exposes the permafrost and ice-rich materials to thaw resulting in similar effects to those noted above.	Minimize the surface area of open cut. Grade slopes to minimize slumping. Grade material storage and working areas to promote drainage and avoid standing water. Restore the borrow source when construction is completed by grading slopes to match the natural ground and drainage of the surrounding area, and replacing overburden.
Introduction of the granular material embankment.	Alters the air/surface temperature balance such that heat is gained, the active layer becomes deeper and there is thawing of ice-rich soils and subsidence due to permafrost loss.	Design and construct embankments with thickness or height based on terrain type. Thicker embankments on more thaw-sensitive ground to provide an insulative layer and promote the development of a frozen embankment core. Design the alignment to avoid unfavorable thick organic and ice-rich polygonal terrain.

<table>
<tr><th colspan="3">TABLE 4.2.1-1: SUMMARY OF MITIGATION MEASURES</th></tr>
<tr><th>Cause</th><th>Potential Effects</th><th>Mitigation Measures</th></tr>
<tr><td>Accumulation of snow on the sideslope and along the natural ground beyond the toe of the slope.</td><td>Insulates the permafrost, the air/surface temperature regime is impacted and the result is permafrost thaw and differential settlement, resulting in areas of standing water that will further result in thaw.</td><td rowspan="2">The installation of culverts to balance seasonal overland surface flows;
Install sufficient cross drainage to prevent or minimize potential water ponding; and spring and fall inspections of drainage.</td></tr>
<tr><td>Introduction of the granular material embankment</td><td>Forms a barrier to movement of unchannelized surface water. Surface water can accumulate or pond along the toe of the embankment creating negative effects similar to those described above.</td></tr>
</table>

4.2.1.4 Residual Effects

There will be residual effects of the Highway construction that are not likely to be fully mitigated. A borrow source will leave some mark on the land even with the best and most well thought out management practices during the material extraction. The construction practices noted above are, therefore, intended to minimize the footprint of a single borrow source and minimize the number of borrow sources that are opened for the construction phase.

4.2.2 Air Quality

Air quality is the VC for this assessment because it has links to human and general ecological health and the aesthetic quality of the Project.

The Project will produce airborne emissions that will slightly increase ambient concentrations of certain substances in the airshed on a temporary and transient basis. The air quality assessment predicts ground-level concentrations of selected substances emitted by Project equipment during construction, and emissions from vehicle traffic during operations, but the levels should have no lasting effect on ambient conditions.

The focus of the air quality assessment is therefore on predicting changes in air quality concentrations. The effects these changes might have on the receiving environment are considered in Section 4.2.6 (Vegetation) and Section 4.2.7 (Wildlife and Wildlife Habitats). Similarly, climate change is discussed in Section 4.5.1.

4.2.2.1 Applicable Standards, Objectives and Guidelines

Due to the potential human health and environmental issues related to poor air quality, there are several applicable territorial and federal air quality standards or guidelines.

The *Canadian Environmental Protection Act* (CEPA) is the principal Act for the regulation of environmental contaminants. The CEPA allows the federal government to regulate and control substances through national quality objectives, guidelines and/or standards (Health Canada 2006). Under CEPA, the federal government can assess air pollutants and control their impact through the setting of *National Ambient Air Quality Objectives (NAAQOs) and Canada-wide Standards (CWSs)*.

National Ambient Air Quality Objectives (NAAQOs) identify benchmark levels of protection for people and the environment. NAAQOs guide federal, territorial and regional governments in making risk-management decisions, such as local source permitting and air quality index, and are viewed as effects-based long-term air quality goals. The current framework establishes a national goal for outdoor air quality that protects health, the environment, or aesthetic properties of the environment. NAAQOs are established under CEPA but may be used differently in each province or territory (Health Canada 2006).

The Government of the Northwest Territories, under the NWT *Environmental Protection Act*, developed the *Guideline for Ambient Air Quality Standards in the Northwest Territories: Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ground Level Ozone (O_3), Total Suspended Particulate (TSP), and Fine Particulate Matter ($PM_{2.5}$)* (GNWT ENR 2011). The guideline sets standards for the maximum concentrations of CO, SO_2, NO_2, O_3, TSP, and $PM_{2.5}$ acceptable in ambient air throughout the Northwest Territories. These standards are applied as a long term management goal for air quality (GNWT ENR 2011).

In June 2000, the Canadian Council of Ministers of the Environment[9] (CCME) endorsed a *Canada-wide Standards (CWS) Agreement for Particulate Matter (PM) and Ozone* in air, in accordance with the 1990 *Canada-wide Accord on Environmental Harmonization* and its *Canada-wide Environmental Standards Sub-Agreement*. The CWSs are intended to be achievable targets that will reduce health and environmental risks within a specific timeframe (Health Canada 2006).

For particulate matter and ozone, the CCME acknowledge that:

- PM and ozone negatively affect human health and the environment;
- There is no apparent lower threshold for the effects on human health; and
- There are additional benefits to reducing and maintaining ambient levels below the standards.

According to the CCME (2007), reducing precursor pollutants, such as NOx and SOx, is a primary means of lowering ambient levels of $PM_{2.5}$ and/or ozone.

[9] With the exception of Quebec.

For the purpose of this proposed Project, the Keeping-Clean-Areas-Clean (KCAC) programs of the CCME's Guidance document are relevant to the Beaufort-Delta Region. In particular, the KCAC "refers to preventative measures applied either across a jurisdiction or within a specified area that are intended to avoid or minimize increases in overall ambient concentrations of PM and ozone in areas not significantly affected by local sources of emissions" (CCME 2007).

A detailed discussion of these standards and guidelines and their goals are located in Section 3.1.3. The goals set by these standards and guidelines were applied to assess the acceptability of potential residual air quality effects resulting from the proposed Project during the Construction and Operations Phases.

4.2.2.2 Key Indicators

Key indicators provide a means of practically measuring and assessing changes in air quality.

For the purpose of this assessment, the rationale used to select key indicators includes:

- Substance emissions are monitored at the regional level, in Inuvik;
- Substance emissions have territorial and/or federal standards and objectives; and/or
- Substance emissions are directly related to this Project, such as coarse particulate matter and greenhouse gas (as it relates to vehicle emissions).

The key indicators selected for this Project include:

- Fine particulate matter ($PM_{2.5}$);
- Coarse particulate matter (PM_{10});
- Sulphur dioxide (SO_2);
- Nitrogen oxides (NOx);
- Ground level ozone (O_3);
- Greenhouse gas; and
- Visibility.

Indicators with specific standards and objectives, such as carbon monoxide and total particulate matter, are not assessed as key indicators as they are not actively monitored in the local communities or the region.

Arctic haze was not considered as a key indicator because it is a large-scale phenomenon caused by continental movements of fine airborne particles and aerosols and dominated by large Arctic weather systems. As the Project will not influence these systems, Arctic haze was rejected as a key indicator (IOL et al. 2004).

4.2.2.3 Emission Sources

Air pollution is a broad term applied to any chemical, physical, or biological agent that modifies the natural characteristics of the atmosphere (Environment Canada 2011). Individual pollutants differ from one another in their chemical composition, reactions with other chemicals, sources, persistence, ability to travel through the atmosphere, and effects. Some of the substances classified as air pollutants are naturally occurring, and come from sources such as forest fires and soil erosion, while others are generated from human activities (Environment Canada 2011). Sources of emissions that may cause air pollution are discussed in this section.

Borrow and Construction Activities

The primary construction-related emissions will be dust generated from borrow sites, heavy equipment, and vehicle movements along access roads and the newly constructed sections of the Highway. Other emissions will be generated from by heavy equipment and construction vehicles, including volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO) and sulphur oxides (SOx). Both nitrogen oxides (NOx) and volatile organic compounds (VOCs) are involved in a series of complex reactions that result in the formation of ground-level ozone (Environment Canada 2011). Construction camps will also be potential sources of other air emissions from space heating. This phase of the Project is anticipated to take up to four years.

Construction-related dust and emissions are expected to be localized, short-term, intermittent and transient in nature. Since traffic will not be stationary but travelling along the access roads and newly constructed Highway, it is highly unlikely that the emissions will have any measureable effect on ambient air quality. Air quality effects from the construction camps would be limited to the immediate vicinity of the camps, and would be consistent with other typical residential air emissions such as occur at Inuvik and Tuktoyaktuk.

Sources of fugitive dust related to the construction phase include: materials handling (excavation of borrow sources and construction activities), vehicle traffic during summer (construction and operations phases), open area wind erosion, and storage pile wind erosion. Construction dust emissions are based on area, amount of earth moved, duration of earth moving and other material movement, and travel distances. Materials handling dust emissions depend on the silt and moisture content of the material. Dust emissions from roads have been found to vary directly with the fraction of silt (particles smaller than 75μm in physical diameter) in the road surface materials. Finally, open area and storage pile wind erosion emissions rely on threshold friction, terrain, threshold wind velocities, wind events, and rainfall events (Western Governors' Association 2006).

Other emissions-producing equipment includes mechanical equipment, power generators and heaters.

Operation and Maintenance Activities

The primary operations-related emissions will be fugitive dust from Highway use (approximately 150 to 200 vehicles per day) and vehicle emissions. Fugitive dust emissions from traffic on the Highway are expected, particularly during the summer months. As required, dust suppression techniques that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998) will be applied. During the winter season, the Highway will typically be covered with snow and ice; therefore, fugitive dust emissions from traffic on the Highway are not expected to be a major air quality issue.

Similar to the construction phase, emissions will be generated from vehicles and maintenance equipment, including volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO) and sulphur oxides (SOx) (Environment Canada 2011).

In general, all emissions from operation of the Highway are expected to be localized, transient and of short duration.

Typical dust sources include: vehicle travel along the Highway, regular grading of the Highway surface. Emissions will be produced from vehicles using the Highway.

4.2.2.4 Emissions of Concern

A variety of emissions, in limited amounts, are anticipated to be generated during construction and operation of the proposed Highway. These key indicators (or emissions of concern) are described according to Project phase in Tables 4.2.2-1 (construction phase) and 4.2.2-2 (operations phase).

The emissions of concern are the same as those generated during the use of the existing winter road, except that the Highway will be used year-round instead of only during the winter months.

TABLE 4.2.2-1: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY CONSTRUCTION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Fine Particulate Matter ($PM_{2.5}$)	Heavy equipment operation (vehicle exhaust, brake wear, tire wear, re-suspension of loose material)	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; forest fires; surface material moisture and temperature (i.e., frozen), vehicle weight, traffic volume, number of wheels per vehicle	Spring and summer	Intermittent, during snow-free periods
Coarse Particulate Matter (PM_{10})	Borrow source and Highway construction activities	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; forest fires; surface material moisture and temperature (i.e., frozen), vehicle weight, traffic volume, number of wheels per vehicle	Spring and summer	Intermittent, during snow-free periods

TABLE 4.2.2-1: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY CONSTRUCTION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Sulphur Dioxide (SO_2)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use; forest fires	Year-round	Intermittent
Nitrogen Dioxide (NO_2)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent
Ground Level Ozone (O_3)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent
Carbon Monoxide (CO)	Construction vehicles; transporting staff to work site	Regular vehicle use	Increased vehicular use	Year-round	Intermittent
Greenhouse Gas (GHG)	Construction vehicles; transporting staff to work site; camp activities	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent

TABLE 4.2.2-2: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY OPERATION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Fine Particulate Matter ($PM_{2.5}$)	Vehicle exhaust, brake wear, tire wear, re-suspension of loose material	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; traffic volumes, surface material moisture content, forest fires	Spring and summer	Intermittent, during snow-free periods
Coarse Particulate Matter (PM_{10})	Highway surface during summer	Unfrozen Highway surface; Minimal dust during winter months when Highway covered in snow/ice.	Wind velocity; traffic volumes, surface material moisture content, forest fires	Spring and summer	Intermittent, during snow-free periods
Sulphur Dioxide (SO_2)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use; forest fires	Year-round	Intermittent
Nitrogen Dioxide (NO_2)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent

TABLE 4.2.2-2: EMISSIONS OF CONCERN GENERATED FROM HIGHWAY OPERATION

Emission Type	Emission Source	Normal Operation Conditions	Upsets	Timing	Duration
Ground Level Ozone (O_3)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent
Carbon Monoxide (CO)	Highway traffic and maintenance vehicles	Regular vehicle use	Increased vehicular use	Year-round	Intermittent
Greenhouse Gas (GHG)	Highway traffic and maintenance vehicles	Regular vehicle use	Industrial activity in the area; increased vehicular use	Year-round	Intermittent

As stated previously, the primary emission of concern is dust. Dust emissions are anticipated to remain primarily in the LSA. Dust, in the form of fine ($PM_{2.5}$) and coarse (PM_{10}) particulate matter and total suspended particulates, is expected to be emitted during the construction and operations phases. The review of scientific literature identified consistent factors that affect dust deposition behaviour and include the deposition load, duration, frequency, and chemical properties of the dust. Particle size also plays a role in determining how far away from a source dust effects can be expected to occur. The effects of road dust on vegetation have been detectable 100 m away (Auerbach et al. 1997), 200 m away (Santelmann and Gorham 1988; Angold 1997), and up to 400 m away from a source (Lamprecht and Graber 1996). These distances are consistent with United States Environmental Protection Agency (US EPA 1995) observations of the deposition properties of particles with various aerodynamic diameters (under more "typical" conditions).

Larger dust particles (e.g., with aerodynamic diameters more than 100 μm) typically settle within 10 m of a source, while particles with aerodynamic diameters between 30 to 100 μm settle out within 100 m. Smaller particles than these are less susceptible to gravitational settling and can be transported over greater distances (US EPA 1995). It is anticipated that the largest effects to vegetation ecosystems and plants from fugitive dust will occur within 100 m of a dust source.

Seasonal variations may affect dust deposition as patterns of dust deposition on vegetation are a function of various factors including wind and ambient moisture. During periods of rain, snow, or freezing temperatures, dust is not expected to be generated by any Project activities during construction and operations. Dust previously deposited on vegetation is also expected to be reduced following heavier rain events in particular. However, if dust is generated, dust may be deposited further from the Highway during periods of wind.

4.2.2.5 Potential Effects

Dust and air emissions associated with the relatively short-term construction and longer term operation of the Highway are expected to have limited, localized and relatively temporary effects on air quality and the sound environment in the vicinity of the Highway. These effects, in turn may have effects on the adjacent natural environment and habitats.

The potential effects of each of the following substances are described in this section:

- Fine particulate matter ($PM_{2.5}$);
- Coarse particulate matter (PM_{10});
- Sulphur dioxide (SO_2);
- Nitrogen oxides (NOx);
- Ground level ozone (O_3);
- Carbon monoxide (CO);
- Greenhouse gas (GHG); and
- Visibility.

Fine Particulate Matter ($PM_{2.5}$)

Particulate emissions occur whenever vehicles travel over a paved or unpaved surface. On an unpaved road, the force of the vehicle's wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. Particulate emissions are due to direct emissions from vehicles in the form of exhaust, brake wear, and tire wear emissions and re-suspension of loose material on the road surface (US EPA 2006). The quantity of dust emissions varies linearly with the volume of traffic, as well as other source parameters that characterize the condition of the road, including the fraction of silt (particles smaller than 75 μm) in the surface materials.

Since the Highway will operate during winter periods, when the Highway is typically frozen and covered with snow and ice, fugitive dust emissions from traffic on the Highway are not expected during this time.

The following is a summary of the relevant sources and quantities of $PM_{2.5}$ generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 12 tonnes;
- All off-road vehicles: 105 tonnes;
- Dust from unpaved roads – 312 tonnes; and,
- Forest fires – 36,464 tonnes.

In 2009, the average monthly concentrations of $PM_{2.5}$ in Inuvik were 5 μg/m^3, with only two exceedances of the NWT 24-hour standard (30 μg/m^3) for $PM_{2.5}$. The exceedances were attributed to the long distant transport of smoke from forest fires burning in Alaska and the Yukon at that time (GNWT ENR 2009f).

A review of the $PM_{2.5}$ levels during the periods when the winter road is open (i.e., December to April) indicates the monthly average to be between 2-3 μg/m^3.

The anticipated effect of the proposed Highway is negligible compared to the use of off-road vehicles or natural sources of $PM_{2.5}$, during construction and operation. Although there will be increased traffic during summer months when dust and particulate matter are more likely, Highway dust may be mitigated with the implementation of dust suppression measures.

Coarse Particulate Matter (PM_{10})

The following is a summary of the relevant sources and quantities of PM_{10} generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 13 tonnes;
- All off-road vehicles: 110 tonnes;
- Dust from unpaved roads – 2,358 tonnes; and,
- Forest fires – 44,229 tonnes.

In 2009, the monthly concentrations of PM_{10} in Inuvik ranged between 6-35 μg/m^3. Although there is no NWT standard or objective for PM_{10}, the NWT reports 10 exceedances of an 'adopted' 24-hour standard (50μg/m^3), which generally occurred in the snow-free months. Similar to previous years, the spring-time levels were elevated and were representative of the typical 'spring-time dust event' associated with residual winter gravel and from local construction activities (GNWT ENR 2009f).

The anticipated effects of PM_{10} from the proposed Highway are of low significance during construction and operation of the Highway, following implementation of dust suppression measures. Currently, the monthly averages of PM_{10} in Inuvik are maximum 35 μg/m^3 during spring. The proposed Highway is located in a remote area, with minimal traffic, and is not anticipated to greatly affect the existing PM_{10} levels.

Sulphur Dioxide (SO_2)

The following is a summary of the relevant sources and quantities of SOx generated in the NWT in 2008, including sulphur dioxide (SO_2) and sulphur trioxide (SO_3) (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 3 tonnes
- All off-road vehicles: 9 tonnes

- Dust from unpaved roads – no data or not applicable
- Forest fires – 31 tonnes.

Sulphur dioxide (SO_2) is the predominant form of sulphur dioxides found in the lower atmosphere.

In Inuvik, the 2009 annual average of SO_2 was less than 1 μg/m³, the maximum 1-hour average was 8 μg/m³. The SO_2 concentrations measured in 2009 were very low and similar to previous years' results, with no exceedances of the NWT or National Ambient Air Quality Objectives (GNWT ENR 2009f).

The sources of SO_2 along the proposed Inuvik to Tuktoyaktuk Highway are on-road vehicles. In the NWT, on-road vehicle-related SO_2 comprises approximately 7% of the total SO_2 emissions. While increased movements of vehicles between Inuvik and Tuktoyaktuk are expected, the increased amount of SO_2 generated is anticipated to be minimal.

Nitrogen Oxides (NOx)

Nitrogen oxide (NOx) typically refers to nitrogen oxide (NO) or nitrogen dioxide (NO_2). The following is a summary of the relevant sources and quantities of NOx generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 636 tonnes;
- All off-road vehicles: 1,226 tonnes;
- Dust from unpaved roads – no data or not applicable; and,
- Forest fires and biogenics (vegetation and soils) – 20,816 tonnes.

In the absence of 2009 data, data from 2008 in Inuvik revealed that there were no exceedances of the 1-hour and 24-hour national standards for NO_2 (GNWT ENR 2008a) even though the area typically has winter inversions, which include consecutive days of extremely cold temperatures accompanied with very low wind speeds (calms), reducing dispersal of pollutants (GNWT ENR 2008a).

The sources of NOx along the proposed Inuvik to Tuktoyaktuk Highway are on-road vehicles. In the NWT, on-road vehicle-related NOx comprises less than 3% of the total NOx emissions. With increased movements of vehicles between Inuvik and Tuktoyaktuk expected, the proposed Highway is anticipated to minimally increase NOx levels in Inuvik. This effect is anticipated to be minimal when compared to the effects that off-road vehicles and forest fires have on NOx levels.

Ground Level Ozone (O_3)

Neither the 1-hour national standard (160 μg/m^3) nor the 8-hour NWT standard (127 μg/m^3) for ground level ozone was exceeded in 2009. The annual average was 40 μg/m^3, which is typical of background levels. The maximum 1-hour average was 112 μg/m^3, while the maximum 8-hour average was 106 μg/m^3. Elevated readings typically occur in spring (GNWT ENR 2009f).

Previous studies indicate that consistently elevated ground level ozone concentrations likely result from the intrusion of stratospheric ozone from weather systems passing through the region (IOL et al. 2004).

Since ground level ozone is formed through a series of complex chemical reactions involving other pollutants, such as NOx, the anticipated relatively small NOx increase along the Highway suggests a corresponding minimal increase in O_3 levels. The levels of O_3 are relatively constant in Inuvik throughout the winter months, with a spike in the spring. According to IOL et al. (2004), emission of NOx and VOCs could contribute to higher ground level ozone concentrations when meteorological conditions are suited to photochemical ozone formation. However, such conditions are rare in northern Canada; therefore, no effects are anticipated.

Carbon Monoxide (CO)

Carbon monoxide is not actively monitored at the Inuvik station. Carbon monoxide in the environment typically results from partial or incomplete combustion, usually from vehicle exhaust.

The following is a summary of the relevant sources and quantities of CO generated in the NWT in 2008 (Environment Canada 2010f):

- All on-road vehicles (including heavy duty vehicles, light duty trucks and cars, motorcycles and tire wear and brake lining): 6,357 tonnes;
- All off-road vehicles: 7,486 tonnes;
- Dust from unpaved roads – not applicable;
- Forest fires and biogenics (vegetation and soils) – 428,515 tonnes.

As well, the Northwest Territories Power Plant for Inuvik reports 70 tonnes of carbon monoxide emitted in 2009 (Environment Canada 2008).

Carbon monoxide will be generated from vehicle traffic using the proposed Highway. However, due to the relatively short length of Highway and minimal traffic expected (150 to 200 vehicles per day), the effects are anticipated to be minimal when compared to CO generated from existing on and off-road traffic and/or forest fires in the NWT.

Greenhouse Gas Emissions

Greenhouse gas emission data are collected at the territorial level. Currently the NWT is producing around 2300 Kt of CO_2e/year. GHG emissions in the NWT are increasing steadily due to oil and gas and mining activities. The GHGs generated from transportation have remained constant since 2001 and are forecasted to remain constant, even if such major undertakings as the Mackenzie Gas Project proceed (GNWT ENR 2009a). It seems reasonable to expect, therefore, that the effect of the proposed Highway on GHGs will be negligible.

Visibility

Ice fog forms in calm conditions when there is excess moisture in the air and conditions are cold enough for moisture to freeze; this is aggravated by local emission sources such as idling vehicles (IOL et al. 2004).

The number of vehicles anticipated to use the proposed Highway is between 150 to 200 vehicles per day. Vehicles will be traveling (not idling) on the Highway, which would not lead to a build-up of emissions in one location. As well, due to the lack of other emission sources along the length of the proposed Highway that could contribute to ice fog conditions, an increase in ice fog is not anticipated during the Highway's operation.

Potential increase in ice fog may occur during the construction phase of the Highway when construction vehicles are operating for a period of time in a specific location for a period of time, such as at the borrow source or the portion of the Highway being constructed. By operating in one location, a build-up of emissions from construction vehicles may contribute to ice fog conditions; however, these effects are anticipated to be minimal, of short duration, transient in nature, and would not affect the general public. In particular, ice fog is a naturally occurring event in the region, and should it occur, it will not be a new phenomenon in the region.

4.2.2.6 Project Design and Mitigation Measures

The schedule of the construction phase, Highway design and application of mitigation measures will help to minimize potential air quality effects. Earth moving construction activities are scheduled to occur primarily during winter months, when frozen ground conditions naturally minimize the amount of fugitive dust that would otherwise be created, although some grading and compaction are scheduled during summer.

The Developer will conform to applicable ambient air quality objectives, by using pollution prevention measures and best management practices (CCME 2007).

Mitigation measures during the construction phase include:

- The application of water as per the GNWT's *Guideline for Dust Suppression* (GNWT 1998) during summer months. Water will be effective in controlling dust created by loading and unloading materials, stockpiling and wind erosion;

- To the extent possible, aggregate stockpiling activities will be conducted well downwind of potentially sensitive receptors (based on prevailing winds);
- Effective logistics planning such as the use of buses to haul workers to minimize vehicle movements;
- Closing and progressively reclaiming borrow pits as soon as they are no longer required to reduce potential fugitive dust;
- Ensure proper maintenance of heavy equipment to minimize air emissions;
- Restrict speed limits along the access roads and Highway during construction; and
- Temporarily avoid areas with sensitive wildlife activity or migration (based on recommendations from wildlife monitors).

The GNWT Department of Transportation will be responsible for the ongoing maintenance of the Highway during the operations phase. Specific mitigation measures during the operations phase include conforming to the GNWT's *Guideline for Dust Suppression* (GNWT 1998).

4.2.2.7 Residual Effects

Construction and operations phase traffic are expected to have temporary and intermittent effects in the immediate vicinity of the proposed Highway. Following the application of mitigation measures during construction and operation of the Highway, no residual effects in terms of substances are anticipated. Potential residual effects on wildlife, vegetation and humans are discussed in the corresponding effects sections of this document.

4.2.3 Noise

Noise is considered a VC for this assessment because it has the potential to affect both humans and wildlife. This assessment focuses on environmental noise effects to the general public and wildlife, rather than on occupational (i.e., workplace) noise effects. Project-related activities will occur in remote, uninhabited locations away from the Town of Inuvik and Hamlet of Tuktoyaktuk. Noise sources during construction and operations phases are expected to be intermittent, further reducing the effects.

4.2.3.1 Noise Emission Sources

Construction Phase

Noise generated during the construction phase will be intermittent and temporary. During construction most noise sources are related directly to construction activities (i.e., heavy equipment, trucks, generators, hand tools etc.) and aggregate borrow activities (i.e., blasting frozen borrow material during excavation).

According to *Construction Noise,* an engineering report produced by the Workers' Compensation Board of British Columbia (Eaton 2000), noise levels associated with road construction averages approximately 93 dBA with a maximum of just over 100 dBA.

Trucks will typically be dump trucks or other haul trucks, operating at slow speeds. Noise levels associated with such trucks are typically within 84-86 dBA at 15 m from the truck. Although these levels are of high magnitude they are of short-term duration, intermittent in nature, and are not expected to contribute excessive noise at distances outside the immediate work area.

Aggregate borrow activities are another noise source during construction. Most of the noise will be associated with earth-moving equipment operation during periods of aggregate borrow activity. Blasting activities associated with the borrow source operations will likely be the noisiest activity, producing peak sound pressure levels of approximately 110 dBA at 100 m, but only for very short durations of less than 1 second per blast. In flat open topography, blasting can generate a sound level of approximately 76 dBA at 5 km from the source. Blasting is an infrequent activity during borrow source activities, and ceases completely when construction is finished. The United States Department of Transportation Federal Highway Administration (US DOT FHWA) reports that noise levels are reduced by distance, terrain, vegetation, and natural and manmade obstacles (US DOT FHWA ND).

Since most activities will occur more than 8 km from the residential centres of Inuvik and Tuktoyaktuk, effects from noise on the general public are expected to be negligible. Although there are no local noise regulations that directly apply to construction noise, the Developer will apply reasonable mitigation to reduce the impact of construction noise. Prudent design, best management practices and mitigation can be combined to minimize sound levels during the construction phase.

Operation Phase

Traffic along the Highway will occur year round. The Highway is designed for travel at 80 km/h. Current use of the winter road indicates approximately 139 average daily trips (GNWT DOT 2009b). It is anticipated that once the Highway is constructed that approximately 150 to 200 vehicles will use the Highway each day. Vehicles will include personal vehicles (likely light to heavy trucks) and conventional heavy-duty vehicles (i.e., tractor trailers or fuel trucks), potentially operating at slower speeds.

Noise levels associated with passenger vehicles travelling at speed limit are typically within 72-74 dBA at 15 m from the vehicle (Michael Minor & Associates ND). Heavy-duty trucks traveling at the speed limit are typically within 84-86 dBA at 15 m from the truck, which would not be expected to create excessive noise levels beyond the immediate vicinity of the Highway. These levels are intermittent, short in duration, and transient in nature.

4.2.3.2 Potential Effects

Effects on Humans

The most common effect of noise on humans is annoyance and impairment of daily activities. Noise can have a physical effect on humans, especially with prolonged exposure. The potential health effects are dependent on duration of exposure (acute versus. chronic) and intensity (dBA level).

The physical effects of noise on humans outside the immediate exposure area are typically minimal and limited to an annoyance factor. Since most of the Project will occur in remote areas, noise will primarily affect those working or visiting cabins in the immediate area. Further, exposure will be temporary and/or intermittent, occurring mostly during the construction phase when activities are concentrated in particular areas.

To protect people from occupational noise effects, various federal and provincial standards are implemented to limit noise levels (see Section 3.1.4.2). The Town of Inuvik and the Hamlet of Tuktoyaktuk have no local noise regulations.

Because the noise emissions will be temporary and intermittent there are no anticipated residual negative effects impacting traditional or recreational use of the area.

Effects on Wildlife, Birds and Fish

The effects of the Highway on wildlife and birds are discussed in Section 4.2.7, although a brief summary is provided here.

It is generally accepted that the effects of noise on most wildlife species are poorly understood (Larkin et al. 1996; Brown 2001; OSB 2003). Furthermore, Larken et al. (1996) suggest that response to noise disturbance cannot be generalized across species or among genuses. Wildlife's response to noise can depend on a variety of factors, including:

- Noise level and type;
- Frequency distribution;
- Variation over time;
- Duration;
- Number of events;
- Ambient noise level;
- Time of day and time of year;
- Animal activity and location;
- Age and sex class; and
- Past experience (Larkin et al. 1996; Voipio et al. 1998; Pater 2001; OSB 2003).

An animal's sensitivity to sound varies with frequency and its response to a sound depends largely on the presence and levels of sound in the frequency band (range of frequencies) to which it is most sensitive (Richardson et al. 1995; Larkin et al. 1996).

AMEC Americas Limited (2005) reports that although barren-ground caribou appeared to avoid active roads it was unclear whether it was noise or visual stimuli that caused the disturbance. Some studies suggest that caribou were displaced up to 2 km from a road with moderate to heavy traffic for a two to three-week period around calving time (Dau and Cameron 1986; Cameron et al. 1992). Calving grounds for barren-ground caribou are located away from the Project's RSA (Figure 3.2.9-5). In addition, the Highway is expected to generate a low volume of traffic, approximately 150 to 200 vehicles per day, which is approximately 8.3 vehicles per hour in a 24-hour period). It was also reported that caribou appear to habituate to some industrial activity, including noise (Valkenburg and Davis 1985).

Observations by Hanson (1981) suggest that barren-ground caribou were not greatly affected by diesel generators and vehicle traffic at Prudhoe Bay. A quantitative study of steady-state noise was conducted by McCourt et al. (1974), which indicated that the simulated sound of a gas compressor elicited an increased incidence of alert postures in caribou passing within 300 m of the simulator, with some apparent avoidance of this zone, but no strong reactions observed. This is substantiated by Hanson (1981) where individual caribou appeared undisturbed by steady noise from the generator located approximately 60 m away.

Caribou have shown either no response or a short run-resume feeding response to dynamite blasts. Russell (1977) observed that caribou located 1.2 km from a series of seismic detonations looked up after one of eleven detonations, but otherwise continued to feed or bed. Grindal (1998) confirms that no overt response was detected when barren-ground caribou were exposed to a mine blast approximately 500 m away.

Grizzly bears have shown avoidance and altered behaviour in response to road presence, seismic blasting and other industrial activities (Harding and Nagy 1980, Archibald et al. 1987, McLellan and Shackleton 1988, Mace et al. 1996, Mueller 2001, Gibeau et al. 2002, Wielgus et al. 2002). Follmann and Hechtel (1990) indicated that grizzly bears can habituate to noise disturbance, citing examples of bears that habituate to human developments if there are energetic benefits. Grizzlies typically select den sites >1 km from human activities; dens are abandoned or habitat not selected when closer than 1 km (Harding and Nagy 1978).

Limited information is available for potential effects on moose related to noise. Anderson et al. (1996) found that human sources of disturbance, such as skiers, created flight responses at greater distances and elevated heart rates for longer periods than mechanical sounds. Anderson et al. (1996) attributed this difference to past experience, as moose in the study areas were hunted by hunters on foot or skis, rather than motorized vehicles.

For birds, as well as other wildlife, sound is an important communication and survival tool. Songs are important in the isolation of species, pair formation, mating, territory defence, flocking, and danger alerts. Various studies have indicated that birds were generally displaced, particularly showing a reduction in nesting density, near roadways and in areas of construction (US DOT FHWA 2004). However, the US DOT FHWA (2004) also reported that at light traffic volumes (between 3,000 and 4,000 vehicles per day), which is much higher than the anticipated Highway traffic volumes, both presence and breeding of birds near roads were not affected.

4.2.3.3 Applicable Standards and Guidelines

Occupational noise guidelines, as indicated in Section 3.1.4.2, are applicable during all phases of the Project.

Because of the proximity of the potential borrow sources to waterbodies, some blasting activities may occur near waterbodies that provide fish habitat. The Developer and its contractors will be required to adhere to the DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998). Highlights of the Guidelines include:

- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swim bladder of a fish.
- No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 m/s in a spawning stream bed during the period of egg incubation. For confined explosives, setback distances from the land-water interface (e.g., the shoreline) or burial depths from fish habitat (e.g., from under the riverbed) that will ensure that explosive charges meet the 100 kPa overpressure guideline are identified in the guidelines.

4.2.3.4 Project Design and Mitigation Measures

The schedule of the construction phase, Highway design and application of mitigation measures and best management practices are intended to minimize the potential effects of noise, including the following practices:

- Limit construction activity during sensitive periods (based on recommendations from wildlife experts) to minimize effects on wildlife, particularly blasting activities;
- Effective logistics planning such as the use of buses to haul workers to minimize vehicle movements; and,
- Maintenance of equipment in good repair and provision of appropriate mufflers for all internal combustion engines.

4.2.3.5 Residual Effects

Noises produced by construction and operation activities are anticipated to have a localized, temporary, and intermittent effect in the immediate vicinity of the Highway.

During construction, noise contributions will be of low to moderate magnitude and will be continuous during work hours, but of temporary duration overall. That is, at the end of construction all noise contributions from these activities will cease. It is anticipated that wildlife and birds may temporarily avoid areas with construction or excavation due to human activity and/or noise. However, no residual effects, following completion of construction activates, are anticipated for noise emissions generated during construction.

Noise contributions during the operations phase will be highly limited in duration because of the mobile and temporary nature of noise emission sources (i.e., trucks moving along the Highway will not contribute noise to any one area for a long period of time). Due to the limited amount of traffic (150-200 vehicles per day) anticipated for the Highway, the average noise levels associated with vehicles being (72 to 86 dBA), and the diminishing nature of sound levels with increased distance from the source, it is anticipated that noise contributions during the operations phase will be negligible within the LSA and RSA and no residual effects are anticipated during this phase.

4.2.4 Water Quality and Quantity

Water quality is an important consideration for protection of the aquatic environment within the development area as the lake and stream waters of the watersheds crossed by the proposed Highway are inextricably linked to fish and fish habitat abundance and quality, provide fish habitat, and are sources of freshwater for the Inuvialuit. Changes in water quality and quantity can affect fish and fish habitat and the use of surface water by people. The assessment of the potential effects of the proposed Highway construction on aquatic resources, including water quality and quantity, and the development of effective avoidance or mitigation measures, are major components of the environmental assessment of the proposed Inuvik to Tuktoyaktuk Highway. Effects of works and activities associated with the Highway on water quality and quantity relate primarily to the construction phase of the Project, and secondarily to the operations phase.

Potential effects on water quality and quantity may result from site preparation, road construction activities (including clear-span bridge and culvert installation), and operational maintenance. Most effects to water quality resulting from projects of this nature are due to soil exposure, erosion, and the subsequent flow of suspended sediments to watercourses, while effects to water quantity are due to water extraction, changes to surface drainage patterns and blockages to surface drainage.

Potential effects of the Project on water quality and quantity, and a discussion of mitigation measures necessary to prevent adverse effects are provided in the following subsections. Criteria for the assessment of residual effect significance are shown in Table 4.1.4-1 in Section 4.1.2. However, following the application of suitable mitigation, Highway construction and operation is not expected to result in adverse residual effects to water quality or quantity.

4.2.4.1 Potential Effects

Potential effects (or effect-inducing stressors) that can occur during the construction and operation of the Highway are detailed below and summarized in Table 4.2.4-1. Overall, it is concluded that construction and operation-related effects with respect to water quality and quantity will:

- Be confined to the local study area;
- Persist for short-term duration;

- Be infrequent, since effects occur in isolation from one another; and
- Generally be reversible in the short-term.

By their nature, road construction activities have the potential to cause erosion and consequent sedimentation of receiving streams and lakes. Sediment released to streams and lakes, both in suspended and settled forms, can pose a risk to water quality. However, available guidelines and Best Management Practices (BMPs), such as DFO *Land Development Guidelines* (1993), DFO *Operational Statements*, and INAC *Northern Land Use Guidelines for Roads and Trails* (INAC 2010c), can be effective to avoid or mitigate effects to water quality and quantity.

In addition, the scheduling of embankment construction and most culvert installation activities during the winter period will help to avoid or minimize erosion and sedimentation due to the absence of flowing water during that time. However, some activities, such as final compaction, placement of surfacing materials on the sections of Highway embankment, and adjustments to or installation of certain culverts, will be undertaken in summer periods using appropriate erosion and sediment control measures.

The proposed Highway will cross numerous ephemeral and permanent stream channels and wetland areas, and as such, may affect local hydrological characteristics. The alignment crosses through the Delta Hydrologic Region, 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.

Due to the low relief of the Tuktoyaktuk Peninsula, Rescan (1999a) anticipated that the highway route proposed at that time could possibly cause some disruption to surface drainage patterns. Unless properly mitigated, terrain disturbance and road construction could potentially result in a number of smaller lakes completely drying up or conversely, result in blocked flow paths causing ponding due to (Percy and Hoban 1975). These issues are addressed in the Highway Design Effects section below.

Highway Design (Pre-construction)

The Highway design is influenced by the hydrologic patterns and characteristics of the Project area. Stream crossing structures and cross drainage culverts will be appropriately sized to accommodate flash freshet flows, which can be sudden and intense. Extensive background work has therefore been carried out to develop the current Highway design. Mitigating potential effects and eliminating residual effects to water quality and quantity, which will occur as a result of constructing the Highway, is most effectively accomplished through detailed planning of the Highway route and design and installation of approved crossing structures.

Potential sources of suspended sediment occur from land disturbance, disturbance of bottom or bank sediments during construction, surface runoff from the Highway during the snow-free period, and dust generation during operation. Land disturbance has the potential to occur throughout construction, although the magnitude of such effects is minimized due to frozen conditions during the primary construction season and conformance to available guidelines and BMPs.

Potential effects to water quality and quantity as a result of Highway design include:

- Reduced water quality due to erosion and sedimentation from construction; and,
- Alteration of surface drainage patterns due to stream constriction at stream crossing sites or through obstruction of overland drainage.

Effects to water quality and quantity as a result of Highway design will be minimized by:

- The design and use of crossing structures that are appropriate for site-specific flow conditions;
- Employing erosion and sediment control best management practices (BMPs) and DFO Operational Statements (where possible) as per an approved environmental management plan (EMP);
- Installing appropriately sized cross culverts to divert and manage Highway and surface drainage flows; and
- Undertaking primary Highway embankment construction activities during the winter months.

Each of these potential effects and proposed associated mitigation is described further in the following sections.

Clear-span Bridge Construction (Construction)

As described in the fish and fish habitat impact assessment section, clear-span bridges were recommended to be installed to cross 11 large watercourses but currently it has been determined by the Project Team that about 8 bridges may be needed. Based on field reconnaissance, siting and construction of these bridges will be consistent with the DFO Operational Statement (OS) for Clear Span Bridges (DFO 2009b). Adherence to the conditions of this OS will result in avoidance of adverse effects on water quality and water flow that can occur when structures are placed within the flowing portion of a stream or due to excessive soil disturbance or removal of riparian vegetation.

During the bridge design stage of the Project, it is possible that individual site-specific circumstances might preclude complete adherence to the OS. In particular, there may be cases where abutments, for engineering or practical reasons, must impinge on the floodplain. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize sedimentation or flow constriction.

Culvert Installation and Maintenance (Construction and Operation)

Culverts will be necessary at approximately 35 identified watercourse crossings along the Highway alignment. Additional cross-drainage culverts will need to be installed along the Highway as necessary to accommodate seasonal overland drainage. At each watercourse crossing, culverts will be appropriately sized to avoid or minimize changes in water flow patterns and timing, and will follow installation guidelines such as those contained within the DFO *Land Development Guidelines* (1993) and the INAC *Northern Land Use Guidelines for Roads and Trails* (2010c). These measures are necessary due to the potential effects on water quality and water flow of improper sizing and installation, which can result in:

- Ponding, when culverts are insufficient to handle high flows;
- High water velocities, due to improper culvert sizing; and,
- Bank and stream bed erosion, due to exposure of unconsolidated bank material, excessive flows, lack of suitable armouring, and culvert perching (i.e., culvert not buried sufficiently into the stream bed).

Appropriate culvert sizing, the application of recognized installation guidelines and adherence to erosion and sediment control measures will reduce the magnitude, frequency, and duration of potential effects related to ground disturbance and culvert installation. When watercourse crossings are completed, disturbed materials will be replaced with similar-sized substrates and the stream bed and banks of the watercourse will be stabilized and restored.

Routine monitoring and inspections at watercourse crossings will be carried out to confirm the proper performance of each culvert. This will involve examination for debris buildup, culvert subsidence or lifting, and stream bank or bed erosion. Where necessary, maintenance activities will be carried out in conformance with the DFO (2010) Culvert Maintenance OS, which includes the removal of accumulated debris (e.g., woody debris, boulders, garbage, and ice build-up) that prevents the efficient passage of water and fish through the structure and may also include the reinforcement of eroding inlets and outlets.

As a result of these measures, it is concluded that culvert installation and maintenance will not result in residual adverse effects to water quality or water flow.

Use of Heavy Equipment (Construction)

Heavy equipment will be on-site throughout the Highway construction process and during isolated events for Highway maintenance. Effects on water quality due to the operation of heavy equipment relate primarily to the potential for ground disturbance, soil exposure, rutting, and the consequent mobilization and flow of suspended particulates to streams during snowmelt and rainfall events.

The use of heavy equipment for Highway embankment construction will occur during the winter months when all stream crossing locations will be frozen. Therefore, the potential for erosion and sedimentation from this activity is very low. Highway surface grading and compaction activities, to be conducted in the summer months, will help to mitigate surface runoff associated with the thawing of the surface of the embankment.

Potential effects resulting from erosion and sedimentation will be mitigated by the construction schedule, and implementation of erosion and sediment control plans contained in the construction EMP, an example of which is located in Appendix E. In addition, monitoring of construction works by environmental and wildlife monitors will ensure the application of prescribed mitigation, identify unforeseen and potential erosion sites that could lead to the discharge of sediment to surface or groundwater, and prevent erosion and subsequent sedimentation.

Based on adherence to the proposed mitigation measures, the BMPs, and the EMP, residual effects on water quality from the use of heavy equipment during construction are not anticipated.

Water Extraction (Construction)

Considerable amounts of water will be required for annual winter access road construction. Water for this purpose will be extracted from suitably sized lakes in proximity to the Highway corridor, and will be naturally replenished the following spring. It is anticipated that total water requirements will exceed 300 m^3/day, which will likely trigger the need for a NWTWB Type A Water Licence.

Water withdrawal will be regulated by criteria set out in the Water Licence and the DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories* (see Section 4.2.5.1 for discussion of water withdrawal requirements with respect to fish and fish habitat). As such, no adverse residual effects are anticipated from this activity.

Road Drainage (Construction)

The potential exists for sediment releases to ephemeral and permanent streams due to drainage in summer months from the newly constructed road embankments, and slumpage of road slopes prior to compaction and stabilization. However, since vegetation will not be disrupted at the toe of the road slopes, it is expected that sediment flow will be slowed and filtered by this vegetation to reduce this potential risk. In addition, silt fences will be installed at each road-channel intersection to prevent sediment releases to streams. Silt fences will be left in place until roadways are compacted and stable, and will be routinely monitored and maintained. Cross drainage culverts, which will be installed at regular intervals, will channel road drainage away from streams and allow filtration by natural vegetation. Because of these measures, no residual effects on water quality due to road drainage are anticipated.

Dust Generation (Operation)

Water quality is not expected to be affected by dust during the majority of the Highway's construction, since most work is scheduled to occur during the winter. However, dust generation and subsequent effects may occur periodically during the grading and compaction activities that will take place in summer, and during Highway operation through the dry summer months. Potential effects of dust generation include a reduction of water quality as a result of dust and fines settlement on adjacent waterbodies. However, effects to water quality from dust generation and settlement will be short term and are not anticipated to be significant due to mitigation by the application of non-toxic dust suppression techniques (water trucks) that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998).

Highway Maintenance (Operation)

During Highway operations, it is anticipated that the Highway surface and culverts will require regular maintenance during summer months. Potential effects of Highway operations (i.e. vehicles driving on the Highway surface) relate to erosion of road surfaces or embankments and dust generation, possibly resulting in sedimentation of adjacent watercourses.

Based on adherence to the GNWT DOT's erosion and sediment control BMPs and the *Guideline for Dust Suppression* (GNWT 1998), the residual effects on water quality during regular maintenance activities are not anticipated.

4.2.4.2 Project Design and Mitigation Measures

Table 4.2.4-1 provides a summary of the expected activities, potential effects and mitigation measures that apply to the design, construction and operation of the Highway. The potential for erosion and sedimentation effects exists at all phases of the Project due to the nature of Highway construction activities. In recognition of the potential adverse effects of sediment, an environmental management plan (EMP) will be prepared prior to construction and submitted to regulators for approval, to provide specific and detailed guidance to avoid sediment releases to the aquatic environment. The EMP will refer to appropriate erosion and sediment control guidelines, GNWT erosion and sediment control best management practices (currently being prepared in coordination with DFO), 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 borrow source;
- Minimizing vegetation removal and conducting progressive reclamation at the clear-span abutments, culvert installations and borrow sources;
- Keeping ice bridge and ice road surfaces free from soils and fine gravel that may be tracked out by vehicles;
- Avoiding the use of heavy equipment in streams or on stream banks during summer months, and the adherence to the DFO Operational Statement for Temporary Stream Crossings (DFO 2008), where this is deemed necessary;
- Installing silt fencing and/or check dams, and cross drainage culverts as necessary to minimize siltation in runoff near waterbodies; and,
- Appropriate sizing and installation of culverts, based on hydrological assessments and local experience, to avoid backwatering and washouts.

TABLE 4.2.4-1: POTENTIAL EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON WATER QUALITY AND QUANTITY

Activity	Potential Effect	Avoidance or Mitigation
Highway Construction	Erosion and sedimentation	Complete Highway embankment construction during winter months Implement erosion and sediment control plan and best management practices, as appropriate
	Surface drainage pattern changes due to stream constriction	Abutments to be placed in accordance with DFO's *Operational Statement for Clear-Span Bridges* Appropriate sizing of culverts based on hydrological assessments and local experience
	Temporarily reduce lake levels due to water extraction	Follow DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories*
Clear-span Bridge Construction	Sediment release during construction of abutments	Employ erosion and sediment control best management practices and guidelines, as appropriate; adhere to DFO *Clear-span Bridge Operational Statement* Complete abutment construction during winter period
	Flow changes due to stream constriction	Abutments to be placed at a sufficient distance from active stream channel
Culvert Installation	Sediment release during culvert installation	Implement erosion and sediment control best management practices, and culvert installation guidelines, as appropriate (e.g. DFO *Land Development Guidelines*, Dane 1978)
	Changes in surface drainage patterns	Appropriate sizing of culverts based on hydrological assessments and local experience
Use of Heavy Equipment	Soil erosion and sedimentation	Apply erosion and sediment control best management practices
Highway Operation and Maintenance	Increased dust generation and fine particle settlement into adjacent waterbodies	Effective dust suppression (water trucks) during dry season
	Sediment release during maintenance	Implement erosion and sediment control best management practices as appropriate
	Temporarily reduced surface water quantity	Water withdrawal to occur from appropriately sized lakes Water License and DFO protocol to be followed.
Road Drainage	Sediment discharge to watercourses	Filtration by natural vegetation Silt fences installed at each road-stream intersection Regular spacing of cross-drainage culverts
Culvert Maintenance	Sediment release during maintenance	Apply erosion and sediment control best management practices Inspect and maintain culverts, as needed, in the spring and fall Follow the DFO *Operational Statement for Culvert Maintenance* (DFO 2010) as appropriate

4.2.4.3 Residual Effects

Based on the previously discussed assessments of the various components of Highway construction, operation, and maintenance, the Project is not expected to result in residual effects on water quality, or water quantity and flow patterns, following the implementation of mitigation.

4.2.5 Fish and Fish Habitat

The assessment of the potential adverse effects of Highway construction and operation 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. Effects of construction and operation activities associated with the Highway on fish and fish habitat relate primarily to the construction phase of the Project, and secondarily to the operations phase. Except for the installation of culverts in key fish-bearing streams, stream crossing construction works will be undertaken during the winter months when streams are frozen, as recommended by Percy and Hoban (1975).

As per Section 3.1.7.10, three categories of streams are recognized along the proposed route from the perspective of identifying engineering constraints related to the protection of fish and fish habitat:

- *Ephemeral streams that are not utilized by fish for any part of their life cycles, and are therefore not considered to be fish-bearing.* Crossings over such streams require culverts that are appropriately sized to prevent ponding and erosion (27 crossings);
- *Perennial (except in winter) streams that are potentially utilized by one or more life cycle stages of fish for migration during open water periods.* Appropriately sized and installed culverts are required to permit unimpeded fish passage (8 crossings); and
- *Perennial (except in winter) streams that are utilized by one or more life cycle stages of fish for spawning, rearing and feeding during open water periods, in addition to migration.* Clear span bridges were recommended (11 crossings).

The effects of a linear development were considered by the Mackenzie Environmental Monitoring Program (MEMP), an initiative of INAC, DFO and the governments of NWT and Yukon Territory in 1985 (Rescan 1999a). The findings of that program suggested that linear development, or increased access, could result in potentially increased fishing pressure, leading to decreased distribution and abundance of fish (Rescan 1999a). The species deemed to have the highest potential to be affected by construction and increased harvest pressure were lake trout and whitefish.

However, it was also suggested that these effects could be mitigated by careful route selection, site supervision during construction, and post-construction monitoring. Further, the issue of increased fishing pressure should be jointly resolved through regulation, monitoring and enforcement by stakeholders, such as the FJMC, in consultation with DFO (Rescan 1999a). It was further determined that potential negative effects on fish quality were invalid because there were insufficient data to indicate land disturbance ever affecting palatability of northern fishes.

Additional information exists which shows that many connecting streams, which link small lakes within a watershed to the sea, such as the Mackenzie Delta and Beaufort Sea, may be important migration corridors for coregonids (whitefish) which use lakes as nurseries (Rescan 1999a). This stresses the importance of stream crossing design within potential migratory watercourses. However, very few of the streams along the Highway corridor possess sufficient flow or upstream habitat conditions to support coregonid populations. Whitefish require lakes for spawning that do not freeze to the bottom and are well oxygenated in winter. Lakes with these properties are uncommon in the headwaters of most of the streams crossed by the Highway.

The greatest direct effect from Highway construction on fish and fish habitat (i.e., obstruction or sedimentation of fish migration corridors) will be mitigated by properly designed watercourse crossings and appropriate timing of construction.

Potential effects of the Project on fish and fish habitat, recommended mitigation measures, residual effects, and proposed effect significance levels are provided below. Criteria for the assessment of residual effect significance are shown in Table 4.1.4-1 in Section 4.1.

4.2.5.1 Potential Effects and Mitigation Measures

The principal fish habitat issues and mitigation measures that should be considered as part of the regulatory approval process are discussed below and summarized in Table 4.2.5-1. 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 (as stated previously).

Road embankment construction activities will primarily be conducted during the winter months when all of the watercourse crossings will be frozen. Summer-related work will be on a smaller scale and will include compacting and grading of the embankment (Highway surface), installation of certain culverts, or adjustments to culverts installed in the previous winter.

The installation of culverts in fish-bearing streams in summer is necessary due to the requirement that culverts be buried into the stream bottom to prevent downstream erosion and culvert perching. This latter effect is common when culverts are set on (rather than into) the stream bottom, resulting in undercutting of the stream bottom, leaving the downstream end of the culvert raised (or perched) above the water surface. This creates a barrier to upstream fish passage, particularly for small fish. Frozen channel and stream bed conditions preclude the partial burial of culverts in winter.

In accordance with DFO (2009a), the installation of culverts in fish-bearing streams is not permitted between April 1 and July 15 for watercourses that provide habitat for spring/summer spawners (i.e. grayling, which is the only species potentially spawning in Project area streams). These installations will adhere to appropriate guidelines, such as those contained in the DFO *Land Development Guidelines for the Protection of Aquatic Habitat*

(DFO 1993) and in Dane (1978), to avoid or minimize the potential for erosion, sedimentation or channel effects. Various methods are available for installing culverts in flowing streams. Appropriate techniques will be determined on a site specific basis by qualified biologists working in conjunction with fluvial geomorphologists and road construction engineers, and in consultation with DFO habitat biologists.

Cross drainage culverts or those installed in non-fish bearing streams will be installed under frozen conditions in winter and as such, construction of these watercourse crossings will not result in effects to downstream fish habitat. No other instream work will occur in fish-bearing streams during critical time periods.

Construction-related effects with respect to fish and fish habitat are all considered to be local effects, as they are confined to the local study area, of short-term duration and are infrequent, since effects occur in isolation spatially and temporally from one another. Operational effects of the Highway with respect to fish and fish habitat are similarly considered to be local effects but will vary in duration and frequency.

Several components of the Project have the potential to result in erosion and sedimentation effects on fish and fish habitat in the absence of appropriate mitigation measures. Sediment released to streams and lakes, both in suspended and settled forms, presents a risk to fish and fish habitat. The effects of sediment on fish and their habitat include, but are not limited to:

- Degradation of potential spawning areas;
- Smothering of eggs and 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. Effects due to erosion and sedimentation will largely be avoided due to construction being limited to the winter period when flow (and hence, fish) will be absent from the streams being crossed by the Highway, and when frozen soils are not subject to erosion.

For construction activities taking place in summer, potential erosion and sedimentation effects will be minimized or avoided through approved design and the application of appropriate guidelines and BMPs, as described previously. An erosion and sediment control plan will be developed to integrate existing guidelines and to provide site-specific erosion and sediment control guidance.

TABLE 4.2.5-1: POTENTIAL EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON FISH AND FISH HABITAT

Activity	Potential Effect	Avoidance or Mitigation
Highway Construction	Direct loss of habitat	Avoid critical habitats Design appropriate crossing structures based on site conditions
	Erosion and sedimentation	Complete Highway embankment construction activities during winter months Apply erosion and sediment control plan and best practices
Clear-span Bridge Construction	Direct loss of riparian habitat within abutment footprints	Minimize riparian disturbance (footprint) Follow the DFO *Operational Statement for Clear-span Bridges* (DFO 2009b) where appropriate
	Sediment release during construction of abutments	Apply erosion and sediment control plan and best practices Complete primary construction activities during winter period
	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
	Barrier to migration	Employ best management practices for culvert installation Annual monitoring to detect culvert subsidence or lifting
	Sediment release during construction	Construction during winter in non-fish bearing streams Apply appropriate design and erosion and sediment control plan and best practices
	Changes in stream flow patterns	Appropriate sizing of culverts based on hydrological assessments and local experience
Use of Heavy Equipment	Soil erosion and sedimentation	Apply erosion and sediment control plan and best practices
Borrow Source Development	Erosion and sedimentation	Maintain sufficient buffer of undisturbed land between borrow sources and waterbodies Apply erosion and sediment control measures and best management practices
	Fish mortality due to blasting	Follow DFO *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998).
Water Extraction	Oxygen level depression Exposure of eggs and larvae Reduction of available habitat for spring spawners	Follow DFO (2010) *Protocol for Winter Water Withdrawal in the Northwest Territories*
Road Drainage	Sediment discharge to watercourses	Filtration by natural vegetation Silt fences installed at each road-stream intersection Regular spacing of cross-drainage culverts
Culvert Maintenance	Sediment release during maintenance	Employ erosion and sediment control measures as per an Approved erosion and sediment control plan Follow the DFO *Operational Statement for Culvert Maintenance* (DFO 2009b) where applicable
Highway Operation and	Sediment release during maintenance	Implement erosion and sediment control best management practices as appropriate

TABLE 4.2.5-1: POTENTIAL EFFECTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED HIGHWAY ON FISH AND FISH HABITAT		
Activity	**Potential Effect**	**Avoidance or Mitigation**
Maintenance		Follow the DFO *Operational Statement for Culvert Maintenance* (DFO 2009b) where applicable
	Dust generation and fine particle settlement into adjacent waterbodies	Effective dust suppression (water trucks) during dry season Water License and DFO protocol to be followed.
Increased Access to Fish Resources	Increased harvest pressure due to improved access to remote fishing areas	Creation and enforcement of Regulations or guidelines on fish harvest by FJMC with input from DFO, local fisherman and Hunters and Trappers Committees Signage posted at regular intervals on Highway

Highway Design (Pre-construction)

The mitigation of potential effects to fish and fish habitat is most effectively accomplished during Highway routing and design. Appropriate planning will avoid or minimize potential effects due to:

- Loss of instream and riparian habitat at crossing footprints;
- Reduced habitat quality due to erosion and sedimentation from construction activities; and,
- Alteration of surface drainage pattern due to stream constriction.

Effects to fish and fish habitat as a result of Highway construction will be minimized by the planned avoidance of critical fish and fish habitat areas, where possible. Where critical fish habitat cannot be avoided, mitigation will be incorporated into the design, including:

- Sizing and design of appropriate crossing structures based on site conditions present at each crossing;
- Employing erosion and sediment control best management practices according to an approved EMP;
- Undertaking Highway embankment construction during the winter months; and
- Constructing or installing stream crossing structures to avoid the impingement of the active stream channel.

Clear-span Bridge Construction (Construction)

As noted in Section 4.2.4.1, the siting and construction of bridges will be consistent with the DFO Operational Statement (OS) for Clear Span Bridges (DFO 2009b). Adherence to the conditions of this OS will result in avoidance of adverse effects on water quality and water flow that can occur when structures are placed within the flowing portion of a stream or due to excessive soil disturbance or removal of riparian vegetation. Hydrological analysis will be completed prior to bridge design to determine suitable span widths and abutment placement.

During the bridge design stage of the Project, it is possible that individual site-specific circumstances might preclude complete adherence to the OS. In particular, there may be cases where abutments, for engineering or practical reasons, must impinge on the floodplain. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize sedimentation or flow constriction.

Erosion during site preparation and bridge construction will largely be avoided due to restriction of construction to the winter period. However, any exposed areas will be suitably stabilized prior to the spring thaw period. As a result, erosion and sedimentation can be avoided or minimized and residual adverse effects are anticipated to be minor.

Culvert Installation and Maintenance (Construction and Operations)

As discussed in Section 4.2.4.1, appropriate culvert sizing, the application of recognized installation guidelines and adherence to erosion and sediment control measures will reduce the magnitude, frequency, and duration of potential effects related to ground disturbance and culvert installation. In addition, since Highway embankment construction is to occur primarily during winter months, to the extent possible, the potential for erosion and sedimentation effects will be minimized or avoided. Culverts in fish-bearing streams will be installed during the fish window and will be sized and carried out using methods determined on a site specific basis to minimize erosion and sedimentation, and to ensure that flow is maintained during installation. Generally, summer flows in such streams are low and fish movements are very limited. As a result, it is anticipated that effects on water quality, fish habitat, and fish behaviour will be minor.

Routine monitoring and inspections at watercourse crossings will be carried out to confirm the correct performance of each culvert. This will involve examination for debris buildup, culvert subsidence or lifting, and stream bank or bed erosion. Where applicable, maintenance activities will be carried out in adherence to the DFO Culvert Maintenance OS (DFO 2010), which includes the removal of accumulated debris (e.g., logs, boulders, garbage, ice build-up) that prevents the efficient passage of water and fish through the structure and may also include the reinforcement of eroding inlets and outlets.

The measures outlined above are proposed to mitigate potential adverse effects to fish and fish habitat that can result from culvert installation, which include:

- Loss of instream habitat to culvert footprints;
- Creation of migration barriers;
- Reduced habitat quality due to erosion and sedimentation; and
- Changes in surface drainage patterns.

Culverts will be designed and installed according to established guidelines (DFO 1993; INAC 2010c) to avoid the creation of migration barriers, which can occur when culverts are embedded too deeply into the substrate, or more likely, when they are perched above the substrate. Periodic monitoring during the operations phase of the Highway will be carried out routinely to identify culvert maintenance requirements, which will adhere to the DFO Culvert Maintenance OS (DFO 2010).

In summary, no residual effects on fish and fish habitat are anticipated from culvert installation and maintenance due to application of the mitigation measures prescribed.

Use of Heavy Equipment (Construction)

Heavy equipment will be on-site throughout the Highway construction process and during isolated events for Highway maintenance. Effects on fish habitat due to the operation of heavy equipment relate primarily to the potential for ground disturbance, soil exposure, rutting, and the consequent mobilization and flow of suspended particulates to streams during snowmelt and rainfall events. The effects of sedimentation on fish and fish habitat were discussed earlier in this section.

The use of heavy equipment during Highway embankment construction will occur through the winter months when all watercourse crossing locations will be frozen. Therefore, the potential for erosion and sedimentation from this activity is very low.

Potential effects resulting from erosion and sedimentation during the summer months will be mitigated by the implementation of approved erosion and sediment control plans contained in the construction EMP. In addition, monitoring of construction works by environmental and wildlife monitors will: ensure the application of prescribed mitigation; identify unforeseen and potential erosion sites that could lead to the discharge of sediment to surface or groundwater; and, prevent erosion and subsequent sedimentation.

Based on adherence of approved guidelines and BMPs, and the EMP developed for this Project, residual effects on water quality from the use of heavy equipment during construction are not anticipated.

Borrow Source Development (Construction)

Borrow source locations between Inuvik and Tuktoyaktuk are identified in Figure 1.5-2. This figure identifies the general location of borrow sources, some of which are in the vicinity of streams or lakes. However, borrow sources will not be developed immediately in or adjacent to any watercourse. A minimum 50 m vegetated setback will be retained between borrow sites and watercourses.

Drill-and-blast methods may be used to excavate the required volumes of material for construction from frozen borrow sources; therefore, borrow source development near waterbodies has the potential to affect fish and fish habitat. Potential direct effects include reduced habitat quality while indirect effects include the potential for erosion and sedimentation into fish-bearing waterbodies.

Borrow pits will be developed, operated and decommissioned in full compliance with all regulatory requirements (e.g. ILA Land Use Permit and Quarry Permit, INAC Quarry Permits, ILA's ISR *Pits and Quarries Guidelines*, INAC's N*orthern Land Use Guidelines: Pits and Quarries* and according to pit development plans (PDPs). PDPs will include mitigation measures to address potential environmental concerns, and operational and reclamation plans. Mitigation includes developing borrow sources primarily during winter periods, maintaining sufficient distance of undisturbed land between borrow source locations and any waterbody, and application of appropriate erosion and sediment control BMPs for the borrow source activities.

Monitoring of borrow source development will be undertaken by environmental and wildlife monitors to ensure the application of prescribed mitigation, identify unforeseen and potential erosion sites that could lead to the discharge of sediment to watercourses and prevent erosion and subsequent sedimentation by stopping specific activities causing or likely to cause erosion and off-site discharges of turbid water. If blasting is required, it will be conducted according to DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998).

Highlights of the Guidelines include:

- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swim bladder of a fish.
- No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 m/s in a spawning stream bed during the period of egg incubation. For confined explosives, setback distances from the land-water interface (e.g., the shoreline) or burial depths from fish habitat (e.g., from under the riverbed) that will ensure that explosive charges meet the 100 kPa overpressure guideline are identified in the guidelines.

Care will be taken when using explosives in borrow sources located near a stream or lake as the pressure from blasting may harm fish and fish habitat in the proximity of the blasting area. Potential effects include loss of fish and fish habitat and the contamination of waters by blasting residues. Blasting, if required, will occur primarily during winter borrow source development when streams within the Project footprint area are frozen and fish are absent. DFO blasting guidelines (Wright and Hopky 1998) will be followed to preclude the possibility of adverse effects.

Through implementation of mitigation measures during borrow source development, significant adverse residual effects are not expected.

Water Extraction (Construction)

Considerable amounts of water will be required for annual winter access road construction. It is proposed that water for this purpose will be extracted from lakes of suitable size in proximity to the Highway corridor. It is anticipated that water requirements will exceed 300 m^3/day, which will trigger the need for a NWT Water Board Type A Water Licence.

Excessive water withdrawal from small ice covered lakes can potentially result in: the depression of dissolved oxygen concentrations, leading to lethal and sub-lethal effects on fish; 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 and 2008b).

To mitigate these effects, DFO, in conjunction with other regulators and industry, developed the *Protocol for Winter Water Withdrawal in the Northwest Territories* (DFO 2010), 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). 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; and
- 100% if the maximum depth of the waterbody is less than the predicted maximum ice thickness (implying no available overwintering fish habitat).

In addition, the protocol directs that water be withdrawn from depths greater than 2 m 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 *Protocol for Winter Water Withdrawal in the Northwest Territories* (DFO 2010), it will be necessary to carry out bathymetric surveys on all 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).

Following criteria set out in the water withdrawal protocol (2010) and any criteria included within a Type A Water Licence, residual effects on fish and fish habitat are not anticipated.

Road Drainage (Construction)

The potential exists for sediment releases to ephemeral and permanent streams due to drainage in summer months from the newly constructed road embankment, and localized slumpage of road slopes prior to compaction and stabilization. However, since vegetation will not be disrupted at the toe of the road slopes, it is expected that sediment flow will be limited and filtered by this vegetation to reduce this potential risk. In addition, silt fences will be installed at each road-channel intersection to prevent sediment releases to streams. Silt fences will be left in place until roadways are compacted and stable, and will be routinely monitored and maintained. Cross drainage culverts, which will be installed at regular intervals, will channel road drainage away from streams and allow filtration by natural vegetation. Because of these measures, no residual effects on fish habitat due to road drainage are anticipated.

Highway Maintenance (Operations)

During the operations phase of the Highway, it is anticipated that the Highway surface will require routine maintenance (e.g., grading, resurfacing, and dust suppression). The frequency of Highway maintenance is dependent on factors such as Highway safety and condition, the impact of periodic severe weather, and the extent of required maintenance. Highway maintenance and the application of dust suppression techniques can result in the release of fine or granular material directly into streams, and the creation of fine dust, which can settle in nearby watercourses. When discharged or settled in fish-bearing waters, these particulates can potentially affect fish habitat, as described at the beginning of Section 4.2.5.1.

Potential effects to water quality from dust generation and settlement are anticipated to be minor and of short-duration due to mitigation by the application of non-toxic dust suppression techniques (water trucks) that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998). Based on adherence to the dust suppression guidelines, no adverse residual effects are anticipated from maintenance activities.

Increased Access to Fisheries Resources (Operations)

Rescan (1999a) concluded that the greatest potential indirect impact from Highway construction is the potential increase in fish harvest pressure through domestic and sport fishing. This is due to the improved access that will be afforded by the Highway to important, but remote, fish harvest areas in some of the lakes along the proposed Highway, as well as the numerous watercourse crossings. Potential effects of increased harvest pressure include:

- Reduced levels of fish available for subsistence fishing; and
- Increased potential for anthropogenic disturbances to remote fishing areas (i.e., garbage and/or disruption of fish habitat, and increased use of waterbodies for recreational purposes, such as boating).

Potential effects can be avoided or minimized through consultation with and involvement of stakeholders, such as the FJMC and the HTCs in identifying issues of concern and jointly developing strategies and guidelines, in conjunction with regulatory bodies, to manage sensitive fisheries resources. For example, appropriate signage posted at regular intervals on the Highway, and public education can assist with the minimization of effects due to habitat damage and overexploitation of resources.

However, while it is likely that effects will be minimized, it is unlikely that these measures will entirely mitigate the potential for increased harvest pressure during operation of the Highway and residual effects are, therefore, expected. With public involvement and coordination of efforts, adverse residual effects to fish and fish habitat are anticipated to be low and not significant.

4.2.5.2 Monitoring

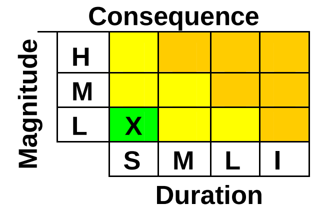
Monitoring of the Highway construction will be carried out by ILA environmental monitors and HTC wildlife monitors who will be on-site throughout construction. Construction monitoring will be carried out as required to ensure that prescribed mitigation measures and BMPs are implemented and to detect and correct unanticipated problems. Post-construction monitoring will be carried out according to the extent, frequency and duration required by regulators to evaluate the success of mitigation measures and to identify required modifications, repairs, or maintenance. Since the Highway construction will proceed over successive years, there is an opportunity to apply adaptive management procedures to this Project. Adaptive management includes learning from experience and applied practices so that modifications can be applied to improve results, if necessary. Methods and procedures applied during a construction season can therefore be evaluated and modified, if necessary, to improve environmental protection in the following construction period.

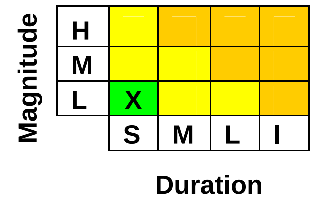
4.2.5.3 Residual Effects

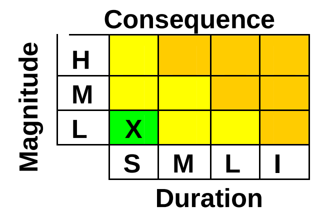
Based on the previously discussed assessments of the various components of Highway construction, operation, and maintenance, and following the implementation of mitigation measures, the Project may result in residual effects on fish or fish habitat. However, these effects are expected to be minor and will not significantly reduce the productive capacity of fish habitat within the area. Specific assessment of the significance of each anticipated residual effect is provided in Table 4.2.5-2. Summaries of the rationale for each assessment are provided following the table.

TABLE 4.2.5-2: RESIDUAL EFFECTS ASSESSMENT FOR FISH AND FISH HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Fish and Fish Habitat - Construction Phase - Loss of Riparian Habitat from Bridge Abutment Construction	High	Local	Long-term	Continuous	Irreversible	High
Fish and Fish Habitat - Construction Phase - Reduced Quality of Habitat from Erosion and Sedimentation during Bridge Construction	Low	Local	Short-term	Isolated	Reversible Short-term	Low
Fish and Fish Habitat - Construction Phase - Direct Loss of Instream Habitat from Culvert Installation	Low	Local	Long-term	Continuous	Irreversible	High
Fish and Fish Habitat - Construction Phase - Reduced Quality of Habitat from Erosion and Sedimentation during Culvert Installation	Low	Local	Short-term	Isolated	Reversible Short-term	Low







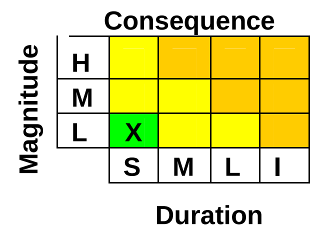


TABLE 4.2.5-2: RESIDUAL EFFECTS ASSESSMENT FOR FISH AND FISH HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						Consequence
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Fish and Fish Habitat - Operation Phase - Increased Harvest Pressure	Low	Local	Short-term	Isolated	Reversible Long-term	Moderate	X (Magnitude L, Duration S)

Consequence

Magnitude	S	M	L	I
H				
M				
L	X			

Duration

Clear-span Bridge Construction (Construction)

Siting and construction of bridges will be consistent with the DFO *Operational Statement for Clear Span Bridges*. Adherence to the conditions of this OS will result in avoidance of adverse effects on water quality and water flow that can occur when structures are placed within the flowing portion of a stream or due to excessive soil disturbance or removal of riparian vegetation. Hydrological analysis will be completed prior to bridge design to determine suitable span widths and abutment placement.

During the bridge design stage of the Project, it is possible that individual site-specific circumstances might preclude complete adherence to the OS. In particular, there may be cases where abutments, for engineering or practical reasons, must impinge on the floodplain. In such cases, DFO will be consulted in advance to discuss and approve of proposed plans, which will include mitigation measures necessary to prevent or minimize sedimentation or flow constriction.

Culvert Installation (Construction)

Culverts will be designed and installed according to established guidelines to avoid the creation of migration barriers, which can occur when culverts are embedded too deeply into the substrate, or more likely, when they are perched above the substrate. Periodic monitoring during the operations phase of the Highway will be carried out routinely to identify culvert maintenance requirements, which will adhere to the DFO Culvert Maintenance OS.

Adherence to culvert installation and sediment and erosion control measures contained in Dane (1978), DFO *Land Development Guidelines,* and GNWT erosion and sediment control best practices will result in minimal and non-significant releases of sediment.

Use of Heavy Equipment (Construction)

As Highway embankment construction is to occur during the winter months, potential effects resulting from erosion and sedimentation during this time will be negligible. Sedimentation associated with drainage from the embankment during the summer months is expected to be localized and limited. With the use of silt fences at road-channel intersections and the natural filtration provided by the vegetation in overland areas, no significant residual effects on fish or fish habitat are expected to occur.

Borrow Source Development (Construction)

No significant residual effects are expected to occur as a result of borrow source development on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between borrow source developments and fish and fish habitat is expected.

Borrow Source Blasting (Construction)

No significant residual effects are expected to occur as a result of blasting on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between blasting and fish and fish habitat is expected.

Water Extraction (Construction)

No significant residual effects are expected to occur as a result of water extraction on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between the water extraction and fish and fish habitat is expected.

Culvert Maintenance (Operations)

No significant residual effects are expected to occur as a result of culvert maintenance on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between Highway culvert maintenance and fish and fish habitat is expected.

Highway Maintenance (Operations)

No significant residual effects are expected to occur as a result of highway maintenance on fish and fish habitat. With application of mitigation measures discussed previously, no interaction between Highway maintenance and fish and fish habitat is expected.

Increased Access to Fisheries Resources (Operation)

It is likely that effects resulting from increased access to fisheries resources will be minimized through mitigation measures described. However, it is unlikely that these measures will entirely mitigate the potential for increased harvest pressure effects during operation of the Highway and adverse residual effects are, therefore, expected. Following establishment, monitoring and enforcement of guidelines and regulations, residual effects to fish and fish habitat are anticipated to be low and not significant due to the low magnitude and negligible frequency rating for anticipated increases to fishing harvest.

4.2.6 Vegetation

The main effects of the proposed Inuvik to Tuktoyaktuk Highway will be the removal and/or burial of vegetation types and plant species by the Highway footprint. Other anticipated effects include the deposition of dust on plants and substrates adjacent the roadway, the potential introduction and spread of invasive or non-native plant species into natural areas, and changes to local surface hydrology. These effects can directly or indirectly affect the heath and function of the plant species and vegetation types present. The assessment of Project effects included looking specifically at effects to rare plant species and unique vegetation types in the study areas.

4.2.6.1 Removal and/or Burial of Vegetation Types and Plant Species

The proposed Inuvik to Tuktoyaktuk Highway footprint will disturb approximately 383 ha which is 2.8% and 0.1% of the LSA and RSA, respectively (Table 4.2.6-1). Of the EOSD land cover classes present within the proposed footprint, the Bryoids, Shrub Low, Shrub Tall, Broadleaf Dense, and Mixedwood Dense classes will be most affected overall. These classes could represent various vegetation types in the study area such as the Dwarf Shrub Heath, Upland Shrub, Upland Alaska Birch-Spruce, Riparian Shrub, and Riparian Black Spruce/Shrub types. With the exception of the Riparian Black Spruce/Shrub vegetation type, all are fairly extensive throughout the LSA and RSA.

The Riparian Black Spruce/Shrub vegetation type was only identified in the vicinity of Holmes Creek and Hans Creek, and represents the only forested vegetation type in the Tundra Plains Ecoregion. It is also the northernmost extent of black spruce in the area. While it is unlikely that any stream crossings will be developed through this vegetation type, assessments of stream crossings in the vicinity of Holmes and Hans creeks will be carried out ahead of construction for this vegetation type specifically, and if present, it will be avoided.

Although not identified spatially, approximately 50 ha of additional area will be disturbed as a result of the excavation of borrow sources for construction material. These areas would likely be associated with the Exposed/Barren Land or Rock/Rubble EOSD land cover classes due to their lack of vegetation cover and higher possibility of containing granular material. The Exposed/Barren Land cover class in particular could represent the Dry Saxifrage Tundra vegetation type, which was identified as having a high potential of supporting suitable habitat for the Sensitive plant, Yukon stitchwort (*Minuartia yukonensis*).

All borrow source locations will be surveyed by a qualified biologist/botanist for the presence of Yukon stitchwort and other rare plant species in advance of construction. Should any rare species be present, they will be avoided wherever possible. If avoidance is not possible, other suitable mitigation strategies, such as transplanting or collecting specimens for donation to a herbarium, will be developed.

Approximately 62 ha of treed area will be affected by the proposed Inuvik to Tuktoyaktuk Highway footprint (Table 4.2.6-1). The majority (57 ha) occurs either near or below the treeline and are composed primarily of broadleaf or mixedwood stands. The trees themselves are likely of little merchantable value.

TABLE 4.2.6-1: DISTRIBUTION OF VEGETATION TYPES WITHIN THE FOOTPRINT AREA

Level IV Ecoregion	EOSD Land Cover Class[1]	Footprint Area[2,4] (ha)			Local Study Area[2] (ha)			Regional Study Area[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
	Water				1.7			9,092.9
	Not Classified (Cloud)	0.04			29.3			2,783.0
	Coniferous Dense				1.3			2,776.9
	Broadleaf Dense	2.5			95.0			2,440.0
	Mixedwood Dense	2.1			55.2			2,160.0
	Wetland Shrub				4.2			1,246.4
	Exposed/Barren Land							1,112.0
	Wetland Herb				0.2			1,095.2
Mackenzie Delta HS	Coniferous Sparse	1.8	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	31.3	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	854.0
	Coniferous Open	0.1			2.7			513.8
	Broadleaf Open	1.2			39.5			375.5
	Mixedwood Open				0.1			332.1
	Wetland Treed							326.1
	Shrub Tall	0.1			0.7			301.5
	Bryoids							293.6
	Shrub Low				0.4			245.4
	Herbs							24.9
	Rock/Rubble							0.2
Mackenzie Delta HS Total		**7.9**			**261.7**			**25,973.7**
	Broadleaf Dense	4.0			142.7			916.8
	Mixedwood Dense	3.0			99.9			466.9
	Coniferous Sparse	1.4			62.1			260.9
	Broadleaf Open	1.3			49.6			218.4
Sitidgi Plain HS	Not Classified (Cloud)		Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	0.1	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	76.1
	Water				10.2			34.8
	Coniferous Dense	0.1			6.2			33.4
	Coniferous Open	0.2			5.7			25.8
	Wetland Shrub	0.5			4.8			13.0

TABLE 4.2.6-1: DISTRIBUTION OF VEGETATION TYPES WITHIN THE FOOTPRINT AREA

Level IV Ecoregion	EOSD Land Cover Class[1]	Footprint Area[2,4] (ha)			Local Study Area[2] (ha)			Regional Study Area[3] (ha)
		Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	Primary 2009 Route	Alternative 2 (Upland Route)	Alternative 3 (2010 Minor Realignment)	
Sitidgi Plain HS (cont'd)	Shrub Low	0.1	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	2.4	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	11.7
	Herbs				0.2			3.6
	Wetland Herb				0.4			3.0
	Wetland Treed				0.7			2.8
	Bryoids				1.0			1.0
	Shrub Tall	0.1			0.4			0.8
	Exposed/Barren Land				0.4			0.4
	Mixedwood Open							0.2
Sitidgi Plain HS Total		**10.7**						**2,069.9**
Caribou Hills LA	Bryoids	38.4	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	1,244.5	Same alignment as Primary 2009 Route	Same alignment as Primary 2009 Route	25,917.2
	Coniferous Sparse	10.6			446.7			17,208.5
	Shrub Low	26.1			684.7			16,832.6
	Water	0.1			343.6			14,309.3
	Exposed/Barren Land	12.6			448.5			9,092.8
	Mixedwood Dense	6.8			255.5			6,986.7
	Shrub Tall	6.7			276.3			4,801.5
	Broadleaf Dense	17.7			370.8			4,179.7
	Coniferous Open	1.0			73.0			2,885.2
	Herbs	2.8			95.6			1,886.0
	Coniferous Dense	0.3			49.8			1,853.3
	Wetland Herb	0.4			53.9			1,694.3
	Broadleaf Open	2.8			84.2			1,665.9
	Wetland Shrub	1.7			87.9			1,660.5
	Rock/Rubble	2.4			68.7			1,009.7
	Not Classified (Cloud/Shadow)				16.4			608.7
	Wetland Treed	0.03			13.3			395.0
	Mixedwood Open				5.2			214.1
Caribou Hills LA Total		**130.4**			**4,618.5**			**113,200.9**

TABLE 4.2.6-1: DISTRIBUTION OF VEGETATION TYPES WITHIN THE FOOTPRINT AREA

Level IV Ecoregion	EOSD Land Cover Class[1]	Footprint Area[2,4] (ha) Primary 2009 Route	Footprint Area[2,4] (ha) Alternative 2 (Upland Route)	Footprint Area[2,4] (ha) Alternative 3 (2010 Minor Realignment)	Local Study Area[2] (ha) Primary 2009 Route	Local Study Area[2] (ha) Alternative 2 (Upland Route)	Local Study Area[2] (ha) Alternative 3 (2010 Minor Realignment)	Regional Study Area[3] (ha)
Tuktoyaktuk Coastal Plain LA	Water	0.4	0.1	0.2	1,426.4	1,377.6	1,540.2	109,974.7
	Bryoids	88.3	68.4	81.0	2,370.7	1,789.9	2,126.1	39,434.5
	Shrub Low	89.4	99.1	91.0	2,238.3	2,457.8	2,200.8	38,586.9
	Shrub Tall	28.6	35.6	29.6	960.2	1,105.8	992.4	16,871.8
	Wetland Herb	3.2	2.8	3.1	311.7	354.2	305.0	7,728.5
	Wetland Shrub	7.4	4.5	7.5	346.5	299.3	331.5	6,435.3
	Exposed/Barren Land	6.8	4.3	5.8	270.2	171.0	247.0	5,886.4
	Herbs	5.3	6.5	6.6	232.4	297.9	250.2	4,477.8
	Coniferous Sparse	1.7	2.9	1.7	86.8	109.1	86.6	2,673.8
	Coniferous Open	1.5	1.8	1.5	69.0	112.2	69.0	1,650.3
	Wetland Treed	0.2	0.3	0.2	25.5	43.5	26.4	959.1
	Rock/Rubble	0.9	1.1	0.8	39.1	26.2	38.2	513.6
	Mixedwood Open	0.8	0.5	0.8	13.4	15.5	13.4	242.5
	Mixedwood Dense	0.01		0.01	1.1	1.3	1.1	157.8
	Coniferous Dense							78.0
	Broadleaf Open							22.0
	Not Classified (Cloud/Shadow)							17.0
	Broadleaf Dense							4.3
Tuktoyaktuk Coastal Plain LA Total		**234.3**	**227.9**	**229.7**	**8,391.3**	**8,161.4**	**8,228.0**	**235,714.4**
Grand Total		**383.3**	**376.9**	**378.7**	**13,658.3**	**13,428.4**	**13,494.9**	**376,958.9**
Proportion of LSA (%)		**2.8**	**2.8**	**2.8**				
Proportion of RSA (%)		**0.1**	**0.1**	**0.1**				

[1]As per Wulder et al. (2004)
[2]The route alignment options only occur within the Tuktoyaktuk Coastal Plain Low Arctic Ecoregion; therefore, all other Ecoregion calculations will remain the same for all alternatives.
[3]All route options
[4]Approximately 50 ha of additional area will be disturbed as a result of excavation for borrow source materials and could be represented by the Exposed/Barren Land or Rock/Rubble land cover classes

4.2.6.2 Effects of Dust

Construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. The principal air quality concerns related to vegetation effects arise from the deposition of fugitive dust and gaseous emissions, primarily NOx and SO_2.

Activities associated with the construction of the Highway and vehicle traffic will generate dust. Undisturbed areas of the Arctic tundra are relatively free of natural dust sources, so the consequences from anthropogenic sources can be noticeable. Fugitive dust emissions can have both direct and indirect effects on vegetation.

Patterns of dust deposition on vegetation are a function of various factors including particle size, wind, ambient moisture, and vehicle and traffic characteristics. Small particles travel farther, especially if borne by strong winds.

Dust particle size plays a role in determining how extensive the effects of dust can be. Road dust has been detected on vegetation 100 m away (Auerbach et al. 1997), 200 m away (Santelmann and Gorham 1988; Angold 1997), and up to 400 m away from a source (Lamprecht and Graber 1996). These distances are consistent with deposition studies conducted by the United States Environmental Protection Agency (US EPA) on particles with varying aerodynamic diameters (US EPA 1995).

Dust particles with larger aerodynamic diameters (e.g., >100 μm) were found to settle within 10 m of a source. Smaller particles (e.g., with aerodynamic diameters between 30 to 100 μm) settled out within 100 m. Particles smaller than 15 μm tend to be less influenced by gravitational settling and can be transported over greater distances (US EPA 1995). For the proposed Inuvik to Tuktoyaktuk Highway, it is anticipated that the largest effects to ecosystems and plants from fugitive dust will occur within 100 m of the Highway.

Common effects of dust on vegetation include the physical smothering of leaf surfaces, the blocking of stomata, and the alteration of leaf physiology. The deposition of dust onto leaf surfaces can reduce photosynthetic efficiency in the plant by physically blocking stomata and restricting the amount of light reaching photosynthetic organs (Thompson et al. 1984; Pyatt and Haywood 1989; Farmer 1993). Dust can also alter leaf physiology by increasing leaf surface temperatures, which can negatively affect photosynthesis but can positively affect respiration (Eller 1977).

The more indirect effects of dust can manifest as changes to the surrounding environment such as alterations to soil pH, soil nutrient regime, the depth of permafrost thaw, and earlier snowmelt due to changes in the surface albedo of snow (Walker and Everett 1991; Auerbach et al. 1997; Gunn 1998). These more subtle changes can induce subsequent changes in plant species composition as they adjust to the altered growing conditions.

Dust effects may also be more prevalent on plant groups that are more sensitive to disturbance, such as lichens and some moss species, such as *Sphagnum* (Spatt and Miller 1981). Lichens in particular are often used as indicators of air quality conditions due to their sensitivity to environmental pollutants (Tyler 1989; Markert 1993). Lichens often accumulate substances such as sulphur, nitrogen, and metals from atmospheric sources better than vascular plants (Blett et al. 2003). Local lichen populations may be negatively affected by regular dust deposition. *Sphagnum* moss species are often indicative of nutrient poor and low pH conditions which could change with regular dust deposition as well.

4.2.6.3 Potential Introduction and Spread of Invasive Plants

Several factors contribute to the successful colonization of an area by invasive plant species, and include the provision of suitable habitat, access to a source of invasive plant material, a means of access to unaffected areas, and a mechanism of dispersal. Activities associated with major development projects can coincidentally supply all of these factors, from exposed soils and ground disturbance to the import and export of dirty machinery and equipment that may contain seeds and/or vegetative parts (propagules) of invasive plants.

Currently the incidence of invasive plants in the Arctic is low, however recent studies from Alaska suggest invasions may just be delayed or had not been formally documented until more recently (Schrader and Hennon 2005; Carlson and Shephard 2007). The increased level of development in more remote areas combined with a more deliberate assessment of invasive plant species presence suggest invasions are on the rise.

The introduction, spread, and overall effects of invasive plant species on the surrounding environment can be controlled through effective management strategies established early on in Project planning and carried out through operations. Preventing the introduction of invasive species into an area is the most effective and efficient management strategy compared to managing their removal once established (Clark 2003; Polster 2005; USDA 2006; Carlson and Shephard 2007).

While invasive plant species are largely restricted to populated and high-use areas in the Arctic, development and operation of the proposed Inuvik to Tuktoyaktuk Highway could result in an increase in invasive plant species presence, primarily along the roadside.

4.2.6.4 Alteration of Local Hydrology

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, which can result in changes to both upstream and downstream plant communities (Pomeroy 1985; Spellerberg and Morrison 1998; Trombulak and Frissell 2000). The interception or diversion of surface and shallow subsurface flows by roads can increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions (Pomeroy 1985; Trombulak and Frissell 2000). Ponding can also lead to permafrost degradation and the development of thermokarst conditions (Pomeroy 1985).

Sedimentation from the Highway surface as well as from diverted surface and subsurface flows can result in localized sediment and nutrient loading in receiving areas. During the first summer following winter construction, sedimentation and runoff from the Highway surface could occur in some areas, resulting in the deposition of granular material immediately adjacent to the embankment. Associated runoff is expected to filter through the existing tundra vegetation. Vegetation types that are naturally nutrient poor (e.g., *Sphagnum*-dominated vegetation types) or more sensitive to changes in their environment (e.g., lichens) would likely be affected most.

Vegetation types in the Project area that are likely to be most affected by altered hydrological conditions include those that are lichen or *Sphagnum*-dominated, wetlands, and very dry vegetation types, all of which are either composed of sensitive plant species or species assemblages adapted to a particular moisture regime.

4.2.6.5 Contaminants in Plants

Similar to terrestrial wildlife, levels of organochlorines (OCs) and metals in Canadian Arctic vegetation is minimal therefore few studies have been conducted and little data exists on the subject. Air quality effects associated with specific Project activities will be minimal and temporary.

The accidental spillage of fuel, lubricants, and/or anti-freeze at a work site or during the construction phase represents a potential hazard. In the event of a spill, clean-up measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. Further information regarding accidents and malfunctions is found in Section 4.4.

4.2.6.6 Project Design and Mitigation Measures

The primary mitigation measure for reducing potential effects to vegetation types will be to restrict the size of the overall Highway footprint, where possible, and to carefully plan the overall route, which includes avoiding sensitive and unique vegetation types and rare plant species (Table 4.2.6-2). The route options limit effects to Bryoids and Shrub Low land cover types by avoiding more sensitive areas such as wetlands and riparian areas.

The most effective mitigation strategy for rare plant species that may be present within the Project footprint is avoidance. Additional surveys will be conducted throughout the construction phase in areas with a high potential of supporting rare plants, such as in borrow source areas that are characterized as the Dry Saxifrage Tundra vegetation type. Should rare plants be identified, they will be avoided where possible. If avoidance is not an option, specimens will be collected, transferred to another suitable location, and/or donated to local herbaria for educational purposes.

Areas in the vicinity of Holmes Creek and Hans Creek that are characterized as the Riparian Black Spruce/Shrub vegetation type will also be avoided if possible. If disturbance to this vegetation type is unavoidable, efforts will be made to maintain as much of this vegetation type intact and limiting potential fragmentation.

Borrow source areas will be recontoured progressively once activities are completed, if possible. The principal means of revegetation associated with abandoned borrow sources will be by natural colonization. Those areas that could support deliberate re-vegetation efforts will be scarified and seeded with appropriate northern, native plant species.

Even with the application of reclamation measures, areas used for borrow material will not be completely restored to their previous state due in part to the alteration of local surface topography resulting from excavation. Re-vegetation efforts, combined with slow natural re-vegetation processes, will lead to the slow re-establishment of vegetation characteristic of naturally granular upland areas.

The primary mitigation measure to control the effect of dust during construction and operation of the Highway will include applying water as needed, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998).

Potential strategies for mitigating potential effects on the vegetation types in the vicinity of the Highway and associated borrow operations are provided in Table 4.2.6-2. 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.

There is a potential for contaminant spills to occur during the construction phase of the Highway. In the event of a spill, clean-up measures will be implemented immediately. All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies.

TABLE 4.2.6-2: POTENTIAL EFFECTS AND MITIGATION STRATEGIES FOR VEGETATION ALONG THE HIGHWAY

Potential Effect	Potential Consequence	Mitigation Measures
Vegetation – Removal and Burial	Removal of vegetation; reduction of vegetation types with restricted distribution	Minimize footprint; Minimize development on vegetation types with restricted distribution; Avoid sensitive or rare plant vegetation types; Restrict off-site activities (e.g., ATV use) to footprint area; Reclaim to viable and self-sustaining vegetation types.
Dust	Potential reduction in vegetation health and productivity	Application of dust suppressants, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998).
Potential Introduction and Spread of Invasive Plants	Displacement of native species and alteration of plant species composition of adjacent vegetation types	Minimize footprint; Ensure machinery and equipment is clean prior to use on site; Periodic monitoring of roadsides for invasive species establishment

TABLE 4.2.6-2: POTENTIAL EFFECTS AND MITIGATION STRATEGIES FOR VEGETATION ALONG THE HIGHWAY

Potential Effect	Potential Consequence	Mitigation Measures
Alteration of Surface Hydrology	Change in water flow patterns and quantity; possible nutrient and sedimentation loading in receiving areas	Design and engineering of roadbed and drainage structures tailored appropriately to accommodate unique environmental conditions; Adequate drainage in wet lowland areas through the installation of culverts as necessary.
Contaminant Spills	Reduction in vegetation health and productivity due to spills	Contain and clean-up spills immediately. Contact authorities immediately to determine appropriate course of action. Respond according to site-specific spill contingency plan and the contractor's HSE manual and procedures.

4.2.6.7 Residual Effects

Within the LSA, the removal or burial of vegetation types and plant species/groups will occur during construction and the effects will remain so long as the Highway is in place (Table 4.2.6-3). The effect is considered a high magnitude and of moderate consequence overall.

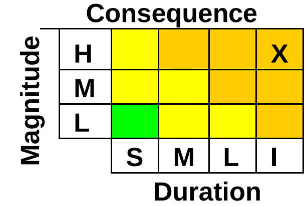
The effects of borrow source development on vegetation types and plant species/groups will also occur during construction however the duration is short-term. The effect is still of high magnitude, however, due to the reversibility of the effect over the long-term, the consequence is low. The structure and species composition of reclaimed borrow source areas may be different than what was originally present; however, efforts will be made to establish a self-sustaining vegetative cover that is appropriate for the surrounding environment.

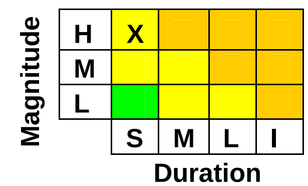
The potential degradation of vegetation types and plant species resulting from dust deposition, the introduction of invasive plant species, and the alteration of local hydrology has been assessed as a low magnitude, local effect that will persist over the long-term. Effects will be periodic throughout the life of the Project and are reversible over the long-term. As such the effect has been rated as being of low consequence.

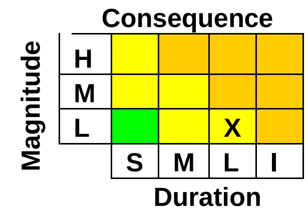
Residual effects to vegetation types and plant species are anticipated to be negligible in the context of the RSA, and as such have not been assessed further.

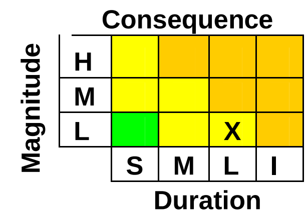
TABLE 4.2.6-3: RESIDUAL EFFECTS SUMMARY FOR EFFECTS TO VEGETATION TYPES

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Likelihood**
Removal/Burial of Plant Species and Vegetation Types (Highway Alignment)	High	Local	Long-term	Continuous	Irreversible	High
Removal/Burial of Plant Species and Vegetation Types (Borrow Sources)	High	Local	Short-term	Sporadic	Reversible Long-term	High
Dust Deposition	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Introduction of Invasive Plant Species and Alteration of Local Hydrology	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate









4.2.7 Wildlife and Wildlife Habitat

Potential effects and mitigation measures for wildlife species identified as VCs are described in this section. Wildlife species identified as VCs include:

- Caribou – Barren-ground and woodland caribou;
- Grizzly Bears;
- Moose
- Furbearers –Wolverine, red fox and Arctic fox; and,
- Birds.

According to Jalkotzy et al. (1997), corridors function in five different ways for wildlife, acting as habitat, conduits, filters or barriers, sources, and sinks. Roads may 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 are 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 (Del Frate and Spraker 1991; Oosenbrug et al. 1991; Underhill and Angold 2000). 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.

4.2.7.1 Species at Risk

Three wildlife species were identified as at risk within the study area, grizzly bears, wolverines, and Boreal Woodland Caribou. Grizzly bears and wolverines are ranked by COSEWIC as Special Concern and by NWT General Status Ranking as Sensitive. Boreal Woodland Caribou are currently listed under SARA as Threatened (COSEWIC 2009).

Potential effects and mitigation measures for grizzly bears are described in the grizzly bears section (Section 4.2.7.3). Potential effects to wolverines are discussed in the Furbearers section (Section 4.2.7.5). Boreal caribou have been shown to be affected by linear development (GNWT ENR NDg); however, the density of linear development in the RSA is less than the threshold predicted to impact populations (Canadian Boreal Initiative 2007). Potential effects to caribou are discussed in Section 4.2.7.2.

4.2.7.2 Caribou and Caribou Habitat

Effects associated with the construction of the proposed Highway and its associated borrow sources can be in the form of effects on caribou and effects on their habitat. Habitat effects include the loss, fragmentation, or degradation of habitat. Habitat loss will occur during the construction phase, along the Highway and borrow source footprints. 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. The work will occur within caribou winter range and as such a caribou monitoring and protection plan during construction will be required (see Section 7.1).

Potential effects on caribou from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and fragmentation of habitat;
- Physical and physiological disturbance;
- Displacement away from the proposed Highway;
- Increased activity and energy expenditure near the proposed Highway;
- Delayed crossing or failure to cross the proposed Highway;
- Altered migration;
- Reduced use of habitats adjacent to the proposed Highway;
- Habituation to the Highway;
- Injury or death from collisions with vehicles; and,
- Increased hunting pressure along the proposed Highway.

Potential effects on caribou are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following section.

Potential Effects

Habitat Loss

The direct effects of the proposed Highway include the loss of existing habitat under the Highway footprint and the excavation of the borrow sources. Roads eliminate the habitat upon which they are built by burying the vegetation that it covers. The footprint of the proposed Highway is anticipated to be approximately 137 km long by 28 m wide. The amount of habitat lost to the Highway is estimated to be 383 ha, approximately 0.002% (217 ha) of the Bluenose-West Herd winter range, approximately 0.019% (212 ha) of the

Cape Bathurst Herd winter range and approximately 0.0008% (32 ha) of suitable Boreal caribou habitat.

The majority of the proposed Highway alignment is situated on upland tundra habitats. Caribou tend to favour wetland and riparian habitats during the early growing season, shrub dominated sites in the summer and wind-swept ridges with accessible lichens during the winter. Upland, snow free areas are more important in the winter for easier access to food. Within the RSA, the Bryoid, Exposed/Barren Land and Shrub Low habitats were identified as lichen dominated upland tundra sites likely to be important caribou feeding habitats in winter. While the removal of upland tundra habitat will represent a loss, at the landscape scale the loss is small compared to the amount of similar habitat available (137,414 ha) within the RSA. The Highway footprint represents approximately 0.005% of upland tundra in the RSA.

Boreal caribou are dependent on arboreal lichens which are associated with coniferous trees. Within the RSA the coniferous and mixedwood habitats were identified as arboreal lichen sites likely to be important for boreal caribou feeding and life requisites. While the removal of forested habitats will represent a loss, at the landscape scale the loss is small compared to the amount of similar habitat available (41,374 ha) within the RSA of which the Highway footprint represents approximately 0.007% of that habitat type.

Borrow excavation activities will cause some localized, temporary habitat loss. Borrow source areas will be re-contoured progressively once activities are completed. The principal means of re-vegetation associated with abandoned borrow sources will be by natural colonization. Those areas that could support deliberate re-vegetation efforts will be scarified and seeded with appropriate northern, native plant species. Re-vegetation efforts, combined with slow natural re-vegetation processes, will lead to the slow re-establishment of vegetation characteristic of natural granular upland areas. Since terrestrial lichens are slow growing, it is likely to be decades before there will be sufficient lichen to provide food for caribou.

Limited effects related to habitat fragmentation and edge effects are expected to occur because the proposed Highway is primarily located in the tundra and does not involve the creation of openings in forest canopy.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation.] Changes in plant species composition could alter the availability of food and the effect could be positive or negative, depending on the specific conditions.

Dust deposition from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations can cover vegetation and decrease the abundance of forage. Dust created by Highway traffic during the summer months is expected to settle within 100 m of roads (see Section 4.2.6.2 for a more complete description of effects of dust on vegetation). This represents 2,740 ha (0.007%) of caribou winter range. However, the quantity of dust is unlikely to have a major effect on vegetation and food availability. Dust suppression methods as described in *Guideline for Dust Suppression* (GNWT 1998) will be employed to minimize potential issues associated with dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. 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.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents another potential hazard. In the event of a spill, cleanup measures will be implemented immediately. All spills will be reported to the GNWT Spill Line and other appropriate agencies.

Disturbance

Activities related to the construction and operation of the Highway may alter the behaviour or distribution of caribou in the RSA. Caribou can be sensitive to sensory disturbance (noise from machines, human presence and vehicles) and displacement from habitat adjacent to roads has been reported. Habitat displacement can result in reductions in access to security areas and in the efficiency of foraging strategies, with possible population-level consequences. Disturbances such as traffic noise and blasting can result in high metabolic stress levels in caribou (Bradshaw et al. 1998). Vehicle traffic along roads can also affect migration movements during certain periods of the year.

Caribou may avoid areas within a zone of influence of the Highway. Many factors affect the distance of a zone of influence, such as topography and the presence of security cover and environmental conditions such as wind and snow cover. How caribou respond to various stimuli is influenced by the degree of habituation of the individual involved. Studies of roads and barren-ground caribou report varying effects. Studies on oilfield development in Alaska report that calving caribou were displaced within 2 to 4 km of roads (Dau and Cameron 1986; Cameron et al. 1992, 2005). Also in Alaska, Curatolo and Murphy (1986) reported that caribou crossed roads and pipelines as frequently as control areas. Caribou around diamond mines in Northwest Territories have been commonly observed resting and feeding near airstrips and roads (Gunn et al. 1998; BHPB 2007). A review by Wolfe et al. (2000) reports that infrequently travelled transportation corridors did not deter crossing by caribou and had no observable effect on traditional migration routes or annual distribution, whereas heavy traffic accentuated the reaction to roads and may impede crossing and serve as a barrier. The elevate road structure itself could present a visual barrier to caribou and could result in delayed crossing. Wolfe et al. (2000) concluded that roads elevated more than 1.2 above ground level were more likely to deflect caribou from crossing.

It is expected that caribou will generally avoid the proposed Highway due to sensory disturbance, though some degree of habituation may occur. The degree of avoidance is likely to be higher once construction is complete and regular vehicle traffic commences.

Mortality

Caribou mortality could increase due to vehicular collisions and increased hunting as a result of enhanced hunter access.

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 wildlife reaching the opposite side of a road, with an increase in any factor reducing the probability of wildlife crossing safely. The Highway is expected to have low levels of traffic (in the order of 150-200 vehicles per day), which can be expected to minimize potential traffic-related mortality along the Highway. Speed limits, giving wildlife the right-of-way, and signage in areas with caribou concentrations could help minimize the potential for caribou-vehicle collisions.

Caribou mortality could increase should hunting be allowed near the Highway. The Highway will allow hunters year-round access to harvesting areas and, consequently, human-induced mortality for caribou will increase. Residents of Tuktoyaktuk and Inuvik 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 (DENR and DOT) will need to continue to work cooperatively to develop guidelines and conditions for use of the Highway. 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 education program that would include signage along the Highway highlighting current hunting regulations and discouraging excessive hunting along the corridor.

The implementation of hunting restrictions and other proposed mitigation measures could be used to minimize the effects of hunting on caribou. The proposed Highway alignment is located within Area I/BC/07, which is currently closed to barren-ground caribou hunting due to low caribou numbers. Should the caribou population recover, the creation of hunting restrictions along the Highway corridor could be considered on the basis of public safety or conservation as per the IFA. No-hunting corridors have been successfully established along the Liard and Mackenzie Highways and the Ingraham Trail (Highway 4). These no-hunting corridors apply to all hunters, and represent a significant cooperative venture in the wildlife management field (Treseder and Graf 1985).

Project Design and Mitigation Measures

The objectives of wildlife protection activities along the proposed Highway will be to mitigate potentially negative effects on caribou in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase;
- Minimize disruption of migration patterns due to vehicle traffic; particularly when the barren-ground caribou arrive within the study area for the fall rut and their departure to the calving grounds in the spring;
- Minimize direct mortality due to collisions with vehicles;
- 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 ENR to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-1 presents the mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on caribou.

TABLE 4.2.7-1: MITIGATION MEASURES FOR CARIBOU AND CARIBOU HABITAT

Project Activity	Potential Effect	Mitigation Measures
All Activities	Habitat Disturbance/ Degradation	• Project footprint has been minimized and previously disturbed areas will be used, wherever. • A wildlife protection plan will be implemented for the construction phase. • Waste will be trucked out, rather than using a sump. • Application of dust suppressants (water) during the summer, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998), to limit potential reduction in caribou winter forage quality and productivity.
All Activities	Sensory and other Disturbances	• Highway access will be restricted during peak barren-ground caribou migration periods (i.e. arrival during fall rut and departure to calving grounds in the spring). • 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 occur when caribou are > 500 m from the blast site.
All Activities	Caribou Incidents	• Provide field workers with education and awareness of the wildlife protection plan guidelines and programs.

TABLE 4.2.7-1: MITIGATION MEASURES FOR CARIBOU AND CARIBOU HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
		• The Field Supervisor and Safety Advisor will educate all field workers on the applicable practices contained within the wildlife protection plan. • All sightings of caribou will be reported to environmental staff on-site. • Maintain a minimum distance of 500 m between field operations and caribou for the duration of the Project. • Workers must avoid all interactions with caribou unless crew safety is at risk. • Field workers will not feed, harass or approach caribou. • Any caribou encountered will have the right-of-way. • All human/caribou conflicts and incidents will be reported to the Wildlife Monitor, Field Supervisor and Safety Advisor and documented. • Access to the surface facilities will be limited to authorized personnel during construction. • No hunting by Highway construction and maintenance workers. • Caribou sightings will be recorded (including location data, GPS if possible) to be submitted to the GNWT DOT Planning, Policy and Environmental Division and GNWT ENR's Inuvik office upon completion of the Project.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm caribou.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage caribou from entering the affected area.
Mortality	Vehicular impacts and hunting.	• Caribou have the right-of-way at all times. • During construction, the presence of caribou in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when caribou are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of caribou mortality due to collisions. • Caribou advisory signs will be placed along the Highway, as needed. • Highway closures will be required during periods of high caribou presence. • No hunting by Highway construction and maintenance workers. • Any caribou mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009)

Residual Effects

Table 4.2.7-2 and 4.2.7-3 provides a summary of residual effects on caribou and caribou habitat in the LSA and RSA, respectively.

The amount of habitat lost to the Highway is estimated to be 383 ha, approximately 0.002% (217 ha) of the Bluenose-West Herd core winter range, approximately 0.019% (212 ha) of the Cape Bathurst Herd core winter range and approximately 0.0008% (32 ha) of suitable Boreal caribou habitat. In the context of both the LSA and RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

It is expected that caribou will generally avoid the proposed Highway due to sensory disturbance, though some degree of habituation may occur. In the LSA, the effect is considered moderate in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of moderate. In the context of the RSA, the magnitude changes to low, resulting in a consequence rating of low.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-2: RESIDUAL EFFECTS ASSESSMENT FOR CARIBOU AND CARIBOU HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						Consequence
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	Magnitude L / Duration L: X
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	Magnitude L / Duration L: X
Disturbance	Moderate	Regional	Medium-term	Periodic	Reversible Long-term	Moderate	Magnitude M / Duration M: X
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	Magnitude L / Duration M: X

Consequence — Habitat Loss

Magnitude	S	M	L	I
H				
M				
L			X	

Consequence — Habitat Degradation

Magnitude	S	M	L	I
H				
M				
L			X	

Consequence — Disturbance

Magnitude	S	M	L	I
H				
M		X		
L				

Consequence — Mortality

Magnitude	S	M	L	I
H				
M				
L		X		

(Duration: S, M, L, I)

TABLE 4.2.7-3: RESIDUAL EFFECTS ASSESSMENT FOR CARIBOU AND CARIBOU HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Disturbance	Low	Regional	Medium-term	Periodic	Reversible Long-term	Moderate
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate

Habitat Loss – Consequence

Magnitude	S	M	L	I
H				
M				
L			X	

Duration

Habitat Degradation – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

Disturbance – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

Mortality – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

4.2.7.3 Grizzly Bear and Grizzly Bear Habitat

Effects on grizzly bear and their habitats may occur during construction and operation of the proposed Highway. Effects on grizzly bear include physical (e.g. direct mortality) and behavioural disturbance (e.g., displacement and habituation). Habitat effects include the loss, fragmentation or degradation of habitat. Habitat loss would occur during the construction phase. Degradation and fragmentation of habitat may occur during construction and operation and could result in reduced habitat effectiveness.

Potential effects on grizzly bear from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and fragmentation of habitat;
- Increased activity and energy expenditure near the Highway;
- Delayed crossing or failure to cross the Highway;
- Reduced use of habitats adjacent to the Highway;
- Attracted to waste from temporary construction camps;
- Attracted to Highway-killed wildlife or gut piles from harvests as a potential food source;
- Attracted to potential garbage and waste from passing vehicle traffic;
- Disturbance of denning bears;
- Increased direct mortality due to defence of life and property incidents;
- Injury or death from collisions with vehicles; and
- Increased harvesting of bears near the Highway.

Disturbance arising from construction, maintenance, and use of linear developments can result in individual grizzly bears becoming vulnerable (COSEWIC 2007).

Potential effects on grizzly bear are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following section.

Potential Effects

<u>Habitat Loss</u>

The direct effects of the proposed Highway include the loss of existing habitat under the Highway footprint and the excavation of the borrow sources.

The primary diet of grizzly bears in the Mackenzie Delta consists of horsetail (*Equisetum* spp.), grass, sedge (*Carex* spp.), sweetvetch (*Hedysarum* spp.) and all available berry species as well as caribou, moose and beaver (Edwards et al. 2010). Grizzly bears within the central and western Arctic have also been observed hunting reindeer, muskrat, Arctic hare, lemmings, voles, and ground squirrels, which they excavate from burrows, and fish such as whitefish (*Coregonus* spp.) and longnose sucker (*Catostomus catostomus*) (Edwards et al. 2010; Gau et al. 2001).

High quality grizzly bear feeding habitats include productive wetlands, riparian zones and berry producing sites. The majority of the proposed Highway alignment is situated on upland tundra habitats. Overall, approximately 21.3 ha of wetland habitat, 80.3 ha of riparian habitat and 135.0 hectares of berry-producing habitat will be lost. The amount of overall habitat loss within the RSA is small (0.20%) compared to the amount of similar habitat available (120,012 ha).

<u>Habitat Degradation</u>

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation]. Changes in plant species composition could alter the availability of food (e.g., berry producing plants for grizzly bears). The effect could be positive or negative, depending on the specific conditions.

Dust from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. For grizzly bears, this may result in a reduction of food through reduced productivity or loss of berry-producing species (including lingonberry and blueberry) during late summer and fall. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway. However, the area of disturbance is within the LSA, which is relatively small in size compared to the RSA or the Inuvialuit Settlement Region. It is likely that grizzly bears will therefore, not be directly affected by changes to vegetation as a result of dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. 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.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential degrading effect on habitat. 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.

Disturbance

Grizzly bears can be sensitive to disturbance, and displacement from habitat adjacent to roads can result in blockage to movements. Habitat displacement can result in reductions in access to areas that provide food and security. Disturbance can affect bears within a zone of influence around the source. However, habitat within the zone of influence is not lost; it is just reduced in effectiveness.

Grizzly bears are sensitive to human activity and are frequently displaced by industrial developments (McLellan 1990). During construction of the Highway and excavation of borrow sources, there is a risk of disturbance to denning grizzly bears. Typical den sites are situated on steep, southerly slopes. From the last week of October to the last week of April, nearly all grizzly bears are in dens (McLoughlin 2000). According to Harding and Nagy (1980), bears may be displaced from their dens by intensive industrial activity. Disturbance during denning may lead to den abandonment, cub mortality and decreased survival (Goodrich and Berger 1994). Specifically, 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. Bears that leave their dens during winter will likely experience severe nutritional and physiological stress and may die, and abandoned cubs will not survive (Reynolds 1981).

Other studies have reported that while in their dens, grizzly bears may be relatively tolerant of disturbance. Reynolds et al. (1986) found that no bears deserted their dens despite seismic activity within 800 m and, in one instance, the passage of a supply train within 100 m. The amount of snow cover for insulation, 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.

Grizzly bears may habituate to predictable disturbances, as long as they are not associated with strongly negative consequences such as hunting or direct harassment. Several studies (Tracy 1977; McLellan and Mace 1985; McLellan and Shackleton 1989; Bader 1989) suggest that grizzly bears may become accustomed to predictable occurrences, including traffic. Aune et al. (1986) found that road-habituated bears "showed no significant road avoidance in spring or summer in the study's 0-500 m category". In the case of the proposed Highway, it is likely that bears will initially behave warily, but may habituate over time. The degree of avoidance is likely to be higher once construction is complete and regular vehicle traffic commences.

The risks associated with Highway construction and borrow source activities is that precise locations of dens for that season are not known, and construction and excavation activities may inadvertently encroach on dens. This risk can be mitigated by conducting grizzly bear den surveys in the fall within the LSA and documenting their locations, prior to construction and excavation activities. Freshly dug dens can be mapped such that construction activities will avoid active dens during the hibernation period. The potential effects to grizzly bear denning disturbance are eliminated once construction is completed. Presumably, bears will not den in close proximity to the active Highway.

The proposed Highway alignment occurs within the Community of Tuktoyaktuk Grizzly Bear Denning Areas, site 322C (Community of Tuktoyaktuk 2008). A fall den survey will be conducted prior to any winter work. Wildlife monitors will be made aware of known denning areas for the purposes of avoidance and worker safety.

Mortality

Grizzly bear mortality could increase through hunting and collisions with vehicles. Mortality associated with roads is categorized by direct and indirect causes. Death caused by vehicular collision is an example of direct mortality, while increased hunting as a result better access with a new road is an example of indirect mortality.

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 wildlife reaching the opposite side of a road, with an increase in any factor reducing the probability of wildlife crossing safely.

Several studies have reported collision mortality in grizzly bear populations (LeFranc et al. 1987; Gunson 1995; Huber et al. 1995; Gibeau and Heuer 1996). In the Prudhoe Bay oilfield development, at least one grizzly bear was killed in a collision, and there have been several near misses (R. Shideler, pers. comm). Bears that are attracted to roads as travel routes may be more likely to be struck by vehicles. Use of roads as travel routes may also lead bears into developed areas with increased risk of negative interactions with humans.

The Inuvik to Tuktoyaktuk Highway is expected to have low levels of traffic (approximately 150-200 vehicles per day). Such low levels of traffic would be expected to limit the risk of potential traffic-related mortality along the Highway.

Grizzly bear mortality could increase should hunting be allowed near the Highway. The Highway will allow hunters year-round access to harvesting areas and, consequently, human-induced mortality could increase. Grizzly bears are harvested under quota in the ISR so the overall harvest will not exceed the quota but the number of tags available for subsistence harvesting may be reduced if DLP or vehicle collisions increase.

Bears are currently managed by Wildlife Management Advisory Councils, Inuvialuit Game Council, HTCs and ENR. It is anticipated that these organizations will continue to work together with DOT to develop strategies to reduce impacts on grizzly bears, after the Highway is constructed. The success of this approach would require a high level of voluntary compliance from the users of the proposed Highway. Additional public education campaigns, such as highway signs, may be necessary to encourage good hunting practises along the corridor and to avoid potential bear-human conflicts.

Indirect mortality from hunting has also been documented for grizzly bears. Gut piles from harvesting other species could attract bears to the Highway. Indirect mortality can also result from potential bear-human conflicts due to bears being attracted to garbage and human settlements, including camps.

Project Design and Mitigation Measures

The objectives of wildlife protection activities along the proposed Highway will be to mitigate potentially negative effects on grizzly bear in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase.
- Identification of active grizzly bear dens in the fall prior to each construction season in order to avoid denning bears;
- Minimize direct mortality due to collisions with vehicles;
- 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 ENR to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-4 presents the types of mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on grizzly bears.

TABLE 4.2.7-4 MITIGATION MEASURES FOR GRIZZLY BEAR

Project Activity	Potential Effect	Mitigation Measures
All Activities	Disturbance or injury to bears and their habitat.	• Project personnel will be provided with wildlife awareness training. • Wildlife monitors will be on-site during construction to monitor wildlife and manage risks.
All Activities	Denning bears could be disturbed and could abandon den sites	• Den surveys will be conducted in the fall prior to construction and excavation activities. Freshly dug dens will be mapped such that construction activities will avoid active dens during the hibernation period. • If possible, no activities will occur 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 construction site after the pre-construction survey, GNWT ENR will be contacted immediately to determine a course of action. • No blasting will occur if active bear dens are confirmed within 500 m of proposed blasting areas.

TABLE 4.2.7-4 MITIGATION MEASURES FOR GRIZZLY BEAR

Project Activity	Potential Effect	Mitigation Measures
		• Wildlife monitors will be on-site during construction to monitor wildlife and manage risks.
All Activities	Disturbance of denning bears by workers walking off-site during the winter months.	• 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 GNWT Bear Safety Guidelines training, and will be instructed not to disturb any wildlife. • Personnel are to maintain a minimum distance of 500 m between sighted and/or known bear den sites for the duration of the Project.
All Activities	Grizzly bears may approach construction sites, potentially resulting in an incident or mortality.	• Grizzly bears have the right-of-way at all times. • ENR will be contacted if an active grizzly bear den is identified within 500 m of Project activities to determine appropriate course of action. • 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 and slugs. All work crews will have at least one can of bear spray while bears are active. The use of any deterrent method will be reported to ENR.
All Activities	Grizzly bear may approach camp, potentially resulting in an incident or mortality.	• 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 installing adequate lighting, incorporating proper waste management, cleaning and maintaining the kitchen and dining area, and wildlife detection.
Waste Storage	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

TABLE 4.2.7-4 MITIGATION MEASURES FOR GRIZZLY BEAR		
Project Activity	**Potential Effect**	**Mitigation Measures**
		• 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).
Waste Storage	Poorly secured waste can blow off site and pose risk of injury or mortality to bears.	• 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 to collect and properly dispose of any waste material that have blown off site.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm grizzly bears.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage grizzly bears from entering the affected area.
Vehicle/ Equipment Use	Vehicular impacts may cause mortality.	• Grizzly bears have the right-of-way at all times. • During construction, the presence of grizzly bears in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when grizzly bears are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of grizzly bear mortality due to collisions. • Grizzly bear advisory signs will be placed along the Highway, as needed. • Any grizzly bear mortalities will be reported to ENR.
Hunting	Hunting may cause grizzly bear mortalities.	• No hunting by Highway construction and maintenance workers. • Any grizzly bear mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009).

Residual Effects

Table 4.2.7-5 and 4.2.7-6 provides a summary of residual effects for grizzly bears and grizzly bear habitat in the LSA and RSA respectively.

The loss of habitat due to the development of the proposed Highway will be approximately 236.6 ha of high rated bear feeding habitat. This will result in a loss of 0.20% of available high-rated bear feeding habitat within the RSA.

In the context of both the LSA and the RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low. At this time the amount of suitable grizzly denning habitat (south-facing slopes ≥ 25% grade; McLoughlin et al. 2002) cannot be calculated as digital elevation model (DEM) data at the resolution required is not available. It is anticipated that this data will be available prior to the design phase of the Project.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

It is expected that grizzly bear will avoid the proposed Highway due to sensory disturbance, though some degree of habituation may occur. In the LSA, the effect is considered moderate in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of moderate. In the context of the RSA, the magnitude changes to low, resulting in a consequence rating of low. Since den surveys will be completed in fall prior to each winter construction season, no effects on denning bears are anticipated.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-5: RESIDUAL EFFECTS ASSESSMENT FOR GRIZZLY BEAR AND GRIZZLY BEAR HABITAT IN THE LSA

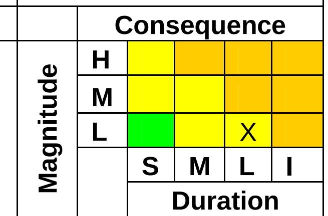
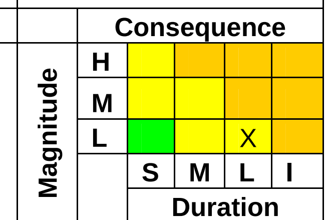
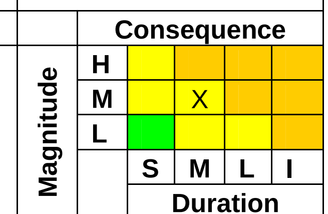
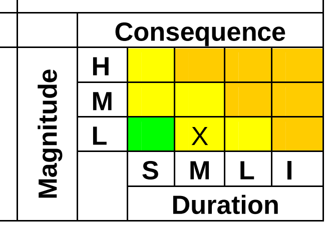
Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						Consequence
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate	
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	

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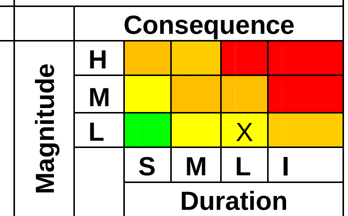
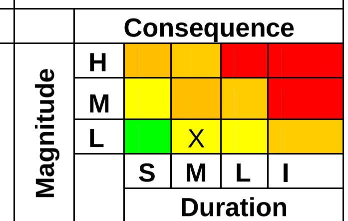
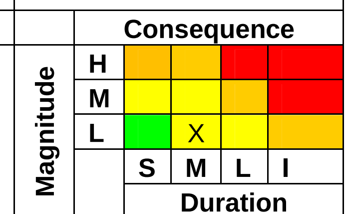
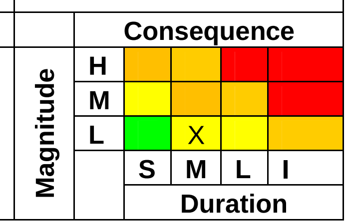
TABLE 4.2.7-6: RESIDUAL EFFECTS ASSESSMENT FOR GRIZZLY BEAR AND GRIZZLY BEAR HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	

4.2.7.4 Moose and Moose Habitat

Effects associated with the construction of the proposed Highway and its associated borrow sources can be in the form of effects on moose and effects on their habitat. Habitat effects include the loss, fragmentation, or degradation of habitat. Habitat loss will occur during the construction phase, along the Highway and borrow source footprints. 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 when moose are mainly south of the treeline or within the riparian areas of the Mackenzie River and its major tributaries.

Potential effects on moose from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and fragmentation of habitat;
- Physical and physiological disturbance;
- Displacement away from the proposed Highway;
- Increased activity and energy expenditure near the proposed Highway;
- Delayed crossing or failure to cross the proposed Highway;
- Altered migration;
- Reduced use of habitats adjacent to the proposed Highway;
- Habituation to the Highway;
- Injury or death from collisions with vehicles; and,
- Increased hunting pressure along the proposed Highway.

Potential effects on moose are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following sections.

Potential Effects

<u>Habitat Loss</u>

The proposed Highway traverses four Ecoregions, which include the Mackenzie Delta, Caribou Hills, Sitidgi Plain, and Tuktoyaktuk Coastal Plain. The footprint of this proposed Highway is anticipated to be approximately 137 km long by 28 m wide. The amount of habitat lost to the Highway is estimated to approximately 383 ha. The Mackenzie Delta Ecoregion's northern extent corresponds with the treeline and represents the highest quality moose habitat within the local study area. The habitats south of the treeline provide deciduous shrubs for fall and winter food and thick conifers for winter cover (GNWT

ENR 2011). Less than 8 ha of potential winter moose habitat will be impacted within the Mackenzie Delta Ecoregion.

North of the treeline the local study area falls within the Caribou Hills, Sitidgi Plain, and Tuktoyaktuk Coastal Plain Ecoregions. The boreal forest extends into parts of the Caribou Hills Ecoregion and as such limited winter moose habitat (12 ha) also occurs with this Ecoregion. Riparian habitats north of the treeline are utilized for feeding during the growing season (GNWT ENR 2011) when accessibility related to snow depths and climatic factors are not limiting (Dussault et al. 2005, Stephenson et al. 2006).

Within the study area the community of Tuktoyaktuk has identified the south boundary at Sitidgi Lake, northward to the southern end of Husky Lakes, east to Kugaluk River as important spring harvest areas for moose (Community of Tuktoyaktuk et al. 2008). The Alternative 2 (Upland Route) option would avoid habitats associated with the spring moose harvest area. Away from the lakes and wetlands moose are predominantly found within the tall shrub riparian zones within the river valleys as these habitats provide both food and security cover (GNWT ENR 2011). The majority of the proposed Highway occurs on uplands and intersect with the riparian zones at river crossings. Riparian communities are known only from two creek valleys, where the Project stream crossings are limited and it is not expected to significantly impact this community type.

In addition to the proposed Highway, borrow sites will also alter vegetation cover. The gravel borrow sources typically occupy upland areas which are dominated by bryoids and low shrub cover types. These are considered low quality moose habitats due to the limited available preferred food (willows and aquatic vegetation) and security cover; consequently, it is anticipated that the vegetation classes lost due to gravel extraction are insignificant to moose.

The overall effect of habitat loss to moose from the proposed Highway and the proposed gravel borrow sources is considered to be very small and insignificant and will not affect the population at the local level.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation.] Changes in plant species composition could alter the availability of food and the effect could be positive or negative on moose, depending on the specific conditions.

Dust deposition from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations can cover vegetation and decrease the abundance of forage. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway (see Section 4.2.6.2 for a more complete description of effects of dust on vegetation). In a fugitive dust assessment of an Arctic road through tundra habitat conducted in northwest Alaska the authors concluded that the effects of fugitive dust on moose forage would not affect moose on a population level (Exponent 2007). However, the quantity of dust is unlikely to have a major effect on vegetation and food availability. Dust suppression methods as described in *Guideline for Dust Suppression* (GNWT 1998) will be employed to minimize potential issues associated with dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. 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.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents another potential hazard. In the event of a spill, cleanup measures will be implemented immediately. All spills will be reported to the GNWT Spill Line and other appropriate agencies.

Disturbance

Moose may be disturbed and/ or displaced by the presence of the proposed Highway and/ or human activities associated with the Highway. This is most evident in hunted populations as moose populations are sometimes reduced adjacent to roads (Rolley and Keith 1980). In a study of moose distribution in an area of oil and gas development in northwestern Alberta, use of habitat near roads was significantly reduced compared to control areas away from a road (Intera Environmental Consultants 1973). The degree of avoidance varies greatly depending on the species, habitat attributes, and prior disturbance history. Human activity associated with development corridors is the primary source of disturbance for wildlife (Jalkotzy et al. 1997).

The majority of the proposed Highway traverses habitats not likely to be utilized moose for forage. The higher quality moose forage habitat is restricted to a few tall shrub riparian zones found in the river valleys where the Highway will cross at 90 degrees. The proposed Route design and the fact that there are few moose occurring in the LSA, the potential disturbance effects will be limited. The net disturbance effects from the proposed development are expected to apply only to the local populations.

Mortality

Moose mortality could increase due to vehicular collisions and increased hunting as a result of enhanced hunter access.

Collisions with vehicles can be a significant source of human-related mortality. The numbers of moose killed can be substantial in some regions of North America. For example, between 1984 and 1989, an average of 216 moose was killed each year on Alaska's roads (Del Frate and Spraker 1991). Road mortality appears to be related to traffic volumes and speed (Del Frate and Spraker 1991; Oosenbrug et al. 1991; Underhill and Angold 2000). Collisions in Alaska were found to be grouped in the winter months and typically were more severe where roads crossed moose winter range during deep snow conditions (Del Frate and Spraker 1991).

The proposed Highway is expected to have low levels of traffic (in the order of 150-200 vehicles per day), which can be expected to minimize potential traffic-related mortality along this Highway. Speed limits, giving wildlife the right-of-way, and signage in areas with caribou concentrations could help minimize the potential for moose-vehicle collisions.

The proposed Highway will allow hunters year-round access to harvesting areas and, consequently, human-induced mortality for moose could increase. There is little documented information for Northwest Territories, though the effect of increased hunting with road development is well documented elsewhere. Moose attracted to, or crossing, a disturbance corridor may suffer greater mortality than elsewhere within their home ranges; the mortality often occurs as a result of hunting (Jalkotzy et al. 1997). In New Brunswick, Boer (1990) found that hunter kills of moose were highly clumped; 92% of moose were killed within 1 km of forest roads. Major access routes radiating from population centres seemed to direct the flow of hunters in Quebec (Bider and Pimlott 1973). Overharvests of moose occurred in areas with greater access (Bider and Pimlott 1973). Lynch (1973) documented increased moose harvests in an area of development with associated increases in access. Most hunting activity occurred within 1.6 km of roads. Similar results have been documented in the NWT along the Liard and Mackenzie Highways (Treseder and Graf 1985).

Despite these impacts the situation in the Project area would likely be different due to fewer hunters and fewer moose. Human-induced mortality is higher in areas associated with major access routes radiating from population centres in southern localities (Bider and Pimlott 1973). In the north this effect would be reduced as a result of fewer hunters and fewer access roads. For example, one study from the Kenai Peninsula in Alaska found the mean annual survival rate of female moose was 0.92, the mean annual mortality rate as a result of collisions with vehicles was 0.04 while the annual hunting mortality rate was just 0.01 (Bangs et al. 1989). In isolation these mortality rates probably would not result in population declines (Jalkotzy et al. 1997).

The impact on the few individual moose occurring along the proposed Highway might be significant at the local level. However, with the implementation of the proposed mitigation measures and voluntary compliancy for no-hunting along the proposed Highway corridor from community members, these impacts would be greatly reduced, if not eliminated. No-hunting corridors have been successfully established along the Liard and Mackenzie Highways and the Ingraham Trail (Highway 4). These no-hunting corridors apply to all hunters, and represent a significant cooperative venture in the wildlife management field (Treseder and Graf 1985). Consultation with local residents would be a prerequisite for a wildlife management program that would include a no-hunting corridor along the proposed Highway. If these mitigation measures were successfully implemented the impacts on moose would be low and insignificant at the local level.

Project Design and Mitigation Measures

The objectives of wildlife protection activities along the proposed Highway will be to mitigate potentially negative effects on moose in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase;
- Minimize disruption of migration patterns due to vehicle traffic; particularly when the barren-ground caribou arrive within the study area for the fall rut and their departure to the calving grounds in the spring;
- Minimize direct mortality due to collisions with vehicles;
- 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 with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-7 presents the mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on moose.

In addition to Project mitigation measures, ENR in consultation with the HTAs and communities should consider the establishment of a no-hunting zone along the proposed Highway. A no-hunting corridor would not only protect moose, as well as other wildlife, but also for human safety concerns that arise from hunting from roadways.

Residual Effects

Table 4.2.7-8 and 4.2.7-9 provides a summary of residual effects on moose and moose habitat in the LSA and RSA respectively.

The amount of lost moose habitat from the proposed Highway and the proposed gravel borrow sources is small. In the context of both the LSA and RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-7: MITIGATION MEASURES FOR MOOSE

Project Activity	Potential Effect	Mitigation Measures
Off-site Activities	Workers walking off-site may disturb moose.	• Workers will not walk off-site onto the land at any time of year, unless there is a specific need (e.g., waste clean-up, emergency). • All workers will be instructed not to disturb any moose observed. • Wildlife monitors will be on-site during construction to monitor potential wildlife issues and manage risks.
Waste Storage	Poorly secured waste can attract predators, which may increase predation pressure on moose in the area.	• All waste products will be properly secured, stored and transported. • Waste removal crews will be sent to areas surrounding each construction site to collect and properly dispose of any waste material that has blown off site.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm moose.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • In the event of a spill, all efforts will be made to properly contain and manage the spill. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage moose from entering the affected area.
Vehicle/ Equipment Use	Vehicular impacts may cause mortality.	• Moose have the right-of-way at all times. • During construction, the presence of moose in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when moose are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of moose mortality due to collisions. • Moose advisory signs will be placed along the Highway, as needed. • Any moose mortalities will be reported to ENR.
Hunting	Hunting may cause moose mortalities	• No hunting by Highway construction and maintenance workers. • Any moose mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009).

TABLE 4.2.7-8: RESIDUAL EFFECTS ASSESSMENT FOR MOOSE AND MOOSE HABITAT IN THE LSA

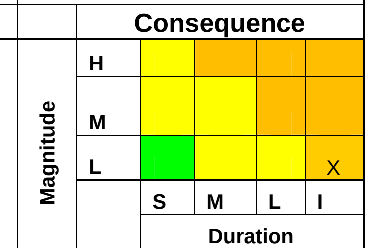
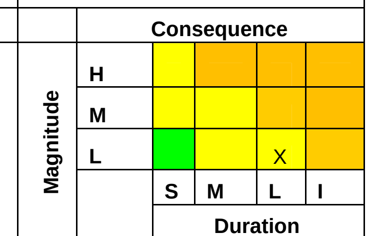
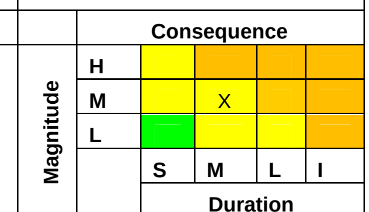
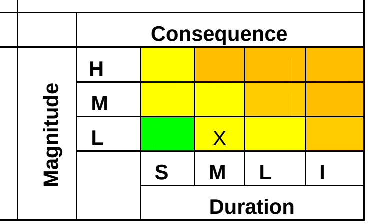
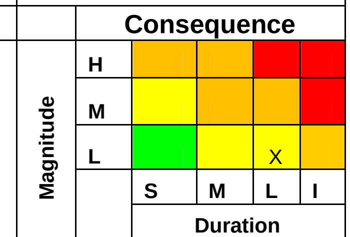
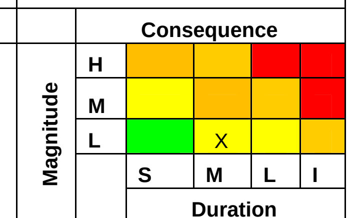
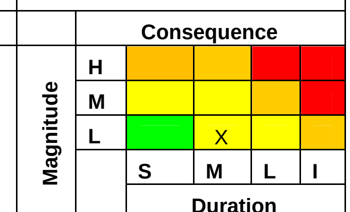
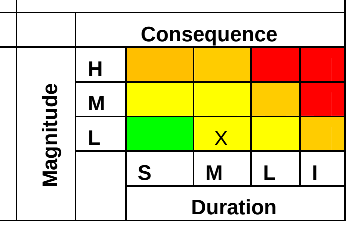
Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate	
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	

TABLE 4.2.7-9: RESIDUAL EFFECTS ASSESSMENT FOR MOOSE AND MOOSE HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	

4.2.7.5 Furbearers and Furbearer Habitat

For the purposes of this assessment, furbearers include wolverine, Arctic fox and red fox. Effects on furbearers and their habitats may occur during construction and operation of the proposed Highway. Effects include physical (e.g. direct mortality) and behavioural disturbance (e.g., displacement and habituation). Habitat effects include the loss, fragmentation or degradation of habitat. Habitat loss would occur during the construction phase. Degradation of habitat may occur during construction and operation and could result in reduced habitat effectiveness.

Potential effects on furbearers from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Loss of habitat and habitat fragmentation;
- Displacement away from the Highway;
- Increased activity and energy expenditure near the Highway;
- Delayed crossing or failure to cross the Highway;
- Reduced use of habitats adjacent to the Highway;
- Attracted to waste from temporary construction camps;
- Attracted to Highway-killed wildlife or gut piles from harvests as a potential food source;
- Attracted to potential garbage and waste from passing vehicle traffic;
- Habituation to the Highway;
- Disturbance of denning furbearers;
- Injury or death from collisions with vehicles; and
- Increased harvesting of furbearers near the Highway.

Potential effects on furbearers are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following sections.

Potential Effects

Habitat Loss

The direct effects of development of the proposed Highway and associated borrow sources will include loss of habitat. The footprint is anticipated to be approximately 137 km long by 28 m wide. The amount of habitat lost to the proposed Highway (the Primary 2009 Route) is therefore 383 ha, which is 0.1% of the RSA.

The majority of the proposed Highway alignment is situated on upland tundra habitats. Feeding habitat for wolverine and foxes is associated with the occurrence of prey species rather than vegetation types and prey can be found in a variety of habitats. It is anticipated the wolverine and foxes would den in upland tundra sites with suitable features (COSEWIC 2003 and Mueller 1995).

Wolverine dens can be classified as natal or maternal den sites (COSEWIC 2003). Multiple dens may be used in sequence (Copeland 1996) and from year to year (MacDonald 2009; Lee and Niptanatiak 1996). Dens can vary from simple rest beds to complex natal dens with extensive tunnel networks (Pullianinen 1968 and Magoun 1985 as cited in Mulders, 2000). Natal dens are frequently located among boulders, under deadfall, or in snow tunnels (Magoun and Copeland 1998) in tundra habitats (Lee and Niptanatiak 1996). Lee and Niptanatiak (1996) observed a den repeatedly used for three years in the central Arctic, approximately 160 km southeast of Coppermine. This den was situated in a large snowdrift covering a boulder field. Caves, rock crevices, fallen logs and holes in the snow and burrows are also used for shelter (Community of Inuvik et al. 2008).

Fox den sites are usually associated with Arctic ground squirrel den sites (Mueller 1995) which are also a known prey species for both wolverine and foxes (Mulders 2000 and Banfield 1974). Fox denning habitat typically consists of well-drained, stable soils (Martell et al. 1984). Arctic fox den sites include areas that are gently sloping with sandy soil near rivers or lakes or on elevated areas free from permafrost (GNWT ENR 2011).

In general, furbearer denning sites within the study area are similar to sites utilized by grizzly bears. Denning habitat for wolverine and other furbearers is not considered to be limited in the Canadian tundra (Lee and Niptanatiak 1996).

At this time the amount of suitable wolverine and fox denning habitat (slopes with well drained soils) cannot be calculated as digital elevation model (DEM) data at the resolution required is not available. It is anticipated that this data will be available prior to the design phase of the Project.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation]. Changes in plant species composition could alter the availability of food (e.g., different prey availability for furbearers). The effect could be positive or negative, depending on the specific conditions.

Dust from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. For furbearers, this may result in changes to prey species abundance. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway. However, the area of disturbance is within the LSA, which is relatively small in size compared to the RSA or the Inuvialuit Settlement Region. It is likely that furbearers will not be directly affected by changes to vegetation as a result of dust.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. 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.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential degrading effect on habitat. 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.

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 (Jalkotzy et al. 1997). Disturbance can affect wildlife within a zone of influence around the source.

In general, there is a paucity of information regarding the effects of linear developments on furbearers. Information on species' disruption is not well-documented in the literature and is typically from southern studies within forested ecosystems. However, in the case of wolverines, a study in Idaho raised the possibility that human disturbance at natal den sites may cause den abandonment (Copeland 1996). Habitat avoidance has been documented to varying degrees for medium sized carnivores. Banci (1994) conducted a review of the wolverine literature in 1994. The majority of references to wolverines in the literature are either anecdotal or refer to incidental observations. The reported anecdotal information on disturbance to wolverines is varied. Wolverines have been reported to be sensitive to human activity (Copeland 1996). Impacts of development activities on wolverines are assumed to be similar to those on grizzly bears: yet in the north where they are more common, some wolverines tolerate civilization to the extent of scavenging at dumps and living adjacent to developments (Jalkotzy et al. 1997).

Construction activities, including borrow excavation activities, are anticipated to generate more intensive disturbance effects than routine traffic. Additionally, during the primary winter construction season there is a risk of disturbing denning furbearers. Foxes are considered a species possessing a high level of adaptability in their ecology (GNWT ENR 2011). Consequently, impacts on these adaptable species are of lesser concern within this Project. However, other species such as wolverines may be more sensitive.

Mortality

Furbearer mortality could increase due to vehicular collisions and increased hunting as a result of enhanced hunter access. Traffic-related mortality can be linked to several factors including traffic density, vehicle speed and/ or road width (Jalkotzy et al. 1997). Any of these factors can directly affect the success of wildlife reaching the opposite side of a road, with an increase in any factor reducing the probability of wildlife crossing safely. The Inuvik to Tuktoyaktuk Highway is expected to have low levels of traffic (in the order of 150-200 vehicles per day) at most times. Such low levels of traffic would be expected to minimize the potential of traffic-related mortality along the Highway.

Indirect mortality in the form of increased hunting and trapping is a concern for furbearers. The proposed Highway will allow hunters and trappers more ready access to harvesting areas and, consequently, human-induced mortality may potentially increase for furbearers, as well as other wildlife species. The proposed Highway could also assist in providing trappers with access into previously more remote areas along the corridor. Wildlife populations sustain increased mortalities from hunting and trapping as a result of better access (Jalkotzy et al. 1997).

Residents of Tuktoyaktuk have expressed concern that hunting pressure on wildlife may increase as a direct consequence of building the Highway. To protect wildlife, organizations such as the ILA, the HTCs, ITC, WMAC, and GNWT Department of Environment and Natural Resources will need to continue to work together with DOT to develop strategies to reduce impacts on furbearers, after the Highway is constructed. The success of this approach would require a high level of voluntary compliance from the users of the proposed Highway. Additional public education campaigns, such as highway signs, may be necessary to encourage good hunting practises along the corridor.

Project Design and Mitigation Measures

The objectives of furbearer protection activities along the proposed Highway will be to mitigate potentially negative effects on furbearers in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- A wildlife protection plan will be implemented for the construction phase.
- Identification of active dens in the fall prior to each construction season in order to avoid active areas;
- Minimize direct mortality due to collisions with vehicles;
- 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 ENR to work together with DOT to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-10 presents the types of mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on furbearers and furbearer habitat.

TABLE 4.2.7-10: MITIGATION MEASURES FOR FURBEARERS AND FURBEARER HABITAT

Project Activity	Potential Effect	Mitigation Measures
All Activities	Disturbance or injury to furbearers and their habitat.	• Project personnel will be provided with wildlife awareness training.
All Activities	Disturbance of denning furbearers:	• If active 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. • Wildlife monitors will be on-site during construction to monitor wildlife and manage risks. • Personnel are to maintain a minimum distance of 500 m between sighted and/or known wolverine den sites for the duration of the Project and to contact ENR to determine an appropriate course of action. • 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 furbearer periods. • All workers will receive, at minimum, orientation to the wildlife management plan, and will be instructed not to disturb any furbearers.
All Activities	Wildlife incident or mortality: furbearers may approach sites while workers are present potentially resulting in an incident or mortality.	• Furbearers have the right-of-way at all times. • The wildlife monitor and designated, trained staff will have access to wildlife deterrent materials including bear spray, cracker shells, and a 12 gauge shotgun with plastic slugs. The use of any deterrent method will be reported to ENR. • 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 a wolverine and other wildlife that may be in the vicinity. • Camps and associated infrastructure will be designed to incorporate proper wildlife safety, including installing adequate lighting, incorporating proper waste management, cleaning and maintaining the kitchen and dining area, and wildlife detection. • No hunting by Highway construction and maintenance workers

TABLE 4.2.7-10: MITIGATION MEASURES FOR FURBEARERS AND FURBEARER HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
Waste Storage	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).
Waste Storage	Wildlife incident or mortality: poorly secured waste can blow off site and pose risk of mortality to furbearers.	• All waste products will be properly secured, stored and transported. This includes the use of wildlife-proof storage containers that reduce odours at all times. • Waste removal crews will be sent out to areas surrounding each construction site to collect and properly dispose of any waste material that have blown off site.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm furbearers.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • All vehicles and equipment will be refueled at least 100 m from waterbodies. • 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. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage furbearers from entering the affected area.

TABLE 4.2.7-10: MITIGATION MEASURES FOR FURBEARERS AND FURBEARER HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
Mortality	Vehicular impacts and hunting.	• Furbearers have the right-of-way at all times. • During construction, the presence of furbearers in the areas of construction and access roads will be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when furbearers are on the road or near the road, respectively. • Vehicle speeds during construction and post construction will be regulated to reduce the potential of furbearer mortality due to collisions. • Furbearer advisory signs will be placed along the Highway, as needed. • No hunting by Highway construction and maintenance workers. • Any furbearer mortalities will be reported to ENR.

Source: Adapted from GNWT DOT (2009).

Residual Effects

Table 4.2.7-11 and 4.2.7-12 provides a summary of residual effects for furbearers and furbearer habitat in the LSA and RSA respectively. The loss of habitat due to the development of the proposed Highway is small (less than 0.1% of the RSA). In the context of both the LSA and the RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low. At this time the amount of suitable wolverine and fox denning habitat (slopes with well drained soils) cannot be calculated as digital elevation model (DEM) data at the resolution required is not available. It is anticipated that this data will be available prior to the design phase of the Project.

Effects of habitat degradation, which is primarily related to reduction in food availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

Disturbance from operational activities will be variable depending upon time of year but may influence individual furbearers in proximity to the proposed Highway. Disturbance will reduce habitat effectiveness adjacent to the proposed Highway. This is expected to affect wolverines more than foxes; regardless, the magnitude of habitat disruption is unknown. Disturbance will be limited only to those furbearers with territories adjacent to the construction activity and, to a lesser degree, the proposed Highway during operation.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-11: RESIDUAL EFFECTS ASSESSMENT FOR FURBEARERS AND FURBEARER HABITAT IN THE LSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Disturbance	Moderate	Local	Medium-term	Periodic	Reversible Long-term	Moderate
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate

Habitat Loss – Consequence

Magnitude	S	M	L	I
H				
M				
L			X	
	Duration			

Habitat Degradation – Consequence

Magnitude	S	M	L	I
H				
M				
L			X	
	Duration			

Disturbance – Consequence

Magnitude	S	M	L	I
H				
M		X		
L				
	Duration			

Mortality – Consequence

Magnitude	S	M	L	I
H				
M				
L		X		
	Duration			

TABLE 4.2.7-12: RESIDUAL EFFECTS ASSESSMENT FOR FURBEARERS AND FURBEARER HABITAT IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect						
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Consequence
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High	See matrix below
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High	See matrix below
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	See matrix below
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate	See matrix below

Habitat Loss – Consequence (Magnitude × Duration)

Magnitude	S	M	L	I
H				
M				
L			X	

Habitat Degradation – Consequence (Magnitude × Duration)

Magnitude	S	M	L	I
H				
M				
L		X		

Disturbance – Consequence (Magnitude × Duration)

Magnitude	S	M	L	I
H				
M				
L		X		

Mortality – Consequence (Magnitude × Duration)

Magnitude	S	M	L	I
H				
M				
L		X		

4.2.7.6 Birds and Bird Habitat

Potential effects and mitigation measures for waterfowl, raptors and upland birds, including the VCs, are described in this section. Bird species identified as VCs, are as follows:

- Waterfowl (Horned Grebe, Tundra Swan, Greater White-fronted Goose, Snow Goose, Canada Goose Mallard, Northern Pintail);
- Raptors (Peregrine Falcon, Short-eared Owl); and
- Upland Birds (Rusty Blackbird, Rock and Willow Ptarmigan).

Effects on birds and their habitats may occur during both construction and operation of the proposed Highway. Effects include physical (e.g. direct mortality) and behavioural disturbance (e.g., displacement and habituation). Habitat effects include the loss, fragmentation or degradation of habitat. Habitat loss would occur during the construction phase. Degradation of habitat may occur during construction and operation and could result in reduced habitat effectiveness.

Potential effects on birds from construction of the proposed Highway and its associated borrow sources, the physical presence of the proposed Highway and vehicular traffic include:

- Displacement away from the Highway;
- Increased activity and energy expenditure near the Highway;
- Loss of habitat and habitat fragmentation;
- Reduced use of habitats adjacent to the Highway;
- Attracted to Highway-killed wildlife or gut piles from harvests as a potential food source;
- Attracted to potential garbage and waste from passing vehicle traffic;
- Habituation to the Highway;
- Disturbance of nesting birds;
- Injury or death from collisions with vehicles; and
- Increased harvesting of birds (i.e. waterfowl) near the Highway.

Potential effects on furbearers are considered in four categories: habitat loss, habitat degradation, disturbance and mortality. These are discussed in the following sections.

Potential Effects

<u>Habitat Loss</u>

The direct effects of development of the proposed Highway and associated borrow sources will include loss of habitat. The footprint is anticipated to be approximately 137 km long by

28 m wide. The amount of habitat lost to the proposed Highway (the Primary 2009 Route) is therefore 383 ha, which is 0.10% of the RSA.

The majority of the proposed Highway alignment is situated on upland habitats (Bryoid, Exposed/Barren Land and Shrub Low habitats). Upland habitats are utilized by passerines, ptarmigan and shorebirds such as golden plovers. The removal of upland habitat along the 2009 Primary Route footprint represents a loss of 261.7 ha. This loss is small compared to the amount of similar habitat available (137,414 ha) within the RSA, of which the Highway footprint represents approximately 0.19% of that habitat type.

Within the RSA the Coniferous, Mixedwood, Broadleaf, Shrub Tall, Wetland-treed, Wetland-herb, Herbs habitats were identified as riparian sites. Lakes, ponds and associated wetlands are utilized by a number of waterfowl and shorebird species. Lakes and ponds also attract waterfowl during the post-breeding moult as these habitats provide security from predators (Ehrlich 1988). Of the four proposed Highway alignment options, the Primary 2009 Route impacted the greatest amount of wetland and shrub riparian habitat (84.14 ha) compared to the amount of similar habitat available (84,227 ha) within the RSA, of which the Highway footprint represents approximately 0.10% of that habitat type.

Borrow excavation activities may cause some localized, temporary habitat loss. Because these activities will be generally limited to the winter period, effects on birds are anticipated to be minimal. Progressive reclamation will occur to ensure that only active areas will be disturbed. Where possible, areas will be recontoured and revegetated, with available native seed mixes to match the surrounding terrain upon completion of excavation activities. In areas where the disturbed habitat is not compatible with native seed mixes then the areas will be recontoured and allowed to revegetate naturally. Exposed areas are exploited by some bird species feeding, nesting and cleaning (dust baths). For example, some passerines commonly feed in areas of exposed gravel, as it is easier to forage for insects and seeds. Other species, such as the Semipalmated Plover seek out gravel exposures for nesting while ptarmigan frequently used gravel sites for dust baths (Ehrlich 1988).

Birds will experience some habitat loss associated with the proposed Highway and associated borrow sources. Of greater consequence, however, is the predicted pattern of snowmelt along the proposed Highway, which is expected to accelerate green-up by 10-14 days in the spring (Walker and Everett 1987, as cited in Truett et al. 1997). This could provide spring foraging opportunities for passerines, waterfowl, and raptors, and advanced nesting for passerines.

Habitat Degradation

Areas adjacent to the Highway surface could become degraded as a result of alteration of local hydrology and deposition of dust and contaminants.

Linear developments such as roads can disrupt local surface water drainage and sedimentation patterns, increase ponding in certain areas, and drying in others, which can subsequently change local plant species composition in response to new growing conditions. [See Section 4.2.6.4 for a complete of effects of altered hydrology on vegetation]. Changes in plant species composition could alter the availability of food (e.g., different prey availability for furbearers). The effect could be positive or negative, depending on the specific conditions.

Dust from construction of the Highway, excavation of the borrow sources, and Highway traffic during operations may lead to degradation of vegetation and result in reduced productivity or shifts in species composition over a given area. For birds, this may result in changes to food availability. Dust created by Highway traffic during the summer months is expected to settle within 100 m of the Highway. However, the area of disturbance is within the LSA, which is relatively small in size compared to the RSA or the Inuvialuit Settlement Region. It is likely that birds will not be directly affected by changes to vegetation as a result of dust.

The deposition of dust adjacent to the Highway in the early spring is anticipated to affect snowmelt patterns along the proposed Highway which is expected to accelerate green-up by 10-14 days (Walker and Everett 1987, as cited in Truett et al. 1997). This could provide earlier spring foraging and nesting opportunities for birds attracted to snow-free sites.

Nitrous oxides and sulphur dioxide emitted from power generators and construction equipment are potential sources of contaminants. Air emissions associated with the Project are unlikely to affect feeding habitats for birds. Air quality effects associated with particular Project activities and local meteorological conditions will be minimal and temporary.

The accidental spillage of fuel, lubricants and/or anti-freeze at a work site or during transportation represents a potential degrading effect on habitat. 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.

Disturbance

Displacement associated with disturbance may have physical and physiological effects that can act at the level of individuals, groups, or populations. Birds that are displaced from important habitats may sustain increased energetic costs that can directly influence health and survival of themselves, their offspring, and their population (Diavik 1998). They may also face reduced security and increased predation risk.

During incubation, nesting females draw on fat reserves to sustain themselves throughout the incubation period (Davis and Wiseley 1974). The stress of disturbance could affect the female's energy reserves, leading to mortality of the adult, eggs or nestlings. Disturbance may cause the nesting bird to abandon nest and clutch. The absence of the female from the nest also allows predators access. Some species, such as jaegers (*Stercorarius* spp.) and gulls, have learned to follow humans and prey on the eggs of nesting birds that have been flushed by humans (MacInnes and Misra 1972).

During the summer months birds may encounter some noise during construction of the proposed Highway; however, the majority of the works will occur in the winter when most birds are not present within the study area. Summer-related work will be on a smaller scale and will include compacting and grading of the embankment (Highway surface), installation of certain culverts (to protect fish habitat), or adjustments to culverts installed in the previous winter. Disturbance from the summer activities are anticipated to be relatively minor and will be local and temporary as the construction progresses along the route. Once the proposed Highway has been built, disturbance from passing vehicles is likely to be negligible.

Based on bird surveys and anecdotal observations collected at a tundra diamond mine site between 1995 and 2000, birds typically show little or no detectable responses to stressors and that effects from mining and associated activities are negligible (Smith et al. 2005). Furthermore, despite anthropogenic disturbances, waterfowl (including loons) and shorebirds continued to utilize lakes and wetlands adjacent to roads and infrastructure (Rescan 1999b). Shorebirds such as Red-necked Phalaropes and Least Sandpipers continued to use ponds within the existing footprint. Several pairs of Semipalmated Sandpipers have nested adjacent to developed areas over the years (S. Moore, Wildlife Biologist, EBA, pers. obs.). Raptors, including Peregrines, Gyrfalcons and Rough-legged Hawks, were commonly recorded hunting along roads and within built up areas. Bald and Golden eagles have been observed hunting in the vicinity of the diamond mine and Rough-legged Hawks and Short-eared Owls have been documented hunting within the road system (Rescan 1999b). These observations suggest not all birds are displaced.

At Tuktoyaktuk, Gyrfalcons are regular nesters at an abandoned camp facility adjacent to the town and are commonly seen hunting along the roads and infrastructure associated with town (S. Moore, Wildlife Biologist, EBA, pers. obs.) (Photo 4.2.7-1 and 4.2.7-2). The presence, maintenance and usage of roads and infrastructure, including the airport, in and around Tuktoyaktuk does not appear to disturb raptors, passerines or waterfowl from utilizing adjacent habitats for nesting and rearing offspring (S. Moore, Wildlife Biologist, EBA, pers. obs.) (Photo 4.2.7-3 and 4.2.7-4). Nesting habitat for birds of prey, primarily cliffs, does not exist within the LSA. Any tower or structure erected and standing during the nesting period could be potential habitat. Structures would be designed to minimize or prevent they are not utilized as nesting structures. If nesting occurs they would not be disturbed until after the birds have left the area.

The majority of disturbances to birds will be of a temporary nature. Disturbance effects experienced by birds during construction of the proposed Highway and the physical existence of the proposed Highway afterwards are not anticipated to affect the bird populations at the local or regional level.

Photo 4.2.7 -1:
A pair of Gyrfalcons perched on top of a communication tower at Tuktoyaktuk.
Their nest is just out of view, below the bottom edge of the photo.

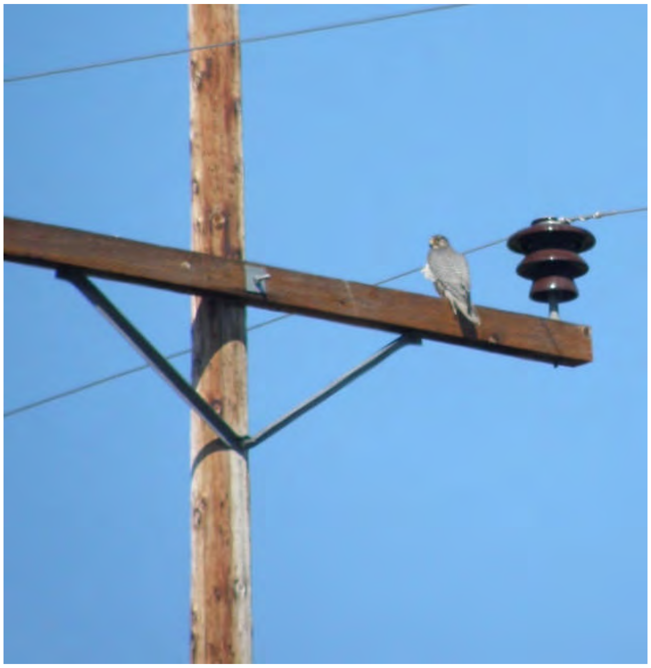


Photo 4.2.7-2:
This Gyrfalcon and its mate were observed regularly using
the telephone poles during their hunting activitie

Photo 4.2.7-3:
Wilson's Snipe nest with eggs 20 m from active roadway on the edge of Tuktoyaktuk, NWT

Photo 4.2.7-4:
Adult male Red-necked Phalarope on nesting territory adjacent to an active road, Tuktoyaktuk, NWT

Mortality

As with any development, there is always a potential for increased mortality through vehicular collisions and hunting. In the presence of road traffic, the potential exists for birds being injured or killed by colliding with vehicles. The development of roads will also provide access to areas that may not have been previously accessible. There is the potential that people will engage in harvesting geese and ducks along the Highway, putting additional stress on avian populations. These mortality effects can be mitigated with the implementation of appropriate mitigation measures.

Project Design and Mitigation Measures

The objectives of bird protection activities along the proposed Highway will be to mitigate potentially negative effects on birds in the following general ways:

- Minimize loss of habitat and reductions of habitat effectiveness via Project design;
- Survey material deposits in the summer (June-July) to document use by nesting birds, if any, occurring within the LSA and protect any active nest sites from excavation during periods of construction.
- 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 nesting birds;
- 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 ENR to work together to develop guidelines and conditions for Highway usage and follow-up with monitoring of harvesting activities.

Table 4.2.7-13 presents the types of mitigation measures that will be integrated into the Project design, construction and anticipated future operational practices to reduce or minimize potential impacts of the proposed Highway on birds.

In addition to Project mitigation measures, the WMAC, IGC and HTCs, could consider the establishment of a no-hunting zone along the proposed Highway as a public safety consideration to address human safety concerns that arise from hunting from roadways.

TABLE 4.2.7-13: MITIGATION MEASURES FOR BIRDS AND BIRD HABITAT

Project Activity	Potential Effect	Mitigation Measures
Off-site Activities	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 the 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. • Workers will avoid conducting Project activities within 500 m of an active raptor nest during nesting season. • • Wildlife monitors will be on-site during construction to monitor bird and manage risks. • If a key nesting feature of a Species at Risk is discovered, both ENR and CWS will be contacted. Activities will be temporarily suspended pending consultation with these agencies.
Waste Storage	Poorly secured waste can blow off site and pose risk of mortality to nearby nesting or foraging songbirds, shorebirds and waterfowl.	• All waste products will be properly secured, stored and transported. • 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.
Workers/ Vehicle/ Equipment Use	Interactions between birds and workers/equipment may cause incidents or mortality.	• During construction, the presence of birds on the proposed Highway is to be communicated to other drivers. • Construction and maintenance vehicles will stop or reduce speeds when birds are on the road or near the road, respectively. • Vehicle speeds during construction and post construction in strategic areas will be regulated to reduce the potential of bird mortality due to collisions. • Bird advisory signs will be placed along the Highway, as needed. • No hunting by Highway construction and maintenance workers.
Vehicle/ Equipment Use and Refueling	Spills or leaks may harm birds.	• Spill contingency plans will be implemented to prevent and address leaks and spills. • All vehicles and equipment will be refueled at least 100 m from waterbodies. • 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. • All spills greater than 5 litres will be reported to the GNWT Spill Line and other appropriate agencies. • The spill area will be monitored closely and appropriate deterrents (e.g., warning noises, flagging) employed to discourage birds from entering the affected area.

TABLE 4.2.7-13: MITIGATION MEASURES FOR BIRDS AND BIRD HABITAT		
Project Activity	**Potential Effect**	**Mitigation Measures**
Construction	Structures erected during the nesting period could become potential habitat.	• Structures will be designed to minimize or prevent potential to be utilized as nesting structures. If nesting occurs they would not be disturbed until after the birds have left the area.
Construction	Active birds nests may be destroyed during borrow pit excavation in summer.	• Conduct pre-disturbance bird nest surveys June-July to document use by nesting birds in areas proposed for summer construction work.

Source: Adapted from GNWT DOT (2009).

Table 4.2.7-14 outlines mitigation measures for bird Species at Risk. Species that may occur within the Project corridor that are protected by SARA include 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).

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 Highway construction and borrow source work. The mitigation measures outlined in Table 4.2.7-14 will be implemented in addition to Table 4.2.7-13 (Mitigation Measures for Birds) to mitigate potential effects on bird Species at Risk.

TABLE 4.2.7-14: SUMMARY OF MITIGATION MEASURES FOR BIRD SPECIES AT RISK		
Bird Species	**Activity/Potential Effect**	**Mitigation Measure**
Eskimo Curlew **Rusty Blackbird** **Short-eared Owl**	Birds may be at risk of mortality from leaks and spills.	•• In the event of a spill, all efforts will be made to properly contain and manage the spill, including bird removal and treatment if necessary.
	Nests may be abandoned due to disturbance from Project activities.	• 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).
Peregrine Falcon	Birds can collide with wires, especially during the migration period.	• Guy wires will not be used.

TABLE 4.2.7-14: SUMMARY OF MITIGATION MEASURES FOR BIRD SPECIES AT RISK		
Bird Species	**Activity/Potential Effect**	**Mitigation Measure**
	Lights 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. Lights will be turned off, whenever possible (e.g., when personnel are not at camps or other facilities).
	Disturbance to Peregrine Falcon nesting during construction or borrow source activities.	• An aerial survey will be conducted along the final route and proposed borrow sources to determine if nests are present. • Appropriate federal (CWS) and territorial (ENR) authorities will be contacted immediately before continuing work if a Peregrine Falcon nest is identified within predetermined set-back distances (as determined through consultation with CWS/ENR).

Residual Effects

Table 4.2.7-15 and 4.2.7-16 provides a summary of residual effects for birds and bird habitat in the LSA and RSA respectively. The loss of bird habitat due to the development of the proposed Highway is small (less than 0.10% of the RSA). In the context of both the LSA and the RSA, this amount of habitat loss is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low. Careful planning and design of the Highway corridor to avoid habitats such as wetlands where waterfowl and other wildlife are known to congregate will mitigate impacts on waterfowl populations.

Effects of habitat degradation, which is primarily related to reduction in food and nest site availability, is considered low in magnitude, local in extent and lasting the life of the Project resulting in a consequence rating of low for both the LSA and RSA.

Disturbance from operational activities will be variable depending upon species and time of year but will, regardless, influence bird behaviour and energy budgets. Disturbance will be limited to only those birds immediately adjacent to the proposed Highway and thus a very small fraction of the surrounding population. The net habitat and disturbance effects from the proposed development are expected to apply only to the local individuals and are therefore low in consequence at the local population level with no residual effects.

The majority of construction for the proposed Highway and excavation of the associated borrow sources will occur during the winter period, a time when few birds, are present. Consequently, impacts from construction activities will be mainly temporary and limited.

With the application of mitigation measures, increased mortality as a result of the Highway is expected to be low in magnitude and local in extent, with isolated occurrences over the life of the Project for a consequence rating of low for both the LSA and RSA.

TABLE 4.2.7-15: RESIDUAL EFFECTS ASSESSMENT FOR BIRDS AND BIRD HABITATS IN THE LSA

<table>
<tr><th rowspan="2">Description of Residual Effect (after Mitigation)</th><th colspan="6">Evaluation of Residual Effect</th><th rowspan="2"></th></tr>
<tr><th>Magnitude</th><th>Geographic Extent</th><th>Duration</th><th>Frequency</th><th>Reversibility</th><th>Likelihood</th></tr>
<tr><td>Habitat Loss</td><td>Low</td><td>Local</td><td>Long-term</td><td>Continuous</td><td>Reversible Long-term</td><td>High</td><td><table><tr><td rowspan="4">Magnitude</td><td colspan="5">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td>X</td><td></td></tr><tr><td></td><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Habitat Degradation</td><td>Low</td><td>Local</td><td>Medium-term</td><td>Periodic</td><td>Reversible Long-term</td><td>High</td><td><table><tr><td rowspan="4">Magnitude</td><td colspan="5">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td>X</td><td></td></tr><tr><td></td><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Disturbance</td><td>Moderate</td><td>Local</td><td>Medium-term</td><td>Periodic</td><td>Reversible Long-term</td><td>Moderate</td><td><table><tr><td rowspan="4">Magnitude</td><td colspan="5">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td>X</td><td></td><td></td></tr><tr><td>L</td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
<tr><td>Mortality</td><td>Low</td><td>Local</td><td>Medium-term</td><td>Isolated</td><td>Reversible Short-term</td><td>Moderate</td><td><table><tr><td rowspan="4">Magnitude</td><td colspan="5">Consequence</td></tr><tr><td>H</td><td></td><td></td><td></td><td></td></tr><tr><td>M</td><td></td><td></td><td></td><td></td></tr><tr><td>L</td><td></td><td>X</td><td></td><td></td></tr><tr><td></td><td></td><td>S</td><td>M</td><td>L</td><td>I</td></tr><tr><td></td><td></td><td colspan="4">Duration</td></tr></table></td></tr>
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TABLE 4.2.7-16: RESIDUAL EFFECTS ASSESSMENT FOR BIRDS AND BIRD HABITATS IN THE RSA

Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Habitat Loss	Low	Local	Long-term	Continuous	Reversible Long-term	High
Habitat Degradation	Low	Local	Medium-term	Periodic	Reversible Long-term	High
Disturbance	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate
Mortality	Low	Local	Medium-term	Isolated	Reversible Short-term	Moderate

Consequence – Habitat Loss

Magnitude	S	M	L	I
H				
M				
L			X	

Duration

Consequence – Habitat Degradation

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

Consequence – Disturbance

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

Consequence – Mortality

Magnitude	S	M	L	I
H				
M				
L		X		

Duration

4.3 HUMAN ENVIRONMENT COMPONENTS

The purpose of this section is to present the current socio-economic conditions in the communities affected by the Project, and identify potential effects, mitigation measures, and residual effects from the construction and operation of the Inuvik to Tuktoyaktuk Highway. The Highway will be the first all-weather road connecting southern Canada to the Beaufort Sea. It is expected to provide substantial socio-economic benefits at the local, regional and national levels.

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

The Valued Socio-Economic Components (VSCs) identified for this EIS include:

- Land and resource use by the Inuvialuit;
- Areas of special ecological and cultural importance;
- Land designation areas (as per IFA and CCPs);
- Tourism, commercial and public recreational use; and
- Heritage and archaeological sites.

Table 4.3-1 summarizes the effects identified for the VSCs.

TABLE 4.3-1 VALUED SOCIO-ECONOMIC COMPONENT ASSESSMENT SUMMARY

Valued Socio-Economic Component	Potential Effect	Affected Areas	Duration	Magnitude	Likelihood	Capacity to Manage Effect
Land and Resource Use by the Inuvialuit	Beneficial/ Adverse	Tuktoyaktuk Inuvik ISR	Long-term	Moderate/ Low	Moderate/ Moderate	Territory and ISR partners have the capacity to manage
Areas of Special Ecological and Cultural Importance	Neutral	Tuktoyaktuk Inuvik ISR	Long-term	Low	Moderate	Territory and ISR partners have the capacity to manage
Land Designation Areas (as per IFA and CCPs)	Adverse	Tuktoyaktuk Inuvik ISR	Long-term	Low	Low	Territory and ISR partners have the capacity to manage
Tourism, Commercial and Public Recreational Use	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	High	High	Territory, municipalities and ISR partners have the capacity to manage
Heritage and Archaeological Sites	Neutral	Tuktoyaktuk Inuvik ISR	Short-Term	Negligible	High	Territory, municipalities and ISR partners have the capacity to manage

It was noted that there are both beneficial and adverse effects potentially associated with land and resource use, as a result of the construction of the Highway. Year-round access between communities provides great benefits; however, many people identified during consultation the potential adverse indirect effects related to increased harvesting due to greater access.

Table 4.3-2 summarizes the predicted socio-economic effects for other socio-economic components assessed within the Human Environment section.

TABLE 4.3-2 SOCIO-ECONOMIC ASSESSMENT SUMMARY

Socio-Economic Component	Effect	Affected Areas	Duration	Magnitude	Likelihood	Capacity to Manage Effect
Regional Economy	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	High	High	Territory, municipalities and ISR partners have the capacity to manage
Infrastructure	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	Moderate	High	Territory, municipalities and ISR partners have the capacity to manage
Individual, Family and Community Wellness	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	Moderate	High	Territory, municipalities and ISR partners have the capacity to manage
Traditional Cultures	Beneficial	Tuktoyaktuk Inuvik ISR	Long-term	Moderate	Moderate	Territory and ISR partners have the capacity to manage

4.3.1 Demographics

4.3.1.1 Potential Effects

The populations in the Project area are not anticipated to increase to any great extent as a result of the Highway construction and operation. The Developer is committed to hiring local, regional, and NWT residents, where possible, to fill construction and operation positions, and anticipates that the majority of the labour supply will come from the communities of Tuktoyaktuk or Inuvik. In past years, many Inuvialuit have moved away from the ISR to other regions for employment opportunities. During the Tuktoyaktuk to Source 177 Access Road construction, approximately 70% of the workers were from local communities. It is estimated that with additional training, a similar percentage may be achieved for the Inuvik to Tuktoyaktuk Highway.

Many Inuvialuit living in other regions returned to the ISR to work on the Tuktoyaktuk to Source 177 Access Road. Based on this, some in-migration to these communities by returning residents is anticipated, in addition to the reduction in levels of out-migration as more opportunities for local and regional employment become available, particularly during the construction phase.

A limited number of people may move to Tuktoyaktuk or Inuvik to fill indirect and induced employment opportunities in other goods and services sectors during the construction and/or operations phase of the Highway.

The completed Highway will increase accessibility to the Hamlet of Tuktoyaktuk. Although the population of Tuktoyaktuk has been slowly decreasing since 1996, it is possible that once the Highway is established, Tuktoyaktuk could maintain or increase its population (GNWT Bureau of Statistics 2009a).

However, it is also possible for Tuktoyaktuk to experience an increase in out-migration once the Highway is constructed, as residents could seek employment in Inuvik or other communities; however, this is thought to be less likely due to the connection that residents have with their home community. As noted by the school principal, "Kids in Tuk really like Tuk, I don't see many people leaving" (R. Mahnic, Principal, Inuvik Secondary School, pers. comm., January 25, 2011).

In Inuvik, the population has steadily increased since 1996, and is projected to continue to increase in the future (GNWT Bureau of Statistics 2009b). The Highway is not likely to significantly affect Inuvik's projected growth rate. A minimal increase may occur as a result of in-migration of Tuktoyaktuk residents seeking employment, or from a potential increase in attendance at Aurora College by Tuktoyaktuk residents taking advantage of the improved accessibility. "The school (Samuel Hearne Secondary) may gain a couple of new students as a result of an increased number of parents from Tuk attending programs at Aurora College" (R. Mahnic, Principal, Inuvik Secondary School, pers. comm., January 25, 2011).

Project Design and Mitigation Measures

Government agencies and Inuvialuit organizations responsible for education, housing and other infrastructure regularly assess demographic trends in ISR communities. The anticipated changes in population caused by the Highway are anticipated to be minimal. No additional mitigation measures related to possible demographic shifts are required.

Residual Effects

Negligible changes regarding in/out migration are anticipated.

4.3.2 Regional and Local Economies

Economics are considered an important component of this EIS because of the potential effects that the Highway may have on the local and regional economies, quality of life, and future economic development opportunities.

Predicted effects are derived from baseline conditions, discussions with government agencies and Inuvialuit organizations, and an economic analysis commissioned by the GNWT DOT for the construction of the Highway, entitled *Inuvik to Tuktoyaktuk All-Weather Road Economic Analysis* (GNWT DOT 2010a). This report is found in Appendix F.

4.3.2.1 Contribution to Gross Domestic Product and Direct Taxes

Four economic effects of the Highway were assessed in this report:

- Building and maintaining the all-weather Highway;
- Reduction in the cost of living;
- Increase in tourism activity; and
- Impacts on the Mackenzie Gas Project and related natural gas field exploration and development in the Delta Region.

Economic effects may be singular (short term) or annual (long term). The effects of construction activities, for example, are singular as they effectively end when construction is completed. However, the effects of maintenance, cost of living, tourism, and natural gas development may exact annual effects. To convert the annual effects into a single impact value, annual impacts are calculated over a defined lifespan minus a discounted rate (to account for risk and time value). This comparison of future value to today's value is referred to as *Net Present Value*. In this case, the net present value is calculated over a 45-year time-period and discounted at 5% (GNWT DOT 2010a).

The effects of the Highway are anticipated to occur during both the construction and operations phases and to have both direct and indirect significant beneficial effects. *Direct effects* include the employment created and the goods and services required by the Highway's construction. These effects are associated with supplying major Project components and direct capital outlays by construction contractors. *Indirect effects* are the "ripple effect" of secondary employment and purchases. These effects are associated with the companies that supply goods and services to construction contractors. *Induced effects* are tertiary in nature (e.g., the Developer will pay construction employees salaries, which are re-spent in the economy generating further economic activity in sectors such as retail, restaurants etc.).

Highway construction is likely to result in the following categories of effect:

- Employment and revenue;
- Construction;
- Annual maintenance (during the operations phase);
- Loss of annual winter road construction;
- Cost of living;
- Tourism activity; and
- Oil and gas exploration and development.

Although the initial construction of the Highway is expected to cost the Federal and Territorial government about $230 million, after subtracting the increase in government revenues resulting from the existence of the Highway, the net cost to the Federal and Territorial government will be in the order of $183 million ($230 million minus total tax revenues of $47 million). When all of the economic spin-offs (direct, indirect and induced impacts) are accounted for over the 45-year life of the Highway, this capital investment is expected to create about $248 million in net purchases of goods and services (e.g., material inputs) in the NWT and an additional $97 million in the rest of Canada (GNWT DOT 2010a).

The revenues generated from Highway construction will translate into a net increase in gross domestic product (GDP) in the NWT of about $186 million and an increase in GDP in the rest of Canada of about $84 million. Highway construction will create 1,086 one-time jobs in the NWT and another 860 one-time jobs in the rest of Canada. In addition, Highway construction is expected to create 42 long-term jobs in the NWT and another nine in the rest of Canada. Building the Highway is predicted to earn the Federal and Territorial governments almost $36 million from activities in the NWT and an additional $11 million accruing to governments in the rest of Canada (GNWT DOT 2010a).

Table 4.3.2-1 summarizes the total anticipated economic effect (net present value) of the Highway, excluding oil and gas exploration, over an assumed 45-year lifespan.

TABLE 4.3.2-1: TOTAL ECONOMIC EFFECTS OF THE HIGHWAY (EXCLUDING THE MACKENZIE GAS PROJECT)

Total Net Present Value Effects	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$341,073,370	$75,080,810	$70,901,410	**$421,282,220**	$176,496,770
Material Inputs	$166,941,842	$37,690,952	$43,790,746	**$248,423,540**	$96,970,502
GDP	$127,490,287	$35,281,884	$23,240,519	**$186,013,690**	$84,166,547
Employment (construction) (FTE)	668.3	282.0	135.5	**1,085.8**	859.6
Employment (operations) (FTE)	33	7	3	**42**	9
Wages & Salaries	$82,818,283	$20,148,005	$12,654,482	**$115,621,770**	$44,008,660
Benefits	$5,891,974	$1,502,418	$935,318	**$8,658,710**	$5,431,783
Total Gov't Revenues	$24,468,549	$5,373,043	$4,748,718	**$35,590,310**	$10,966,205
Federal	$14,815,632	$2,938,243	$2,424,744	**$20,179,620**	$6,062,648
Net Indirect Income	$2,191,603	$435,667	$560,351	**$3,187,290**	$1,007,001
Personal Income Taxes	$12,626,026	$2,503,908	$1,863,396	**$16,992,330**	$5,056,250
NWT	$9,655,935	$2,443,800	$3,322,955	**$15,412,690**	$4,903,634
Net Indirect Taxes	$3,646,570	$1,404,718	$2,462,493	**$7,513,780**	$2,914,649
Personal Income Taxes	$6,013,360	$1,028,082	$857,468	**$7,898,910**	$1,988,431

Source: GNWT DOT (2010a)

Several spin-off socio-economic effects are anticipated from the Highway construction. These effects are partially the result of increased economies of scale that the Highway will generate. The effects are summarized as follows (GNWT DOT 2010a):

- Increased regional and territorial economic development due to greater efficiency and reliability of the highway network and reduced transportation costs;
- Reduced sense of isolation due to improved connections between Inuvik and Tuktoyaktuk;
- Improved access to government services and employment opportunities;
- Increased opportunities for Northern and Aboriginal training, employment, business development and equity investment;
- Attraction of new investment from outside the area (i.e., companies relocating to a given area);
- Retention of existing companies in area;
- Improvement of the import substitution and export success of companies located in the area by the provision of overland transport links to key markets;
- Enhancement of the competiveness of the regional economy and thereby reducing storage, warehousing and medical travel costs; and
- Increased opportunities for social and cultural interaction and development through reduced isolation, increased mobility, and expanded learning and training opportunities.

Employment and Revenue

Construction

During the construction phase, temporary effects that are significant and beneficial are anticipated. Construction activities create a demand for goods and services that create both direct and indirect impacts. Several studies have been conducted on the economic effects of constructing the Highway, including *Mackenzie Valley All-Weather Road Opportunity Assessment* (Meyers Norris Penny LLP 2007) and *Socio-Economic Literature Review of the Impact of Linear Developments in the Northwest Territories* (Nichols Applied Management and Knopp 2010). While the total value of labour income varies with each study, a significant net gain is predicted in association with Highway construction.

Table 4.3.2-2 summarizes the economic effects of Highway construction, as estimated by GNWT DOT (2010a). While the majority of economic effects will occur in the NWT, the rest of Canada will also be affected. The economic effects of the Highway construction are based on an initial investment of $230 million.

TABLE 4.3.2-2: ECONOMIC EFFECTS OF HIGHWAY CONSTRUCTION

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Direct and Indirect.
Output	$230,000,000	$55,928,500	$49,630,720	**$335,559,220**	$157,787,352
Material Inputs	$138,553,140	$29,545,230	$32,905,170	**$201,003,540**	$84,740,348
GDP	$91,446,860	$26,383,280	$16,725,550	**$134,555,690**	$73,047,004
Employment (FTE)	668.3	282.0	135.5	**1,085.8**	859.6
Wages & Salaries	$61,277,480	$15,012,190	$9,162,100	**$85,451,770**	$37,857,452
Benefits	$4,238,680	$1,089,250	$664,780	**$5,992,710**	$4,667,674
Total Gov't Revenues	$18,701,490	$3,997,460	$4,206,360	**$26,905,640**	$9,522,410
Federal	$11,801,440	$2,226,930	$1,761,250	**$15,789,620**	$5,269,710
Net Indirect Income	$1,622,000	$317,340	$414,950	**$2,354,290**	$893,430
Personal Income Taxes	$10,179,440	$1,909,590	$1,346,300	**$13,435,330**	$4,376,280
NWT	$6,900,050	$1,770,530	$2,445,110	**$11,115,690**	$4,252,700
Net Indirect Taxes	$1,882,650	$976,370	$1,725,760	**$4,684,780**	$2,531,360
Personal Income Taxes	$5,017,400	$794,160	$619,350	**$6,430,910**	$1,721,340

Source: GNWT DOT (2010a)

Maintenance

Ongoing economic effects will occur following Highway construction arising from required annual maintenance. Unlike the economic effects of the construction phase, which are one-time impacts, operations and maintenance effects carry on for the life of the Highway and have a long-term effect on the economy. The annual economic effects of Highway maintenance, as estimated by GNWT DOT (2010a), are summarized in Table 4.3.2-3.

TABLE 4.3.2-3: ANNUAL ECONOMIC EFFECTS OF HIGHWAY MAINTENANCE	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$1,957,500	$569,210	$570,537	$**3,097,247**	$712,682
Material Inputs	$950,195	$376,302	$378,270	$**1,604,767**	$345,788
GDP	$1,007,305	$292,908	$192,272	$**1,492,485**	$366,895
Employment (FTE)	13.6	4.0	1.6	**19.2**	4.9
Wages & Salaries	$620,983	$180,572	$104,037	$**905,592**	$201,242
Benefits	$53,295	$15,497	$8,930	$**77,722**	$24,435
Total Gov't Revenues	$158,006	$45,946	$45,903	$**249,855**	$46,550
Federal	$82,477	$23,983	$19,591	$**126,051**	$25,680
Net Indirect Income	$10,008	$2,910	$4,397	$**17,315**	$2,980
Personal Income Taxes	$72,469	$21,073	$15,194	$**108,736**	$22,700
NWT	$75,529	$21,963	$26,312	$**123,804**	$20,870
Net Indirect Taxes	$47,025	$13,674	$19,349	$**80,048**	$11,940
Personal Income Taxes	$28,504	$8,289	$6,963	$**43,756**	$8,930

Source: GNWT DOT (2010a)

GNWT DOT (2010a) also calculated the net present value of Highway maintenance, based on a 45-year period discounted at 5%. Over this period the total GDP contribution of maintenance activities will be $27 million and government revenues will be $4.4 million to the NWT. The contribution to the rest of Canada will be $6.5 million in GDP and $827,000 in government revenues.

This new transportation infrastructure will make accessing markets in the NWT easier, facilitating regional trade. New business opportunities in harvesting, preparation, packaging and marketing local products could be generated, thereby adding diversity to the local and regional economies (Nichols Applied Management et al. 2010).

Loss of Annual Winter Road Construction

Building the Highway will eliminate the need to construct the winter road to Tuktoyaktuk each year. There will be cost savings and a reduction in economic activity associated with the purchase of goods, services, and the hiring of labour for the annual construction and maintenance of the winter road.

Table 4.3.2-4 summarizes the reduction in annual economic effects created by eliminating winter road construction.

TABLE 4.3.2-4 ANNUAL ECONOMIC EFFECTS FROM LOSS OF INUVIK TO TUKTOYAKTUK WINTER ROAD

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$128,650	$29,988	$26,758	$**185,396**	$91,619
Material Inputs	$78,790	$15,916	$17,740	$**112,446**	$49,326
GDP	$49,860	$14,073	$9,018	$**72,951**	$42,293
Employment (FTE)	0.4	0.1	0.1	**0.6**	0.5
Wages & Salaries	$33,326	$7,886	$4,947	$**46,159**	$21,818
Benefits	$1,951	$560	$351	$**2,862**	$2,693
Total Gov't Revenues	$10,329	$2,119	$2,273	$$**14,721**	$5,260
Federal	$6,514	$1,175	$952	$**8,641**	$2,920
Net Indirect Income	$954	$170	$224	$**1,348**	$390
Personal Income Taxes	$5,560	$1,005	$728	$**7,293**	$2,530
NWT	$3,815	$944	$1,321	$**6,080**	$2,340
Net Indirect Taxes	$3,815	$525	$986	$**2,579**	$1,350
Personal Income Taxes	$2,474	$419	$335	$**3,501**	$990

Source: GNWT DOT (2010a)

Over the assumed 45-year lifespan of the Highway, the net present value losses in the NWT are estimated at $1.3 million to the GDP and $253,000 in government revenues; net present value losses for the rest of Canada are estimated to be $726,000 in GDP and $90,000 in government revenues.

Cost of Living

The Highway is expected to contribute to a reduction in the cost of shipping goods to Tuktoyaktuk. Lower prices mean residents will be able to buy more goods with the same amount of income, thereby effectively increasing their standard of living.

Prices in Tuktoyaktuk are approximately 10% higher than in Inuvik (GNWT Bureau of Statistics 2005, as cited in GNWT DOT 2010a). The Highway would reduce overall prices, reduce the cost of food, increase the variety of goods and services available to Tuktoyaktuk residents, and make those goods and services available year round.

GNWT DOT (2010) estimates that the community of Tuktoyaktuk receives approximately 160,000 lb of food each year, delivered by the federal government-sponsored Food Mail program. At a cost of $3/lb for air delivery between Inuvik and Tuktoyaktuk, it costs approximately $480,000 per year in food delivery costs. With the construction of the Highway, food can be delivered by truck to Tuktoyaktuk from Inuvik at $0.15/lb (or $24,000). Once the Highway is operational, it is assumed that food costs in Tuktoyaktuk will more closely reflect the prices in Inuvik. Food transportation logistics would transition from air cargo and barge to trucks, resulting in the loss of $456,000 in indirect expenditures, and lower food prices in Tuktoyaktuk. The money residents would save on food purchase would increase their disposable income, resulting in an increase in the general standard of living in the hamlet.

With the Highway in place, it is anticipated that some residents of Tuktoyaktuk would drive to Inuvik to shop where more goods and services are available (e.g., medical and dental services, restaurants, etc.). "Inuvik has shopping, some cheaper prices and banking. There is no bank in Tuktoyaktuk. People currently send banking with people going to Inuvik or by mail" (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). GNWT DOT (2010a) calculated an overall savings of $1.0 million to local residents as a result of the Highway being constructed (excluding extra vehicle costs), including savings from the Food Mail Program.

The combined (positive) effects of reduced cost of goods and the (negative) effects related to the possible reduction of the Food Mail program on flight transport are summarized in Table 4.3.2-5.

TABLE 4.3.2-5 NET TUKTOYAKTUK CONSUMER SAVINGS WITH THE HIGHWAY

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$1,044,00	-$37,928	$86,231	**$186,903**	-$207,491
Material Inputs	-$148,940	-$54,629	$57,170	**-$146,099**	-$108,409
GDP	$287,240	$16,691	$29,057	**$332,988**	-$99,082
Employment (FTE)	1.2	0.1	0.2	**1.6**	-1.3
Wages & Salaries	$126,622	$574	$16,423	**$153,619**	-$53,719
Benefits	-$1,480	-$942	$643	**-$1,779**	-$7,263
Total Gov't Revenues	$53,865	-$1,309	$7,614	**$60,170**	-$14,360
Federal	$27,661	-$32	$3,196	**$30, 825**	-$7,530
Net Indirect Income	$3,681	$187	$745	**$4,613**	-$1,380
Personal Income Taxes	$23,980	-$219	$2,451	**$26,212**	$-6,830

TABLE 4.3.2-5 NET TUKTOYAKTUK CONSUMER SAVINGS WITH THE HIGHWAY

	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
NWT	$26,204	-$1,277	$4,418	**$29,345**	-$6,830
Net Indirect Taxes	$14,055	-$1,106	$3,284	**$16,233**	-$4,410
Personal Income Taxes	$12,149	-$171	$1,134	**$13,112**	-$2,420

Source: GNWT DOT (2010a)

Tourism Opportunities

GNWT DOT (2010) estimates that the total number of tourists to visit the Inuvik-Beaufort-Delta region would increase by about 10% to 5,500 tourists per year with the construction of the Highway. The increased number of visitors is anticipated to spend an additional $1,467,500 in the region.

The average stay per visitor is 4.5 days. With the Highway completed, it is estimated that average visitor days would increase by 1.5 days with easier access to other communities, resulting in an additional 4,125 tourist days per year in the region and additional spending of $1,237,500.

According to Ms. J. Venaas (Regional Tourism Manager, GNWT ITI, pers. comm., January 12, 2011), some tourists are drawn to Tuktoyaktuk because of the ice road, made popular by the television series “Ice Road Truckers”. The exposure has increased the number of tourist visits to both Aklavik and Tuktoyaktuk. The absence of the ice road to Tuktoyaktuk could result in increased tourism in Aklavik where a winter road would still be in use (J. Venaas, Regional Tourism Manager, GNWT ITI, pers. comm., January 12, 2011).

Other tourism industries such as air-based travel to Tuktoyaktuk could also be affected by the new Highway. The Highway may reduce flight-based operations as tourists can drive to Tuktoyaktuk in one day from Inuvik. Conversely, “the Highway may open new forms of tourism, more bus-focused than plane” (J. Venaas, Regional Tourism Manager, GNWT ITI, pers. comm., January 12, 2011).

Inuvik Tourism Coordinator for the Town of Inuvik, Darlene Burden, also noted that the Highway would likely have a positive effect on tourism in the region overall, including Inuvik (pers. comm., February 2, 2011). Table 4.3.2-6 summarizes the projected annual economic effects on tourism.

TABLE 4.3.2-6: ECONOMIC EFFECTS OF INCREASED AND LENGTHENED TOURIST VISITATIONS					
	NWT				Rest of Canada
	Direct	Indirect	Induced	TOTAL	Dir. + Indir.
Output	$2,705,000	$424,402	$467,084	$**891,486**	$856,477
Material Inputs	$831,158	$226,864	$309,670	$**1,367,692**	$459,685
GDP	$873,373	$197,538	$157,406	$**1,228,317**	$396,792
Employment (FTE)	18.0	2.7	1.3	**21.9**	5.8
Wages & Salaries	$533,599	$105,942	$85,344	$**724,885**	$221,230
Benefits	$43,997	$8,864	$7,138	$**59,999**	$25,573
Total Gov't Revenues	$138,770	$30,340	$37,204	$**206,314**	$54,410
Federal	$73,782	$15,460	$15,995	$**105,237**	$29,420
Net Indirect Income	$21,015	$3,613	$3,520	$**28,148**	$5,040
Personal Income Taxes	$52,767	$11,847	$12,475	$**77,089**	$24,380
NWT	$64,988	$14,880	$21,209	$**101,077**	$24,990
Net Indirect Taxes	$44,233	$10,220	$15,488	$**69,941**	$15,400
Personal Income Taxes	$20,755	$4,660	$5,721	$**31,136**	$9,590

Source: GNWT DOT (2010a)

Over the life of the Highway, the net present value of economic effects from tourism is estimated at $21 million with $3.5 million in GDP increases and government revenue, for the NWT; the effect on the rest of Canada is expected to be $7 million in GDP and $1 million in government revenues.

Effects Related to the Mackenzie Gas Project

When the GNWT DOT (2010a) conducted an analysis of the proposed Mackenzie Gas Project, they concluded that constructing the Highway would not significantly affect the overall cost of the pipeline but that some savings could be realized in future exploration and development. These savings stem principally from a reduction in logistic costs associated with more efficient use of leased drilling rigs, camps, and related support equipment. There was also a reduction in risk costs by not carrying excess inventory and competing for scarce resources. Concurrently, the existence of an all-weather Highway facilitates the movement of rig equipment from southern Canada during the non-drilling season, rather than storing rig equipment and incurring storage costs and extended rig rental costs.

GNWT DOT (2010a) analysed the economic effects of the Highway on exploration and development savings for the three anchor fields of the Mackenzie Gas Project (Niglingtak, Taglu and Parsons Lake). Using oil and gas industry estimates, this analysis assumed there would be a 5% savings in development costs at Niglingtak and Taglu and 10% savings at Parsons Lake (as it is closer to the proposed Highway and more wells are likely to be developed in this area).

Building the Highway would have financial implications for the Mackenzie Gas Project and broader effects on the NWT economy (i.e., economic effects include GDP, incomes, taxes, and employment).

Table 4.3.2-7 summarizes the total economic effects (net present value) of building the Highway on future exploration and development in the region and the potential financial effects on Mackenzie Gas Project.

TABLE 4.3.2-7: TOTAL ECONOMIC AND FINANCIAL EFFECTS RELATED TO MACKENZIE GAS PROJECT[1]

	NWT	Rest of Canada	Total Canada
	All Effects	Dir. + Indir.	
Mackenzie Gas Project Profits (Increase)	$346,452,555		**$346,452,555**
GDP	$91,553,744	-$80,325,032	**$11,228,712**
Employment (construction)	1,028.6	807.5	**1,836.1**
Employment (operations)	-1,085.1	-3,674,9	**-4,760,0**
Labour Income	$80,715,792	-$58,375,168	**$22,340,623**
Total Gov't Revenues	$34,922,135	$5,431,783	**$40,353,918**
Federal	$28,134,698	-$22,760,477	**$5,374,221**
NWT/Other Provinces	$6,787,436	-$10,278,448	**-$3,491,012**

Source: GNWT DOT (2010a)

Note: 1. Net present value.

Project Design and Mitigation Measures

The *Canadian Environmental Assessment Act* defines mitigation as "the elimination, reduction or control of adverse environmental effects of a project". Mitigation measures are applied to minimize potential negative impacts of an effect and are not generally applied to positive effects.

Although it is anticipated that local and regional suppliers, contractors and residents will be able to provide the majority of construction related services, some may be sourced from outside the region. The Developer is committed to preferential employment opportunities for qualified local residents and contractors. The implementation of focused socio-economic measures will be the responsibility of the Developer and on-site contractors.

Residual Effects

The construction and operation of the Highway is expected to have a net positive economic impact in the region.

Residual effects of the Project are anticipated throughout the construction phase when labour demand, capital expenditure and economic stimulus will be greatest. The increased positive economic effects during construction will be significant over the short term (i.e., primarily limited to the estimated four-year construction period and greatest during winter construction months).

During the operations phase there will be some continued employment opportunities and labour benefits as well as maintenance expenditures. Residual effects of increased tourism and increased standard of living are also likely. These effects will be long term but of lesser magnitude than those of the construction phase.

The negative socio-economic effects of the Project are the result of eliminating the need for constructing and operating the ice road each year from Tuktoyaktuk to Inuvik. The predicted annual GDP loss is anticipated to be around $73,000, with an annual NWT government revenue loss of $15,000. The air transport industry may see a loss of revenue since goods would be increasingly transported by truck once the Highway is constructed.

Overall, no significant adverse economic effects are anticipated because of this Project. Economic effects will generally increase to the benefit of the region with large magnitude and short duration during construction or with small magnitude and long duration during operations.

4.3.2.2 Available Labour Supply, Participation, and Income Assistance

Potential Effects

The number of workers required by occupation or skill will be determined during the detailed design phase of this Project. Typical types of work and skills involved in highway construction include: surveying, environmental and wildlife monitoring, environmental field studies, heavy duty equipment operators, truck drivers, heavy duty mechanics, and camp personnel. Depending on the occupation, work is likely to be seasonal full-time (i.e., heavy duty equipment operator) or on a per project basis (i.e., environmental field studies). Consultants will be retained to complete the engineering design for the Project.

Table 4.3.2-8 describes the potential available labour supply in the Project area (as of 2009). Potential available labour supply is defined as those persons who are of employment age, but are not currently employed, and can be classified according to those willing to do rotational work, gender, ethnicity, or level of schooling (GNWT Bureau of Statistics 2009a,2009b).

TABLE 4.3.2-8: POTENTIAL AVAILABLE LABOUR SUPPLY, 2009	Inuvik	Tuktoyaktuk
Number of Unemployed	391	221
% Willing to Do Rotational Work	41.2	62.4
% Male	47.1	61.5
% Aboriginal	84.9	92.8
% Less than High School Diploma	59.3	73.8

Source: GNWT Bureau of Statistics (2009a, 2009b)

During the Tuktoyaktuk to Source 177 Access Road construction, approximately 70% of the workers were from local communities. With additional training, a similar hiring percentage may be achieved for the Inuvik to Tuktoyaktuk Highway based on the available labour pool.

In the ISR, men typically comprise the majority of employees in the construction industry; this is not expected to change with the construction of the Highway. Both females and males participate in the accommodation and food service industries, with female participation being slightly higher; this trend is not expected to change over the life of the Project.

In Tuktoyaktuk, the employment rate is highest among those aged 45 to 54, while in Inuvik it is highest among those aged 35 to 44. Individuals in these age categories will likely benefit most from the employment opportunities generated by construction of the Highway.

Highway construction may increase household incomes and the participation rate of people employed in the community.

Although the Developer could face competition for employees from other potential projects, no other large scale projects are currently planned in the area during the proposed construction timeframe (2012-2016). The outlook for the development of the proposed Mackenzie Gas Project is yet unknown.

Income assistance provides funds to those in need of housing, food, and clothing. Since 2000, the number of income assistance beneficiaries, cases and payments in Tuktoyaktuk has increased, while the numbers have decreased in Inuvik (Figure 3.2.4-24). New employment opportunities in the construction industry may reduce the number of people on income assistance.

Project Design and Mitigation Measures

The Developer is committed to ensuring that the people of Tuktoyaktuk and Inuvik have preferential employment opportunities to provide employment benefits to the region. The IFA guidelines for business operation will apply to this Project, giving priority hiring to companies included on the Inuvialuit Business List. This will help to provide economic stimulus to the Inuvialuit community. Furthermore, employment opportunities will be available to all residents, male or female, and will likely result in increased seasonal employment during construction.

Residual Effects

Employment opportunities associated with Highway construction and operation will provide greater social stability in the region, new skills, and more construction-related experience, possibly resulting in increased incomes and less reliance on income assistance.

4.3.3 Education, Training and Skills

4.3.3.1 Education and Training Participation Levels

Potential Effects

The Aurora College campus in Inuvik offers a variety of programs with different levels of certification, including several trades training programs (see Table 3.2.4-5). The College also offers upgrading programs (grades 8-12) for adults, and entry level safety training courses (A.M. Picek, Registration, Aurora College, January 26, 2011).

The percent of the population with a high school diploma or more in the NWT, Tuktoyaktuk and Inuvik has increased since 1986, as shown previously in Figure 3.2.4-28 (GNWT Bureau of Statistics 2010k and 2010l). In 1986, 31.6% of Tuktoyaktuk's population had completed high school, compared to 46.1% in 2009. In 1986, 58.7% of Inuvik's population had completed high school, compared to 68.6% by 2009 (GNWT Bureau of Statistics 2010k and 2010l).

In anticipation of upcoming construction work, residents seeking employment may enrol in applicable training programs at Aurora College. As well, several training programs were set up specifically for the construction of the Tuktoyaktuk to Source 177 Access Road and similar training programs could be made available in association with this Project. For example, the contractor conducted a successful heavy equipment operator course while the ILA sponsored an environmental monitor training program. Training local residents will benefit the region since it will contribute to an overall improvement in the skills and capabilities of the local workforce. Enrolment in training and employment programs would depend on the level of interest generated from community members.

Training programs related to Highway construction projects in the ISR will likely benefit males and, particularly, Aboriginal males. In the NWT, men typically participate in the construction industry (as shown previously in Figure 3.2.4-9); therefore, it is likely that more men will participate in the training programs than women. Similarly, since Aboriginal people comprise the majority of the population in both Tuktoyaktuk and Inuvik (as described in Section 3.2.2.2), it is likely that a greater proportion of Aboriginal residents will participate in training opportunities.

The proposed Highway will create year-round access from Tuktoyaktuk to the Aurora College campus in Inuvik. Potentially, more Tuktoyaktuk residents will have improved access to post-secondary education and training, which may contribute to a future increase in the level of education for some Tuktoyaktuk residents.

Project Design and Mitigation Measures

The proposed Highway is expected to increase training opportunities in the region. The Highway will also create year-round access for Tuktoyaktuk residents to attend post-secondary education in Inuvik.

Residual Effects

The proposed Highway will enable interested residents of Tuktoyaktuk to access a higher level of education.

4.3.3.2 Language and Literacy Levels

Potential Effects

Use of Aboriginal languages is declining throughout the NWT including in the Beaufort-Delta region (GNWT ECE 2010c). In a study looking at potential effects of linear developments, the Status of Women Council in the NWT expressed concerns that a large influx of southern workers might diminish Aboriginal language use, culture and sense of identity (Nichols Applied Management and Knopp 2010). However, the Developer is committed to hiring workers from Tuktoyaktuk and Inuvik, where possible. Therefore, the construction of the Highway is not expected to affect the use of indigenous languages spoken in the ISR (Siglitun and Uummarmiutun).

Literacy is an individual's ability to listen, speak, read, write, view, represent, compute and solve problems in one or more of the NWT official languages at levels of proficiency necessary to function in the family, in the community and on the job (GNWT ECE 2008). Without literacy, NWT residents may lack the basic skills to fulfill the jobs being created or meet the entrance requirements of job-specific training programs. According to GNWT ECE (2008), 70% of NWT Aboriginal adults lack the literacy skills to fully participate in society, compared to 30% of NWT non-Aboriginals. To address this, in January 2001, the Government of the Northwest Territories (GNWT) approved Towards Literacy: A Strategy Framework (2001-2005), to fund several literacy initiatives in the NWT. Aurora College, offers Adult Basic Education (ABE) or Adult Literacy and Basic Education (ALBE) programs in Tuktoyaktuk and Inuvik (Aurora College 2009). The Northwest Territories Literacy Council works with individuals and families to promote literacy in all of the official languages of the NWT (NWTLC ND).

The Highway will provide Tuktoyaktuk residents with better access to language and literacy classes, higher levels of education, and cultural events taking place in the region.

Project Design and Mitigation Measures

The proposed Highway is not expected to adversely affect language or literacy in the region. Aurora College and Inuvialuit organizations continue to identify, implement and promote literacy programs in the region. No further mitigation measures are anticipated to be required as a result of the Highway.

Residual Effects

The proposed Highway will enable interested residents of Tuktoyaktuk to access language and literacy programs and higher levels of education.

4.3.4 Infrastructure and Institutional Capacity

4.3.4.1 Transportation Infrastructure

Potential Effects

The Project will significantly improve ground transportation infrastructure between Inuvik and Tuktoyaktuk enabling easier year-round transportation of goods, services, and people between communities and throughout the region. The Highway will also facilitate commercial and recreational access to the region and will link the Dempster Highway to the Beaufort Sea coast, thereby enabling travellers to drive between Canada's west, east and north coasts.

The Highway will allow residents of Tuktoyaktuk access to a broader range of services in Inuvik. "Inuvik has shopping, some cheaper prices and banking. There is no bank in Tuktoyaktuk. People currently send banking with people going to Inuvik or by mail" (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

Virtually all fuel for Tuktoyaktuk is brought in by barge once a year, with the exception of fuel that is trucked to the community during winter if supply is low. E. Gruben's Transport (Gruben's) moves approximately 3.2 million litres of fuel and 700,000 litres of gas annually. With an all-season highway, Gruben's expects that the diesel and gas would be transported by trucks on an as-needed basis to create several benefits:

- Avoids the need to pay for the entire annual fuel supply at once;
- Reduces the need for fuel tanks to hold a one-year supply of fuel for the community;
- Reduces the potential for large-scale accidents and malfunctions associated with the fuel tanks;
- Creates opportunity for cost-savings if fuel can be purchased when prices are lower, rather than once per year (R. Newmark, CEO, E. Gruben's Transport Ltd, pers. comm., December 16, 2010).

Although the Highway may reduce the amount of air traffic between Inuvik and Tuktoyaktuk, effects are anticipated to be temporary. The economic stimulus created by a highway to a previously isolated community, such as Tuktoyaktuk, is expected to create more business for the airline and barge service sectors over the long term (GNWT DOT 2010a).

The Project will improve year-round access between all of the communities in the Delta, benefiting Tuktoyaktuk residents needing improved access to health and social services. Additional positive effects are anticipated related to increased tourism, cheaper goods and services, and less need for inventory storage. Although negative effects are anticipated for the airline and barge service industry over the short term, additional business opportunities will likely be created over the long term in these sectors.

Project Design and Mitigation Measures

No further mitigation measures are anticipated to be needed.

Residual Effects

The proposed Highway is anticipated to positively affect the communities of Tuktoyaktuk and Inuvik by creating year-round access between these communities, which ultimately provides cost-savings and other benefits.

4.3.4.2 Emergency Response and Local Law Enforcement Services

Potential Effects

Very few collisions occur on the Inuvik to Tuktoyaktuk winter road (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011). In the past 13 years, the Inuvik Fire Department has responded to two motor vehicle incidents (J. Miller, Deputy Fire Chief, Inuvik Fire Department, pers. comm., January 13, 2011) while Medic North stated that they have responded to one emergency incident in the past three years (M. Cross, Base Manager, Medic North, pers. comm., January 26, 2011).

Emergencies are responded to by Tuktoyaktuk's and Inuvik's Fire Departments and RCMP detachments. There are currently no official geographic boundaries for response on the winter road by either of the fire departments (J. Miller, Deputy Fire Chief, Inuvik Fire Department, pers. comm., January 13, 2011); however, typically the RCMP in Tuktoyaktuk will respond to emergencies up to 70 km from Tuktoyaktuk, and the Inuvik RCMP and Inuvik Fire Department respond to emergencies up to 110 km from Inuvik. Both the Tuktoyaktuk and Inuvik RCMP will respond if there is a large accident or emergency (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011).

In the northern NWT, Medic North reported that no more than 5-10% of calls are related to highway accidents; most calls are related to accidents involving all-terrain and recreational vehicles (M. Cross, Base Manager, Medic North, pers. comm., January 26, 2011). While a year-round Highway will increase overall traffic volume, which correspondingly may increase the number of emergency incidents, the number of fatal collisions is not anticipated to increase (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011).

The Highway will require monitoring to enforce speed limits and prevent drinking and driving. When the winter road is open, there are an increase in alcohol-related offenses as people have easier access to alcohol in Inuvik; this may partly be due to the road opening just before Christmas and the holiday season (B. Kershaw, Sergeant, Tuktoyaktuk RCMP, personal conversation, January 25, 2011). Several programs are currently available to prevent or treat alcohol and drug abuse.

Project Design and Mitigation Measures

Year-round operation of the Highway will increase the potential for vehicle crashes to occur. The Inuvik Fire Department is in the process of purchasing a new heavy rescue vehicle specifically for highway response. In Tuktoyaktuk, there is a volunteer Fire Department but no trained emergency technicians or ambulance service. No issues were identified with the level of service available during the winter road operation; however, emergency response levels should be monitored and assessed by GNWT Health and Social Services during the operational phase of the Highway.

The RCMP will patrol the Highway, similar to their responsibilities in other jurisdictions in Canada. The effects on RCMP staffing levels are anticipated to be minimal.

Residual Effects

The Highway is not anticipated to materially affect emergency response and local law enforcement capabilities.

4.3.4.3 Medical and Health Care Infrastructure and Services

Potential Effects

Access to increased health care services is expected to improve with the construction of the Highway. The Highway will provide easier and cheaper access to the primary health center and medical transfers between Tuktoyaktuk and Inuvik.

The Highway is also expected to provide easier access to dental services (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 17 & 18, 2011). There are no permanent dentists in Tuktoyaktuk. Residents can wait for a visiting dentist to come to the community, pay to travel to Inuvik by plane or by winter road to receive immediate treatment, or wait for INAC to authorize travel expenses to Inuvik. The period of time for approval varies and may range from a few days to months.

According to IOL et al. (2004), the most serious threats to health in communities continue to be those posed by substance abuse and derivative accidental or violent injuries. Evidence from Health Canada suggests a link between an individual's health status and the degree of control over health services held by community (Nichols Applied Management et al. 2010). By having better transportation access to regional medical and health services, communities and individuals can be more empowered to seek solutions to medical concerns.

It is not anticipated that the proposed Highway will place significant additional pressures on the Rosie Ovayouk Health Centre in Tuktoyaktuk or Inuvik Regional Hospital. For more information on health effects and mitigation measures, see Section 4.3.5 Human Health and Community Wellness.

Project Design and Mitigation Measures

Comprehensive medical and health programs are provided through Beaufort-Delta Health and Social Services programs in cooperation with Medic North and GNWT programs. The opening of the Highway may cause an initial rise in health care demand in Inuvik, but since it is already a regional medical care hub, it is unlikely to require a significant increase in permanent staff to meet the demand.

Residual Effects

Long term, the health conditions for Tuktoyaktuk residents are likely to improve with year-round access to medical and health care services in Inuvik.

4.3.4.4 Social and Community Support Services

Social and community support services is discussed in Section 4.3.5 Human Health and Community Wellness.

4.3.4.5 Education and Recreational Infrastructure and Services

Potential Effects

Educational attainment in the region is anticipated to be positively affected by the Project due to improved, year-round access to post-secondary education services in Inuvik, which could result in a minor increase in the demand for educational facilities and services.

Year-round travel between the two communities will provide access to recreational opportunities for all residents, and in particular, for regional school and youth teams to meet for tournaments, access recreational facilities, and reduce travel costs. Improved access may affect the existing recreational facilities by having more people use them, but this can be seen as a positive benefit associated with promoting family and community health and well-being, along with increased employment in the recreational services industry.

Project Design and Mitigation Measures

Anticipated Project effects include increased access to post-secondary education facilities and recreational facilities. No mitigation measures are anticipated.

Residual Effects

The residual effect on recreation will likely be increased interactions across the ISR which will strengthen communities and increase participation in recreational activities.

4.3.4.6 Water, Sewage and Waste Disposal Infrastructure

Potential Effects

During the construction phase of the Project, water from local lakes will be used to construct the ice roads during winter months. Water for dust management will be drawn from local lakes and streams during the construction and operations phases during summer months.

Most water used during the construction phase of the Project will be drawn from local lakes. A minimal amount of potable water may be trucked from Inuvik and/or Tuktoyaktuk for the construction camps during the winter construction stages.

Sewage generated at the construction camps will be trucked to community sewage lagoons in Tuktoyaktuk or Inuvik. Both facilities currently have capacity for additional wastewater (Town of Inuvik 2006; Earth Tech 2005).

All other camp-related wastes (i.e., garbage, construction debris, etc.) will be transported and disposed of at the Tuktoyaktuk and/or Inuvik municipal solid waste facilities in accordance with the municipalities' terms and conditions. Both Inuvik and Tuktoyaktuk have solid waste facilities that can accommodate the domestic wastes generated from the construction camps during the construction phase.

Project Design and Mitigation Measures

Water withdrawal will conform to the applicable regulatory guidelines and water licence conditions. For wastewater and solid waste, the Developer will:

- Prior to disposal of waste, provide an estimate of the amount and type of domestic waste to the Town of Inuvik and Hamlet of Tuktoyaktuk; and
- Seek approval from the Town of Inuvik and Hamlet of Tuktoyaktuk to use their sewage lagoon and solid waste disposal facilities.

No negative anticipated effects are anticipated for water, wastewater or waste services.

Residual Effects

No residual effects are anticipated.

4.3.4.7 Quarries and Quarry Materials

Potential Effects

As discussed in Section 2.6, construction of the proposed Highway requires granular materials from select borrow sources in the region. Once operational, the Highway will facilitate future access to these material resources for community use and future development.

Project Design and Mitigation Measures

Borrow pit development plans will conform to the applicable regulatory guidelines related to site conditions, temporary access road design, a defined development approach, mitigation measures to address potential environmental concerns, and operational and reclamation plans. Borrow pits will be closed as soon as they are no longer required and reclaimed according to regulatory standards.

Residual Effects

No residual effects are anticipated.

4.3.4.8 Management of Renewable Resources

Renewable resources, such as wildlife, fish, plants and land, are very important for Tuktoyaktuk and Inuvik residents. Sections 4.3.7 (Harvesting) and 4.3.8 (Land Use) discuss potential effects and mitigation measures related to the management of these resources.

4.3.4.9 Service Industry Capacity

Potential Effects

The Highway will have a positive effect on the movement of goods and services, allowing year-round transportation from Inuvik to Tuktoyaktuk. As discussed in Section 4.3.4 (Infrastructure and Institutional Capacity), it will be possible to transport smaller fuel amounts on a year-round basis to the Hamlet of Tuktoyaktuk by truck, thereby reducing current fuel storage requirements and costs.

Food prices in Tuktoyaktuk are more expensive than Inuvik (GNWT Bureau of Statistics 2004a). Moving smaller shipments more frequently should reduce Tuktoyaktuk's food prices to more closely match food prices in Inuvik (GNWT DOT 2010a) and could likely improve the quality of fresh food.

The Highway will permit Inuvik, Tuktoyaktuk and other regionally-based businesses to compete more effectively for resource-related and government business opportunities. Contract work in Tuktoyaktuk may become more competitive, since more companies in the region will have access to Project work (B. Buckle, Senior Administrative Officer, Hamlet of Tuktoyaktuk, pers. comm., February 2, 2011).

New business opportunities may arise in the private sector, from trucking and fuel service stations to tourism and bus transportation services. Women typically participate more than men in service industry employment. New businesses could be expected to create employment opportunities, which are recognized as critical for young people in the ISR (ICC et al. 2006).

Project Design and Mitigation Measures

Although no direct service industry effects are anticipated, several positive induced effects are anticipated.

Residual Effects

The residual effects are enhanced availability of goods and services, particularly in Tuktoyaktuk, and potential increases in service industry positions as a result of the Highway.

4.3.4.10 Housing

Potential Effects

In Tuktoyaktuk and Inuvik, the percentage of households with more than six people has decreased from 1981 to 2009, as shown in Figure 3.2.2-15. In Tuktoyaktuk, the percentage of households with more than six people has decreased from 42.9% in 1981 to 13.0% in 2009 (GNWT Bureau of Statistics 2010e). Similarly, 10.3% of Inuvik households had more than six people in 1981; by 2009, this percentage had declined to 4.5% (GNWT Bureau of Statistics 2010e).

During the Highway construction period, local workers from Tuktoyaktuk and Inuvik will continue to live in their own houses and will be accommodated at the construction camps during their work schedules. By hiring local workers, the Developer will reduce the potential housing pressures that could otherwise be caused by hiring workers from outside the region. Furthermore, the development of the Highway will facilitate the year-round delivery of house construction materials to the community of Tuktoyaktuk.

Project Design and Mitigation Measures

No effects are anticipated for housing and accommodation due to the construction and operation of the Highway.

Residual Effects

No residual effects are anticipated.

4.3.5 Human Health and Community Wellness

The following section is focused on the possible effects to individual, family, and community wellness during the Project construction phase, with higher levels of employment and income, and during the Project operations phase, with improved year-round mobility between communities.

Overall health conditions are expected to improve, particularly in Tuktoyaktuk, due to the presence of the Highway, which will provide easier, lower-cost, and year-round access to the primary health center in Inuvik.

According to IOL et al. (2004), the most serious threats to health in communities continue to be posed by substance abuse and derivative accidental or violent injuries. The Project is not anticipated to create additional pressure on the capacity of the Rosie Ovayouk Health Centre or Inuvik Regional Hospital.

Potential Effects

During consultation with local health staff, it was clear that there are differing opinions as to how the Highway may affect human health and community wellness. In particular, there are two commonly held views regarding the potential links between increased incomes, substance abuse, and violence. The first view is that increased income from Project employment could potentially contribute to substance abuse-related issues, which correspondingly may create additional burdens on social workers who work 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 and choices for individuals, which in turn may improve self-esteem, self-worth and self-sufficiency.

The Head Nurse at the Tuktoyaktuk Health Center, Ms. M. Heffel, suggested that family violence would not likely increase as a result of the Highway. It is generally believed that the occurrence of family violence increases with the availability of alcohol. There is a concern that the Highway will make alcohol more accessible to the people of Tuktoyaktuk.

There is also concern that there may be a rise in sexually transmitted diseases (STD) rates when the Highway is built. According to Ms. Heffel (Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011), "I have seen it happen before in other communities." She also suggested that there appears to be a rise in rates of STDs when the winter road is in operation possibly due to increased access to residents in other communities.

As discussed previously, the Highway is predicted to support the improvement of dental health in Tuktoyaktuk through year-round access to dental services in Inuvik. The GNWT HSS runs a program called "Little Teeth are a Big Deal" for children of all ages to learn about tooth and gum care. Adult dental care is currently supported by visiting dentists to Tuktoyaktuk. In the event of a dental emergency, patients must either pay for travel to Inuvik or seek financial assistance for travel through INAC, which may take days or months for approval. The Highway will provide year-round access to dental health care facilities for the people of Tuktoyaktuk (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011).

The Town of Inuvik has a greater number of available community wellness services than Tuktoyaktuk. The Highway will allow Tuktoyaktuk residents to directly access these services in Inuvik, a likely positive effect. The ability to travel year-round between communities will provide new recreational opportunities for all residents, including students and youth teams, which will be able to use the facilities in Inuvik for practices, games and events more frequently and at lower cost due to reduced transportation costs. Increased access 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.

During consultations with local stakeholders, it was not possible to identify potential effects on the physical, mental and social health of residents of Inuvik due to the Highway, or the perceived changes in residents' quality of life. The health staff stakeholder that Kiggiak-EBA was directed to speak to by several people declined to comment due to discomfort in stating an opinion publicly as it was felt the opinion was biased (Inuvik Public Health Services, pers. comm., January 12, 2011).

In Inuvik, crimes rates typically are highest during the summer months, potentially as a result of the 24 hours of daylight. The RCMP anticipated that crime rates in Inuvik may increase as a result of the Highway. Restrictions in Tuktoyaktuk on the amount of alcohol that residents may possess may cause residents to travel to Inuvik. "Tuktoyaktuk is currently implementing restrictions on the amount of alcohol an individual is permitted to have in possession at one time. The restriction was voted on by the community" (Ben Kershaw, Sergeant, Tuktoyaktuk RCMP, pers. comm. January 12, 2011).

There are specific groups within a community that are more vulnerable to poverty. These groups include: seniors, persons with disabilities, families led by single mothers and single people in general (GNWT ECE 2007). The Highway is anticipated to reduce the cost of living in Tuktoyaktuk, which should positively affect the most vulnerable population and/or slightly reduce the occurrence of poverty in this region.

Attributes of human health and community wellness are related to environmental conditions and food security. As discussed in Sections 4.2.1, 4.2.2 and 4.2.4, the Project is expected to have little or no significant adverse effects on soil, air, or water 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.

Access to traditional food is not only culturally and nutritionally important, it also plays a fundamental role in food security in the north (Lambden et. al. 2007). The presence of the Highway may increase access to harvesting areas that were previously more difficult to access. The effects from increased access to harvesting areas include increased food security and reduced reliance on store-bought food. Further discussion regarding harvesting and access to harvest areas is found in Section 4.3.7.

Project Design and Mitigation Measures

In general, it is predicted that the Highway will improve the Tuktoyaktuk residents' access for to medical and dental health care facilities in Inuvik.

During the construction phase, when economic activity is higher, violence and criminal behaviour is expected to decrease. Over the long term, the primary concern of stakeholders is that the Highway may increase Tuktoyaktuk residents' access to alcohol. Effects related to alcohol and substance abuse may cause spin-off effects such as increased crime and abuse issues, which in turn may affect social workers and RCMP services in the community. The Hamlet of Tuktoyaktuk, with support from community members, is aware of the issues related to alcohol and substance abuse and has taken steps to reduce this.

In Tuktoyaktuk, the community wellness worker and community support workers provide programs for the prevention of alcohol addiction and abuse (M. Heffel, Head Nurse, Rosie Ovayouk Health Centre, pers. comm., January 18, 2011).

The GNWT HSS has existing programs and strategies (i.e., the NWT Sexually Transmitted Infections Strategic Directions) to prevent and control sexually transmitted infections in the NWT.

Residual Effects

The Highway will create long-term, year-round access between Inuvik and Tuktoyaktuk. The benefits include increased access to medical and dental facilities; while the potential risk is increased access to unrestricted amounts of alcohol. Several programs are currently in place to prevent or treat substance abuse issues. Increased interaction between residents of the two communities, youth groups and schools is expected to positively benefit the communities.

Over time, the decrease in the cost of living may positively affect those most vulnerable to poverty and poverty-influenced illness.

4.3.6 Socio-cultural Patterns

Potential Effects

During consultation sessions, it was stated that the Highway will help residents get to their cabins, camps and harvesting sites (Kiggiak-EBA 2010). The improved access is expected to reduce costs and foster participation for family members and across communities.

Cultural and spiritual life is demonstrated through speaking traditional languages and participating in cultural events and ceremonies. The Highway will allow the residents of Tuktoyaktuk to have more contact with residents in other ISR communities and, by extension, from the rest of Canada. There will be more opportunities to participate in cultural events and celebrations, from festivals such as the Beluga Jamboree, Muskrat Jamboree and Great Northern Arts Festival to drum dancing, Northern Games and other traditional activities sponsored across the region.

The Highway could have a positive effect on the transference of traditional language skills, and knowledge of and identification with traditional culture. Residents in Tuktoyaktuk could participate more easily in social and cultural resource support programs, such as those offered through the Inuvialuit Cultural Resource Centre. Increased access may also support the implementation of territorial strategic plans related to language, education, culture and employment (GNWT ECE 2009 and 2010a). As well, the anticipated increase in tourists visiting Tuktoyaktuk and Inuvik will provide new and greater opportunities for the community to market their local crafts.

The proposed Highway is expected to strengthen family ties by providing year-round access between the communities. Tuktoyaktuk, until now, has been relatively isolated from other communities for much of the year, with access only by air and water during periods when the winter road is closed. As one participant noted during a consultation meeting, Elders would like to be able to visit their families but the ice road is not open for long and it is rough (Kiggiak-EBA 2010). The Highway will also help to facilitate sharing and mutual aid among family and community members.

The Highway will serve to increase tourism, which in turn could promote cultural awareness of the Inuvialuit and Gwich'in peoples among tourists from other regions, provinces and territories.

Project Design and Mitigation Measures

No adverse effects are anticipated; therefore, no mitigation measures are recommended.

Residual Effects

Residents are anticipated to have better year-round access to cultural and family activities once the Highway is constructed, as well as cultural support systems and programs.

4.3.7 Harvesting

Potential Effects

Wildlife and land resources are of primary importance to the Inuvialuit, and are used for cultural, traditional, and subsistence purposes. The importance of these resources is recognized by the number of people involved in traditional activities and by the number of people who consume country foods, as previously discussed in Section 3.2.

The presence of the Highway will create year-round access to harvesting areas that were previously accessible only during certain seasons. Increased access could result in increased harvesting activities, which may provide increased access to country foods, increased food security, and reduced cost of living through less reliance on store-bought food. The potential effects related to wildlife from increased harvesting are discussed in Section 4.2.7 (Wildlife and Wildlife Habitat).

The *Inuvialuit Final Agreement* provides the Inuvialuit with specific harvesting rights to wildlife in the ISR. Under the *IFA*, harvested resources are managed through a variety of organizations including:

- Wildlife Management Advisory Council (WMAC) - Northwest Territories (NWT) and North Slope (NS) are responsible for advising government ministers and Inuvialuit agencies on all matters relating to wildlife.
- Fisheries Joint Management Committee (FJMC) is responsible for managing marine mammals and marine and freshwater fisheries in the ISR.
- Inuvialuit Game Council (IGC) is responsible for representing the collective Inuvialuit interest in wildlife and also advising the government.
- Hunters and Trappers Committees (HTC) is responsible for resource allocation and promotion of Inuvialuit involvement in conservation, research, management, enforcement and utilization.
- Inuvialuit Land Administration (ILA) is responsible for the management and administration of access to Inuvialuit private lands. The ILA is also responsible for screening the development proposals on private lands.

During the construction and operation of the Highway, the above mentioned parties will continue to manage resources within the ISR.

Harvesting licenses and restrictions are management tools implemented by co-management boards and the GNWT ENR. Harvesting restrictions are currently in place for certain wildlife species in the NWT including barren-ground caribou and grizzly bears.

With year-round access between communities, competition may increase for harvesters from other communities. Husky Lakes is an important harvesting area accessed by harvesters from Tuktoyaktuk and Inuvik. The Highway will create easier access to this area and competition could occur if harvesters from one community travel to the other community to harvest. At present, harvesters from Tuktoyaktuk and Inuvik can travel between communities during the winter months along the winter road or by skidoo.

No evidence of existing competition during this season was identified during consultation. If necessary, issues related to harvesting would likely need to be resolved with the assistance of the Tuktoyaktuk and Inuvik HTCs, the Joint Management agencies, ENR and the ILA.

Hunting restrictions are currently in place to manage caribou populations. These restrictions prevent hunting within certain management areas and within certain seasons. Wildlife populations will continue to be managed by the Wildlife Management Advisory Councils and Fisheries Joint Management Committee, and Highway users will adhere to any hunting restrictions that may be in place. During the construction phase, employees will be restricted from hunting while working on the Highway.

Potential effects related to the abundance and distribution of wildlife, birds, fish and vegetation are discussed in Section 4.2.

Project Design and Mitigation Measures

To protect the environmentally and culturally sensitive Husky Lakes area, the Developer, with input from Inuvialuit interests has attempted to identify routes options that maintain a 1 km setback between the Highway and the Husky Lakes.

Residents of Tuktoyaktuk have expressed concern that hunting pressure on caribou and other wildlife may increase as a direct result of the Highway. Responsible management organizations and government agencies will continue to work together to develop strategies for sustainable harvesting in the region, after the Highway is constructed. The success of this approach will require a high level of voluntary compliance from the users of the proposed Highway.

A public education program and signage related to harvesting, fishing, hunting, and responsible use of the Highway will be installed at appropriate and highly visible locations. Educational material is currently provided for the Dempster Highway and includes information on:

- Harvesting rights for Aboriginal harvesters, and resident and non-resident hunters and fishers;
- Potential restrictions, including areas with restrictions or seasonal closures;
- Hunter responsibilities;
- Minimum safety distance from the highway before shooting may occur; and
- Snowmachine use near the highway.

Management of wildlife and fish populations will continue to be managed by GNWT ENR, the Wildlife Management Advisory Council, the Fisheries Joint Management Committee, and the HTCs.

Residual Effects

The Highway will create year-round access to Tuktoyaktuk, and will increase access to harvesting areas. Harvesting activities are managed by the Wildlife Management Advisory

Council and Fisheries Joint Management Committee, with input from the Inuvialuit Game Council and the HTCs.

Although harvesting patterns may be temporarily disturbed due to Highway construction, harvesting patterns should return to normal upon Project completion. With effective Highway user practices, residual indirect effects related to harvesting wildlife and fish populations are expected to be minimal.

4.3.8 Land Use

The proposed Highway route is located on Inuvialuit 7(1)(a) and 7(1)(b) Lands and Crown Land. The proposed Highway alignment passes through several special management areas. In general, the Highway is located near to or within areas with designated Management Categories "B", "C" and "E" (Community of Tuktoyaktuk et al. 2008; Community of Inuvik et al. 2008).

According to the Tuktoyaktuk and Inuvik Inuvialuit Community Conservation Plans, the "community supports development where it is compatible with the Conservation Plan's land use and species management priorities" (Community of Tuktoyaktuk et al. 2008, p. 16; Community of Inuvik et al. 2008, p. 17). As well, the stated community values identify that development projects should be scaled to retain opportunities and ensure the most lasting benefit to the local economy, while maintaining air and water quality and the health of the resources.

There are several overlapping management areas between Inuvik and Tuktoyaktuk. The Tuktoyaktuk and Inuvik Inuvialuit CCPs prepared in 2000 identified an "Overlay of all Site Designations in the Tuktoyaktuk and Inuvik Planning Area" (Map 14) that was used during the development of the route options presented in the Project Description Report. According to this map, the proposed Highway routes were located in areas with Management Categories "B" and "C"[10].

In 2008, the Tuktoyaktuk and Inuvik Inuvialuit CCPs were revised and the "All Site Designations in the Tuktoyaktuk and Inuvik Planning Areas" (Map 8) identified that all proposed route options are located within Management Categories "C" and "E". The "E" designation surrounds the Husky Lakes area[11].

---

[10] According to Community of Tuktoyaktuk et al. (2000) and Community of Inuvik et al. (2000):

Management Category "B" means that the "lands and waters where there are cultural or renewable resources of some significance and sensitivity but where terms and conditions associated with permits and leases shall assure the conservation of these resources".

Management Category "C" means that the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption.

[11] According to Community of Tuktoyaktuk et al. (2008) and Community of Inuvik et al. (2008):

Management Category "C" means that the "lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year. These lands and waters shall be managed so as to eliminate, to the greatest extent possible, potential damage and disruption."

The following subsections discuss and evaluate the potential effects of the Highway on land use in the region.

4.3.8.1 Potential Effects

The following potential effects of the Project on land uses were considered and evaluated. Effects related to harvesting are discussed in Section 4.3.7. Specific mitigation measures are described in the mitigation measures subsection (Section 4.3.8.2).

Minimal effects are anticipated to occur during both construction and operations phases.

Traditional Use

Traditional use, as it relates to land use, includes activities such as accessing hunting, trapping, fishing areas and conserving and protecting these areas. Effects related to harvesting are identified in Section 4.3.7.

The proposed Highway embankment construction period is scheduled to occur in winter, with some grading, compacting and selective culvert installation/ adjustment activities taking place in spring or summer. As such, the construction activities should have little to no effect on traditional harvesting activities that occur during spring, summer and fall. Access to harvesting areas during winter will not be affected by Highway construction as residents typically access the areas using snowmachines. Access to traditional harvesting areas would continue to be unimpeded during the construction and operations phases.

Summer harvesting activities typically include berry picking. Currently, residents of Tuktoyaktuk have limited areas to pick berries due to the difficulty in traveling on the land during the summer months. In 2010, personal communications between the Project Team and a number of Tuktoyaktuk residents revealed that due to the new all-weather access road between Tuktoyaktuk and Source 177 (which is the north terminus of this Project), the residents were able to pick many berries during the summer months, adding to their traditional food source. The addition of the proposed Highway would allow local residents in Tuktoyaktuk and Inuvik to access additional berry picking areas.

Highway construction may affect the local distribution of some wildlife during the winter months. Wildlife may avoid areas under construction due to human activity and vehicle movement. Similarly, wildlife may avoid the primary winter snowmachine trails that extend from Inuvik to Tuktoyaktuk (Figure 4.3.8-1). During consultations, Tuktoyaktuk residents stated that there is little hunting from Inuvik to Husky Lakes, but that hunting usually occurs near Parsons Lake. According to Mr. J. Pokiak, the harvesting activities that occur during winter months include wolf and wolverine harvesting (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). The effects of the Project on fish, wildlife, and birds are discussed in Sections 4.2.5 and 4.2.7, respectively.

Management Category "E" means that the "lands and waters where cultural or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas. These lands and waters shall be managed to eliminate, to the greatest extent possible, potential damage and disruption. This category recommends the highest degree of protection."

During consultation, residents stated differing opinions as to whether the proposed Highway would affect fishing. Some residents from Tuktoyaktuk stated that fishing typically occurs further to the east, so the Highway would not affect their fishing areas. Other residents stated that the Highway would allow easier access to fishing areas (Kiggiak-EBA 2008).

Once the Highway is operational, it is expected to provide easier year-round access to harvesting areas and cabins, particularly during the summer months. New access was considered by those consulted as either a positive or a negative effect. Some people expressed concern that the increased access in the summer to berry-picking sites was beneficial, while others were concerned that new access could cause increased harvest pressures on areas typically not harvested.

An additional benefit of the Highway will be that it will provide a single route of effects; that is, during summer and winter months, people will be encouraged, and will likely find it more convenient, to use this main route for travel rather than traveling across the land on new trails. It will serve to localize the effects of travel rather than creating a "spider-web" of effects across the region, such as may currently occur.

Not all residents of Tuktoyaktuk own vehicles that could travel on the Highway (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). For some residents, the preferred mode of winter travel may continue to be by snowmachine using traditional or more direct overland routes to their cabins or harvesting areas.

During the construction phase, construction workers would be required to stay on authorized access roads and the construction area, and not to access the land. During the operations phase, the Developer will work with the appropriate parties to install signage and/or develop educational materials to encourage Highway users to stay on the designated Highway. During the 2009 consultations in Inuvik, participants indicated that the co-management boards will need to decide how to protect wildlife and fish, and that the users will need to be responsible stewards (Appendix B).

Tourism

Air, water and land-based tours are currently offered within the ISR by a variety of business operators. Local residents and tourists travel and camp along the Mackenzie and Dempster Highways. There is also recreational boat traffic on the Mackenzie River, the Mackenzie Delta and the Beaufort Sea. The construction of the Highway would increase tourist accessibility to Tuktoyaktuk during summer months.

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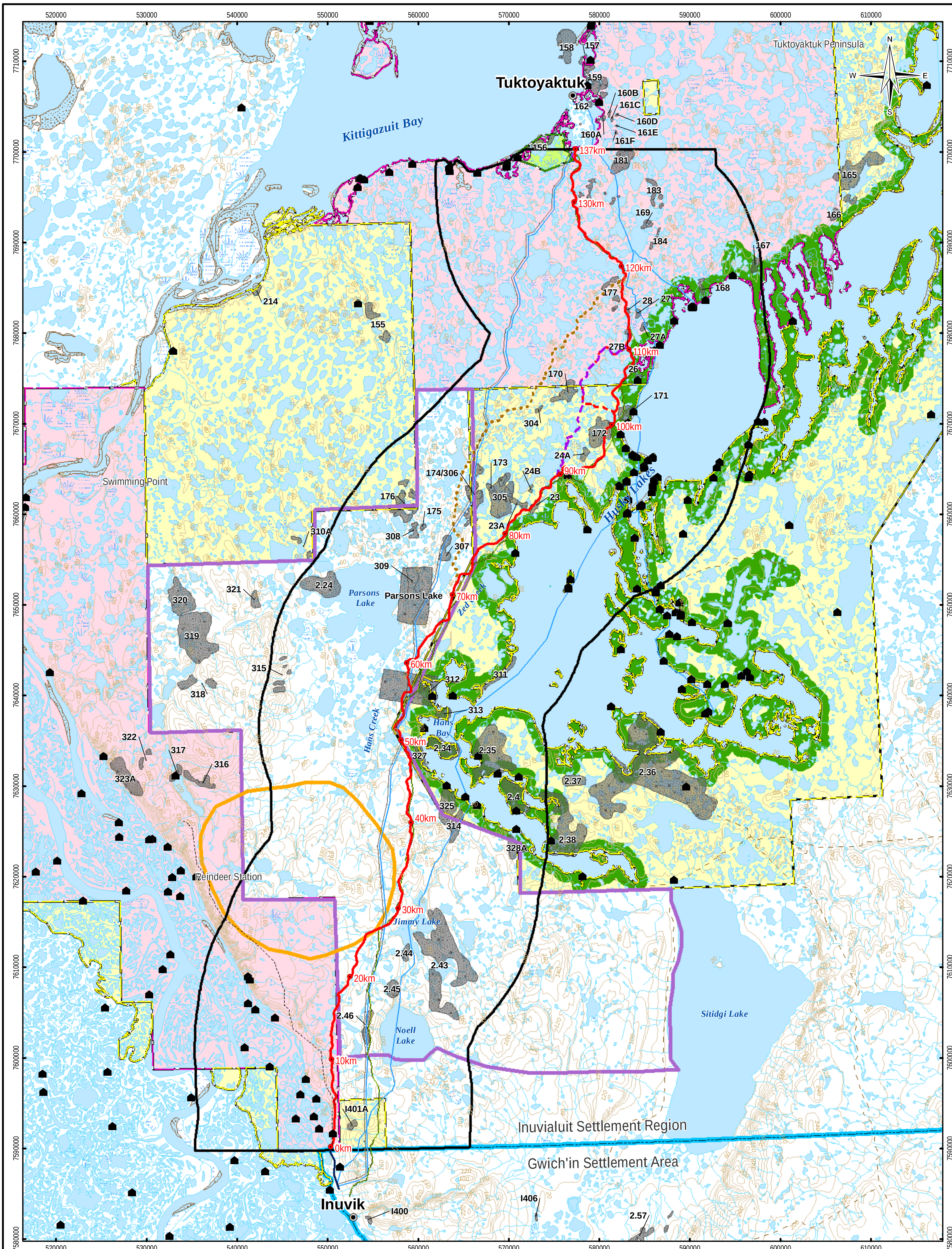

LEGEND

- Residential Leases
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Approximate Winter Reindeer Range
- Approximate Allotment B
- Borrow Sources
- Husky Lakes 1000m Setback
- Former Powerline
- Ikhil Gas Pipeline
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

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

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Existing Land Uses

PROJECTION: UTM Zone 8
DATUM: NAD83

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

FILE NO.: V23201322_EIS_Map022_CEA_ExistLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	RH	0

OFFICE	DATE
EBA-VANC	May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 4.3.8-1

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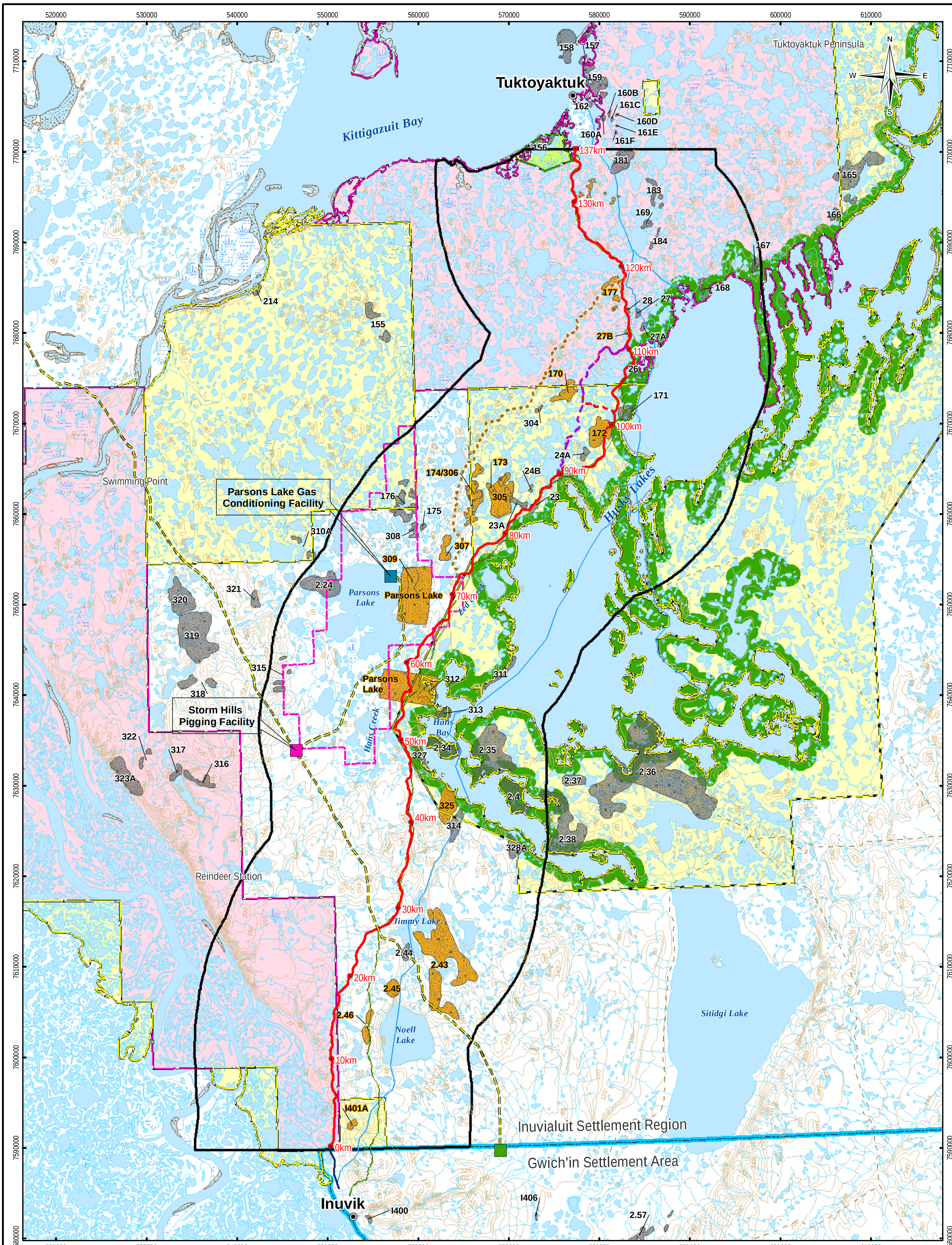

LEGEND

- Facility Site
- Gas Conditioning Facility
- Pigging Facility Site
- Route of Gathering Pipelines
- Significant Discovery Licence Area
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 2 (Upland Route)
- Alternative 3 (2010 Minor Realignment)
- PWC 1977
- Navy Road
- Snowmobile Trails
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Pingo Park
- Gwich'in / Inuvialuit Boundary
- Potential Highway Borrow Sources
- Borrow Sources
- Husky Lakes 1000m Setback
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES
Base data source: NTS 1:250,000
Borrow Sources, ILA Lands, Husky Lakes 1000m Setback: Inuvialuit Land Administration
Mackenzie Gas Project 2004

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY ENVIRONMENTAL IMPACT STATEMENT

Proposed Future Land Uses

PROJECTION: UTM Zone 8
DATUM: NAD83

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

FILE NO.: V23201322_EIS_Map023_CEA_PropLanduse.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE: EBA-VANC
DATE: May 19, 2011

Town of Inuvik
Northwest Territories
KIGGIAK - EBA

Figure 4.3.8-2

Currenty, relatively few tourists visit the Project area during winter or summer. Winter Highway construction is not anticipated to affect tourist activities such as snowmobiling or cross-country skiing. The proposed Highway, once constructed, would provide an alternative to air transportation for tourists traveling to or from Tuktoyaktuk.

The proposed Highway will provide all-weather access from southern Canada to the Beaufort Sea, making it possible to travel by car from Canada's west, east and north coasts. New access is expected to attract more tourists to the area, and generate positive economic 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. Increased tourist visits to Tuktoyaktuk and Inuvik will provide new and greater opportunities for the community to market their local crafts.

The construction of the Highway is not anticipated to displace tourists from local accommodations as workers reside in the communities and will be temporarily accommodated at the construction camps during winter, or will be transported to the work site during summer, as necessary.

Industrial Use

The construction of the Project will facilitate year-round access to material resources for community use and for future development. Use of the borrow sources will represent ongoing sources of royalty income for the Inuvialuit.

The Highway will facilitate better access to future onshore and offshore oil and gas exploration and development in the region. According to GNWT DOT (2010a), the Inuvik to Tuktoyaktuk Highway may result in some cost savings for future oil and gas exploration and development. These savings stem principally from a reduction in logistic costs associated with more efficient use of leased drilling rigs, camps, and related support equipment. There is also a reduction in risk costs by not carrying excess inventory and competing for scarce resources. Concurrently, the existence of an all-weather Highway facilitates the movement of rig equipment from southern Canada during the non-drilling season, rather than storing rig equipment and incurring storage costs and extended rig rental costs. Oil and gas companies will need to determine if and how they may choose to benefit from the existence of the proposed Highway.

Commercial Use

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 for Tuktoyaktuk businesses and service providers. It will also allow Inuvik and other regionally-based businesses to compete for resource-related and government business opportunities in the area between and within Inuvik and Tuktoyaktuk. An expanding commercial sector will lead to higher quality products and lower cost services for consumers in general, and government, distribution, and resource development organizations.

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 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.

Specific Sites or Features

Specific sites or features within the LSA and/or RSA are identified and discussed in this subsection.

- Gungi – this area located south of Tuktoyaktuk was identified by residents during consultation as an area that would be more accessible for picnicking and berry-picking during summer months following construction of the Highway.
- Caribou migration and feeding areas – Tuktoyaktuk Elders stated that the main feeding and migration areas for caribou are along the shores of Husky Lakes, and not on the higher ground (where the proposed Highway is), as there is not much food available at that elevation.
- Husky Lakes – are an important cultural and spiritual place for the Inuvialuit. The finalized route and all aggregate borrow sources will be a minimum distance of 1 km from the Lakes to avoid affecting the environmental integrity or residents' enjoyment of the Husky Lakes area.

The Inuvialuit Land Administration has developed the draft Husky Lakes Special Cultural Area Criteria: ILMS[12] Special Area Plan (ILA 2010), which identifies the boundary of the Husky Lakes Special Cultural Area, in addition to other Husky Lakes management areas. The criteria are a set of goal-oriented, regulatory standards designed to protect the environment in the Husky Lakes area. If approved, the ILA will employ the use of these criteria to review proposed projects. The Primary 2009 Route, Alternative 1 (2009 Minor Realignment), Alternative 2 (Upland Route), and Alternative 3 (2010 Minor Realignment) which was recommended by Inuvialuit interests, are all partially located within the cultural area. Therefore, if approved, the Developer is committed to addressing the performance criteria and management goals identified in the draft ILMS Special Area Plan.

In addition, under the *Inuvialuit Final Agreement*- Annex D, the Husky Lakes have two management designations, Area 1 and Area 2. Area 1 does not allow dredging or marine development. Similarly, Area 2 does not allow dredging or marine development, in addition to having other terrestrial criteria that must be adhered to. The proposed Highway is not located within Area 1 or Area 2.

[12] ILMS – Inuvialuit Land Management System.

Protected Areas and Special Management Areas

According to the Tuktoyaktuk and Inuvik Inuvialuit CCPs, the proposed Highway alignment passes through several special management areas (Figure 3.2.9-5). The potential interactions with special management areas are discussed. Specific wildlife effects are evaluated and discussed in the wildlife effects section (Section 4.2.7).

Grizzly Bear Denning Areas (322C) – the proposed Highway alignment is located within the expansive grizzly bear denning area. Denning occurs during the winter months when grizzly bears hibernate. The potential effects and mitigation measures are discussed in the wildlife section (Section 4.2.7).

Caribou Hills (702B) – the proposed Highway alignment crosses through the southeast edge of the Caribou Hills area, a management area important for subsistence berry picking and harvesting. According to Figures 3.1.9-11 and 3.1.9-12, Bluenose-West and Cape Bathurst herds are in the portion of the Caribou Hills affected by the Highway between October 8 and November 30, but move away from the area after December, when construction would occur. Residents typically access the area using all-terrain vehicles. The proposed Highway will provide easier access to the area for subsistence harvesters. Direct effects will occur to vegetation under the Project footprint. Indirect effects to vegetation will occur from fugitive dust, which are discussed in the vegetation effects section (Section 4.2.6).

Fish Lakes and Rivers (704C) – the northern portion of the Highway is located within the Fish Lakes and Rivers management area. The area includes the rivers and lakes along the shoreline west of Tuktoyaktuk, inland to their headwaters, including Parsons and Yaya lakes, all of which are used by the residents of Tuktoyaktuk and Inuvik for subsistence harvesting. Mitigation measures implemented during the construction phase will minimize potential effects while the operation of the Highway will allow easier access to these important subsistence harvesting areas. The effects and mitigation measures associated with fish and fish habitat are discussed in the fish effects section (Section 4.2.5).

Husky Lakes (705E) – the route re-alignment options are located outside of the 1 km setback from the Husky Lakes Management Area to avoid encroachment, in accordance with the draft "Criteria for Establishing Environmental Standards and Criteria for Evaluating a Developer's Standard of Performance in the Husky Lakes Area" (EIRB 2002).

Bluenose-West Caribou Herd Winter Range (701E) – this expansive area encompasses much of the ISR, including Tuktoyaktuk and the area directly north of Inuvik. The proposed Highway alignment is within this area. The effects and mitigation measures associated with this valued component are discussed in the wildlife effects section (Section 4.2.7).

Winter/Spring Caribou Harvesting (315C/302C) – caribou harvesting areas are located throughout the northern portions of the ISR, including Husky Lakes and Inuvik. Caribou are currently protected from harvesting by hunting restrictions. The proposed Highway alignment is located within Area I/BC/07, which is currently closed to barren-ground caribou hunting due to declining caribou populations. The effects and mitigation measures associated with this valued component are discussed in the wildlife effects section (Section 4.2.7).

Winter Wolverine Harvesting (314C) – similar to caribou, this expansive area encompasses much of the ISR, including Tuktoyaktuk and the area directly north of Inuvik. The proposed Highway alignment is within this area. The effects and mitigation measures associated with wolverines and wolverine habitat are discussed in the wildlife effects section (Section 4.2.7).

Spring Goose Harvesting (304C) – goose are harvested throughout the ISR. The proposed Highway would cross through portions of this management area. The effects and mitigation measures associated with wildlife and wildlife habitat are discussed in the wildlife effects section (Section 4.2.7).

Winter/Summer/Spring Fish Harvesting (316C/307C/305C) – several fish harvesting locations are identified and managed, particularly near the Husky Lakes region. The proposed Highway would cross through portions of this management area. The effects and mitigation measures associated with fish and fish habitat are discussed in the fish effects section (Section 4.2.5).

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 identified in the Protected Areas Strategy.

4.3.8.2 Project Design and Mitigation Measures

The construction timing, Highway design, and mitigation measures are intended to minimize potential land use effects. The route re-alignmnet options are located a minimum of 1 km from the Husky Lakes, an area known for its wildlife and cultural values.

The Developer will conform to applicable ambient air quality objectives, by using pollution prevention measures and best management practices.

Other mitigation measures that will be implemented include:

- Ensuring that construction vehicles stay on access roads or the construction site at all times;
- Prohibiting the recreational use of all-terrain vehicles and snowmachines by construction personnel while working on the Highway; and
- Prohibiting the recreational use of the Highway by Project staff during construction.

4.3.8.3 Residual Effects

The residual effect on land use that will remain after implementation of mitigation measures is the footprint of the all-weather Highway across the landscape.

The Highway routing has been designed to avoid or minimize affecting particularly special cultural areas. Access to traditional or special locations will not be restricted by the Highway.

The proposed Highway is a linear development that potentially influences land use at a regional level. It has long-term, low-magnitude, localized residual effects on land use.

4.3.9 Archaeological Resources

Archaeological resources are protected through various federal, territorial and Inuvialuit legislation and regulations. The *Northwest Territories Archaeological Sites Regulations*, pursuant to the *Northwest Territories Act,* applies throughout the Territories and states:

> 4. No person shall search for archaeological sites or archaeological artifacts, or survey an archaeological site, without a Class 1 or Class 2 permit.
>
> 5. No person shall excavate, alter or otherwise disturb an archaeological site, or remove an archaeological artifact from an archaeological site without a Class 2 permit.

Within the Inuvialuit Settlement Region, the *Territorial Land Use Regulations*, pursuant to the *Territorial Lands Act,* applies to federal crown lands. Two sections are relevant to archaeological sites:

> 10(a) No permittee shall, unless expressly authorized in his permit or expressly authorized in writing by an inspector conduct a land use operation within 30 metres of a known monument or a known or suspected archaeological site or burial ground; and
>
> 16 Where, in the course of a land use operation, a suspected archaeological site or burial ground is unearthed or otherwise discovered, the permittee shall immediately
>
> (a) suspend the land use operation on the site; and
>
> (b) notify the engineer or an inspector of the location of the site and the nature of any unearthed materials, structures or artifacts.

On Inuvialuit private lands, the Inuvialuit Lands Administration Rules and Procedures apply. One section is relevant to the protection of archaeological sites:

> 19(9) Where in the course of an operation, a suspected archaeological site or burial ground is unearthed or otherwise discovered, the Holder shall immediately:
>
> (a) suspend the operation on the site; and
>
> (b) notify the Administrator or an Inspector of the location of the site and the nature of any unearthed materials, structures or artifacts.

The *Historical Resources Act* (Territorial) pertains to Commissioner's Land within the ISR. Protection of sites in these areas is afforded by the following Section:

9(1) Whenever, in the opinion of the Commissioner, any prehistoric or historic remains, whether or not designated as an historic place under this ordinance or under the *Historic Sites and Monuments Act* of Canada is threatened with destruction by reason of commercial, industrial, mining, mineral exploration or other activity, the Commissioner may order the persons undertaking the activity to provide for adequate investigation, recording and salvage of prehistoric or historic objects threatened with destruction.

4.3.9.1 Potential Effects

There are twelve previously recorded archaeological sites within a 5 km radius of the proposed Highway. As shown in Figure 3.2.10-1 Archaeological Sites Previously Recorded, none of the sites occur along the Primary 2009 Route. The absence of archaeological sites is consistent with the Historical and Cultural Sites and Burial Sites figures found in the 2006 Inuvialuit Settlement Region Traditional Knowledge Report (ICC et al. 2006).

Of the twelve previously recorded archaeological sites, two are found within borrow sources within the 1 km setback from Husky Lakes. Neither of these sites would be used to source granular materials. One site is located within a known borrow source located further from the route and has not been identified for construction use at this time. Two other sites are found within borrow sources that may be used during construction, which would require mitigation.

Areas with potential to contain unrecorded archaeological sites are identified in Figures 3.2.10-2, 3.2.10-3 Archaeological Potential Areas do occur along the proposed Highway route. Areas with archaeological potential exist along the Primary 2009 Route and Alternative 2 (Upland Route). Alternative 3 (2010 Minor Realignment) which was recommended by Inuvialuit interests in 2010 was not assessed. Areas with the best potential for archaeology include level and dry banks, terraces or benches along major streams or lakes or elevated landforms.

4.3.9.2 Project Design and Mitigation Measures

Further archaeological impact assessments are required prior to Highway construction, once a route is selected. To adequately complete intensive archaeological inventory survey, the Highway route must be finalized within a 100 m wide corridor and boundaries of all associated components such as borrow sources, work staging areas, construction camps must be identified prior to field work.

Initial archaeological reconnaissance identified that no known archaeological sites occur along the proposed Highway alignments. Of the known sites within 5 km of the proposed alignment, only two are located in areas that may be proposed as borrow sources. In assessing these potential borrow sites, mitigation measures would be implemented to resolve any potential effects to these sites. Furthermore, since much of the proposed alignment is located within areas with potential archaeological resources, appropriate mitigation measures will be implemented throughout the duration of the construction process to ensure compliance with heritage resource protection legislation and regulations.

The combination of background documentary data and overview terrain assessment has resulted in the identification of specific areas with sufficient potential for archaeological resources that ground reconnaissance is recommended.

Prior to the annual construction program, intensive archaeological impact assessments will be conducted along the final alignment, including borrow sources, work staging areas, and construction camp locations. A qualified archaeologist will be hired to perform the study. As fieldwork can only be effectively undertaken during the summer months, NWT Archaeologists Permit applications will be applied for during spring, prior to field season.

On the recommendation of the contract archaeologist in the field the Developer shall implement avoidance or mitigation measures to protect archaeological sites or to salvage the information they contain through excavation, analysis, and report writing, subject to the approval by the PNWHC.

An archaeological impact assessment typically consists of two phases of archaeological research, inventory and assessment, focused on the project footprint or study area (PWNHC ND). An inventory is generally conducted once the direct, indirect and perceived geographical areas affected by the project are well defined. Systematic and intensive fieldwork identifies potential effects on archaeological sites from possible and alternate construction components. All archaeological sites must be recorded and submitted on Archaeological Survey of Canada site survey forms. Information is collected from field, library, and archives to identify likely effects and identify any further required studies or mitigations. An NWT Class 2 Archaeological Permit is required.

Following the inventory phase, an assessment is conducted to predict the form and magnitude of the effects. Assessments provide information on the size, volume, complexity, and content of an archaeological site, which is used to rank the values of different sites and to identify mitigation measures or programs (PWNHC ND).

An archaeological site(s) protection plan will be prepared that will facilitate the continued protection and management of archaeological resources during the construction phase of the Project. A typical plan includes detailed procedures for information flow between relevant agencies, how minor route realignments during construction will be assessed for archaeological impacts, and how this information will be communicated in a timely manner.

Mitigation measures will be designed on an individual basis, and require prior approval by the Prince of Wales Northern Heritage Centre. Mitigation measures may include avoidance (the preferred mitigation), temporary site protection, or systematic data recovery. It is expected that most archaeological sites found will be small and could be readily avoided with a minor Project realignment or footprint adjustment. GNWT Department of Transportation and the Hamlet of Tuktoyaktuk, along with the selected contractor, will make every effort to avoid and protect recorded and unrecorded archaeological and heritage resources during the conduct of this Project.

In the unlikely event that Project relocation is not feasible and a site will be impacted, recommended site mitigation will likely comprise detailed mapping, recording and excavation of a sufficient number of units to ensure a representative sample of the site contents is obtained. This ensures that knowledge of that site is available for future generations.

4.3.9.3 Residual Effects

Archaeological impact assessments will be undertaken on an annual basis, prior to the annual construction program, to determine if there are any archaeological resources present. If present, mitigation measures will be designed in collaboration with the Prince of Wales Northern Heritage Centre, to avoid Project effects on archaeological resources.

4.4 ACCIDENTS AND MALFUNCTIONS

Accidents or malfunctions can be associated with any human activities, including those associated with the construction periods projected for the 137 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 crashes 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, including:

- Implementation of best management and industry practices as appropriate to prevent or minimize the occurrence of accidents or malfunctions;
- Ensuring that all on-site contractors have industry-compliant and satisfactory Health, Safety and Environmental (HSE) policies, programs and manuals and that they are successfully implemented throughout the Project;
- Ensuring that the Developer and its contractors have an environmental management plan and spill contingency plan that will address potential accidents and malfunctions for the life of the Project;
- Compliance with ILA and INAC Land Use Permit and Borrow Permit requirements and conditions issued for the construction phase of the Project;
- Conformance with existing applicable GNWT and Workers Compensation Board standards;
- Fuel and other hydrocarbons will be stored in accordance with CCME's (2003) *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products,* INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities,* and to the extent applicable, and the *CEPA Storage Tank System for Petroleum Products and Allied Petroleum Products Regulations.*
- All vehicles and equipment will be refueled at least 100 m from waterbodies following INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities*;
- Spills will be reported to the 24-hour Spill Report Line (867-920-8130) according to current guidelines; and

- Spill containment and clean-up activities will be implemented in accordance with the site-specific spill contingency plans that will be developed for the Inuvik to Tuktoyaktuk Highway.

In particular, the Developer will ensure that a spill contingency plan is in place that conforms to INAC's (2007) *Guidelines for Spill Contingency Planning* (Appendix E). In particular, the plan will include:

- Descriptions of the type and amount of contaminants stored at the Project location;
- Site map of the location;
- Steps to be taken to report, contain, clean-up and dispose of contaminants in the case of a spill;
- A description of the training provided to employees to respond to a spill;
- An inventory of and the location of response and clean-up equipment available to implement the spill contingency plan.

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.

4.4.1 Fuel Storage and Spills

Fuel needed for the aggregate borrow and Highway construction activities will be stored in double-walled fuel storage tanks. All fuel will be stored in accordance with CCME's (2003) *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products,* INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities,* and to the extent applicable, and the *CEPA Storage Tank System for Petroleum Products and Allied Petroleum Products Regulations.*

4.4.2 Refuelling Operation

All vehicles and equipment will be refueled at least 100 m from waterbodies following INAC's (2011b) *Northern Land Use Guidelines: Camp and Support Facilities.*

4.4.3 Waste Management

4.4.3.1 General Waste Management Planning

The Project will have waste management planning in place that will ensure wastes are handled, stored, transported, and disposed of in a manner that will prevent the unauthorized discharge of contaminants, mitigate impacts to air, land, water, and minimize risks of animal attraction, while maintaining health and safety of personnel and wildlife. In order to achieve this, the Developer will develop a Project specific waste management plan for all wastes associated with preconstruction and construction activities. The waste management plan will apply to the Developer and all its Project contractors involved in the generation, treatment, transferring, receiving, and disposal of waste materials for the Project. The Project specific waste management plan will:

- Identify waste sources and related types, including but not limited to liquid, solid, non-hazardous, hazardous and approximate quantities;
- Describe all on-site or remote treatment and disposal methods;
- Describe all waste streams to be transported off-site and final disposal locations;
- Describe the related waste segregation strategies for the identified waste sources and types to accommodate their respective storage, treatment, transport, and disposal; and
- Description of food and food contaminated waste management methods to mitigate animal attraction from source to transport, treatment or disposal.

4.4.3.2 Waste Handling and Separation, Storage and Processing at Source

All Project wastes will be segregated and stored separately as described in Tables 4.4.3-1 and 4.4.3-2. Effective separation of different types of wastes at the source will enable proper handling from waste creation through treatment and/or disposal.

4.4.3.3 Food and Food-Contaminated Waste and Animal Attraction

The Developer recognizes that timely and responsible segregation, storage, and disposal of food and food-contaminated waste, is of critical importance to minimize risks associated with wildlife attraction. To minimize risks of animal attraction to camps and other related activities while maintaining health and safety of personnel, wildlife, and the environment, all food and food contaminated waste will be stored separate to all other wastes, and in airtight sealed container(s), and enclosed in a bear proof container while in bulk storage prior to final transport, treatment or disposal.

4.4.3.4 General Camp Waste and Sewage

The main wastes produced during the construction of the Inuvik to Tuktoyaktuk Highway are those resulting from camps, which is comprised of waste typical and similar to that of municipal solid and liquid waste streams, as described in Table 4.4.3-1.

TABLE 4.4.3-1: CLASSIFICATION OF CAMP WASTE	
Type of Waste	**Description**
Recyclable material	Paper, glass, bottles, cans, metals, certain plastics
Food contaminated	Biodegradable waste, food and kitchen waste, animal and vegetable wastes: typical of restaurants, hotels, markets, etc.
Composite	Waste clothing, non-recyclable plastics, etc.
Human waste	Sewage related, blackwater
Greywater	Kitchen and washing related liquid waste

Standard sanitation collection and disposal methods will be employed at the construction camps. Acceptable practice for sanitary collection treatment will include the use of stationary/ portable sewage collection systems. Sewage will be hauled on a regular basis to either the Inuvik or Tuktoyaktuk sewage lagoons depending on the location of the camps (see Section 4.4.3.7).

4.4.3.5 Industrial Waste

Industrial waste, as described in Table 4.4.3-2, will encompass all other wastes not defined as camp sourced MSW described above.

TABLE 4.4.3-2: CLASSIFICATION OF INDUSTRIAL WASTE	
Type of Waste	**Description**
Recyclable/reusable construction and demolition	• Building materials etc.
Non-recyclable construction and demolition	• Inert material, such as soil and granular material
Hazardous materials	• Contaminated soil/ snow/ water • Waste fuel • Used oil • Other crankcase fluids • Solvents • Glycol • Batteries • Tank, drum, and container rinsings • Empty drums

4.4.3.6 Hazardous Waste

Hazardous waste will be generated during the construction of the Highway will be properly managed. Part of this management includes compliance with GNWT ENR's requirements to track the movement of hazardous waste from registered generators, carriers, to receivers according to the *Guideline for the General Management of Hazardous Waste in the NWT*. Further, the Developers will prepare and adhere to a Project specific waste management plan.

The Developer and its contractors are expected to generate hazardous wastes such as, but not limited to, those described in Table 4.4.3-2. GNWT DOT is currently a registered generator of hazardous waste and is directly responsible for the hazardous waste generated from their operations. Further, GNWT DOT is indirectly responsible for the hazardous waste generated from private contractors on the Project. The Developer is aware that hazardous waste must be disposed of at an approved facility, and that it is not appropriate to dispose hazardous waste in NWT community solid waste facilities.

To mitigate potential adverse environmental effects associated with improper hazardous waste disposal and to further demonstrate that proper hazardous waste management planning is in place, a hazardous waste management plan (HWMP) will be developed and submitted. The HWMP will encompass all pre-construction and construction phases of the Project and will apply to the Developer and all contractors involved in receiving, transferring, and transporting hazardous waste for the Developer's activities on land, water, and air. The HWMP will include, but not be limited to:

- Identifying hazardous waste sources, types, and approximate quantities to be produced (including liquid, solid, dangerous goods and non-dangerous goods);
- Describing waste segregation methods;
- Describing all on-site treatment and disposal methods; and
- Describing hazardous wastes that will be transported to approved receiving facilities.

4.4.3.7 Project Waste Quantities and Disposal Options

The Developer proposes to transport and dispose of segregated, camp-based, solid and liquid waste at the Tuktoyaktuk and Inuvik solid waste facilities and sewage lagoons. Due to construction taking place from the north and south side of the Highway concurrently, it is necessary that waste from the north end of construction be disposed of in Tuktoyaktuk, and similarly, that waste from the south end of construction be disposed of in Inuvik.

In the first year, several 15-20 person camps will be set up and in the second year, at least one camp housing more than 50 people will be set up. The volume and types of waste taken to the Inuvik landfill and sewage lagoon is expected to not represent a significant increase in the existing community sourced amount of waste entering Inuvik.

The Developer has consulted with the communities of Tuktoyaktuk and Inuvik regarding the disposal of camp sourced municipal solid waste. The Developer will ensure:

- Prior to disposal of waste, an estimate of the amount and type of domestic waste is provided to the Town of Inuvik and Hamlet of Tuktoyaktuk, and compared to the facilities' available capacity;
- Approval from the Town of Inuvik and Hamlet of Tuktoyaktuk to use their sewage lagoon and solid waste disposal facilities will be obtained and applicable Licence, Permits, and/or municipal by-laws regarding the use of these facilities will be followed; and

- Records of the amount of domestic waste shipped to the Inuvik and Tuktoyaktuk landfill will be kept by the Developer to confirm and compare the accuracy of waste projections versus the amounts that actually enter the community.

4.4.4 Vehicle Crashes

Safety measures to prevent vehicle accidents on the proposed Highway have been and will continue to be incorporated into the Highway design. According to the GNWT DOT, there were 861 vehicle collisions in 2008, 179 or 21% of which occurred on highways in the NWT, the remaining accidents were in urban centres or involved all-terrain vehicles (GNWT DOT 2009a, 2009b).

Measures to avoid or minimize accidents will include posted speed limits, adequate signage alerting drivers to Highway curves and upcoming bridges. Bridge design will incorporate guardrails to prevent a vehicle from going off the Highway and into a watercourse in the event of an accident.

While it is recognized that a year-round Highway will increase overall traffic volume, which correspondingly may increase the number of emergency incidents, Corporal Doorinbos did not anticipate many fatal collisions on the Highway as there have been very few on the winter road (S. Doorinbos, Corporal, Inuvik RCMP, pers. comm., January 26, 2011).

4.4.5 Worst Case Scenario

One of the objectives of the *Inuvialuit Final Agreement* (IFA) is to prevent damage to wildlife and its habitat and to avoid disruption of Inuvialuit harvesting activities by reason of development (IFA Section 13.(1)(a)). As such, when a development is proposed, the EIRB must establish limits of liability for a project proponent or developer. Section 13.(11)(b) of the IFA requires an "estimate of the potential liability of the developer, determined on a worst case scenario, taking into consideration the balance between economic factors, including the ability of the developer to pay, and environmental factors." The proposed Highway from Inuvik to Tuktoyaktuk is subject to these terms.

To estimate the potential liability of the developer for impacts of the Highway development, a worst case scenario was identified. Based on consultation and regulatory feedback, it is evident that a worst case scenario would involve environmental damage to the Husky Lakes and effects to traditional activities and harvesting. Therefore, the worst case scenario for the Project would likely be one in which a fuel supply truck crashes on the Highway, in a location nearest the Husky Lakes (e.g., KM 80) and causes a fuel spill of greater than 10,000 L into an open watercourse, which is a direct tributary to the Husky Lakes.

The worst case scenario was further defined to assume that:

- The fuel supply truck crash occurs during spring freshet when water levels, discharge and velocity are at their yearly peak and the potential for the greatest number of available pathways for conveyance downstream to the Husky Lakes is present;

- The spill of diesel fuel into a fish-bearing watercourse and ultimately into Husky Lakes would result in residents avoiding consumption of fish because of the perception that the fuel would taint the fish;
- The fish harvest season from Husky Lakes for that particular year would be lost as a result of the diesel fuel input to Husky Lakes; and
- The fouling of fishing gear would result in replacement costs.

It is recognized that there are strong cultural and traditional values associated with the subsistence fishery within the Husky Lakes (Figure 3.2.8-17 Fish Harvesting Areas Spring, Summer, Fall, and Winter).

The following sections will describe the potential for this type of scenario to occur, the mitigation measures in place to avoid this scenario, and the overall probability of this scenario occurring.

4.4.5.1 Diesel Fuel Transportation

Currently, the vast majority of diesel fuel is transported to Tuktoyaktuk by barge in the summer, via the Mackenzie River, with only very occasional deliveries transported by truck via the winter road (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010). Approximately 3.2 million litres of diesel and 700,000 litres of gas are transported to Tuktoyaktuk for community fuel re-supply, not including that brought in for industrial use. Tuktoyaktuk's fuel tank storage has a capacity of greater than four million litres. Fuel is delivered using the winter road only if fuel prices are low and there is need in the community (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010).

According to E. Gruben's Transport Ltd. (Gruben's), it is expected that in the future, all diesel and gas would be delivered to Tuktoyaktuk via the proposed Highway once it is constructed (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010). Although the cost of delivery by barge or by fuel truck is comparable, the delivery of fuel to Tuktoyaktuk via the Highway would result in overall cost and storage efficiency (R. Newmark, CEO, E. Gruben's Transport Ltd., pers. comm., December 16, 2010).

Currently, when the annual resupply is delivered to Tuktoyaktuk in the summer (August) the community has to pay for a full year's supply of fuel at one time. Transporting fuel at regular intervals over the year would allow the community to pay for fuel at intervals instead. Not only is this easier to afford, but it also allows the community to potentially access a discount if fuel is cheaper at different times of the year. For example, if fuel prices in April 2011 are $1.50 per litre, but decrease to $1.45 per litre in November 2011, then the community may realize a cost savings. As well, the Hamlet of Tuktoyaktuk must currently maintain a four million litre fuel tank farm. If fuel was brought to the community on a regular basis, less fuel storage would be required, which would also require less overall cost for maintenance and upkeep and less overall risk to the community.

Based on the annual fuel requirements and given that the average B-Train truck load can hold a volume of 48,000 litres, it is expected that at least 67 truckloads per year will travel via the Highway. Since open water occurs for approximately four months each year (or 33% of the year), it is estimated that approximately 33% (or 22) of the fuel deliveries will occur during this period. Therefore, approximately 67% (or 45) fuel truck deliveries are expected during the winter months when the risk of spill into an open waterway with access to Husky Lakes is negligible.

Winter conditions and frozen waterways exist between October (first ice) and May (spring melt). The risk of a spill into open water is negligible during winter as the spill would occur on snow and ice. In general, spills that occur on ice are the easiest to clean up. Since ice is impermeable, it allows sorbent materials to soak up the spill, while any remaining contaminated ice can be scraped and removed from the ice surface. Trenches and dykes are also effective at containing spills onto ice. Snow acts as a natural sorbent and spills onto snow can also be easily recovered by shovelling contaminated snow into plastic bags or barrels. Again, dykes can be effective in containing fuel spills onto snow and can be used in conjunction with tarps to pool spills within the snow dyke (INAC 2007b). Consequently there is no perceived risk during this period as response, containment and recovery of fuel spilled over snow and ice is typically very effective and therefore, impacts to fish and fish habitat are unlikely.

4.4.5.2 Fate of Fuel in the Environment

Diesel fuel is most often a light, refined petroleum product. According to the National Oceanic and Atmospheric Administration (NOAA), small diesel spills (2,000 L to 20,000 L) will typically evaporate and disperse within a day or less, even in cold water; therefore, seldom is there any fuel on the surface to recover (NOAA 2006). Heavier intermediate fuel oil may persist longer when spilled.

The characteristics of diesel and small diesel spills include:

- Diesel oil has a very low viscosity and is readily dispersed into the water column;
- Diesel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months;
- Diesel oil is much lighter than water (including seawater); it is not possible for this oil to sink and accumulate on the seafloor as pooled or free oil unless it adheres to fine-grained suspended sediments (adsorption), which can settle out and get deposited on the seafloor. This process is not likely to result in measurable sediment contamination for small spills; and
- Diesel oil is not very sticky or viscous, and tends to be washed off by waves and shoreline clean-up is usually not needed (NOAA 2006).

Due to the toxicity of diesel, fish and marine birds that come in direct contact with a diesel spill may be affected. Small spills (<20,000 L) in open water are so rapidly diluted that fish kills have never been reported, except when small spills occur in confined, shallow water

(NOAA 2006). As well, the number of marine birds typically affected is small due to the short amount of time the diesel oil is on the water surface.

To assess the potential likelihood for spill of diesel fuel into an open waterway, data were obtained from the GNWT on hazardous spills and vehicle accidents. It was found that only seven diesel fuel spills of greater than 10,000 L from a transport truck have been reported in the NWT over the last 10 years (GNWT ENR 2010e). These spill reports are shown in Table 4.4.5-1.

TABLE 4.4.5-1: REPORTED DIESEL FUEL SPILLS OF GREATER THAN 10,000 L IN THE NWT

Year	Location	Type of Spill	Volume of Spill
2/20/2000	North Slave Lake	Diesel Fuel	21,500
3/3/2000	North Slave Lake	Diesel Fuel	15,000
2/20/2003	South Slave Lake	Diesel Fuel	10,000
2/24/2003	Sahtu	Diesel P-50	11,000
3/21/2005	Sahtu	Diesel P-50 (cold weather diesel)	14,000
1/14/2006	South Slave Lake	Diesel Fuel	12,000
3/9/2006	North Slave Lake	Diesel Fuel	14,000

The largest spill reported in the Inuvik region occurred on December 22, 2001 when 7,000 litres of diesel fuel leaked from a storage tank. The largest truck spill reported in the Inuvik region was 700 litres on August 16, 2007 and occurred approximately 80 km south of Inuvik (GNWT ENR 2010e). Data in Table 4.4.5-1 and the spills occurring in the Inuvik region suggest that spills as a result of truck accidents are uncommon.

In the event that some of the fuel product (e.g., Arctic diesel) escaped the containment booms, fuel would be expected to begin to move and spread over the local surface of the stream and/or Husky Lakes in the prevailing direction of surface water circulation. Although on-site spill response efforts would continue to attempt to recapture any of this fuel, it is important to note that Arctic diesel and any of the other, lighter fuel products are relatively volatile and rapidly evaporate and disperse, as discussed previously.

To demonstrate this, an oil weathering model available from NOAA's Office of Response and Restoration called ADIOS® 2.0 (Automated Data Inquiry for Oil Spills) was run using typical winter or summer diesel fuels at a nominal temperature of 10°C and light winds. The resultant graph shown in Figure 4.4.5-1, shows that approximately 50% of winter grade arctic diesel would be expected to evaporate within about 24 hours and 80% of this fuel would likely dissipate within about a week. A summer grade of diesel fuel is projected to degrade somewhat more slowly (~ 50% in one week). Winter mix diesel fuel is a lighter mix of diesel used to maintain flow and avoid freezing; it has a pour point of -36°C. Summer mix diesel fuel is a heavier mix that can be used during warmer months; it has a pour point of -7°C. The typical fuel used in Inuvik and Tuktoyaktuk is winter mix diesel.

As a result, the effects of a typical fuel spill that could potentially occur in the vicinity of the Husky Lakes would be expected to be of a generally localized, short-term, low magnitude and rapidly reversible nature.

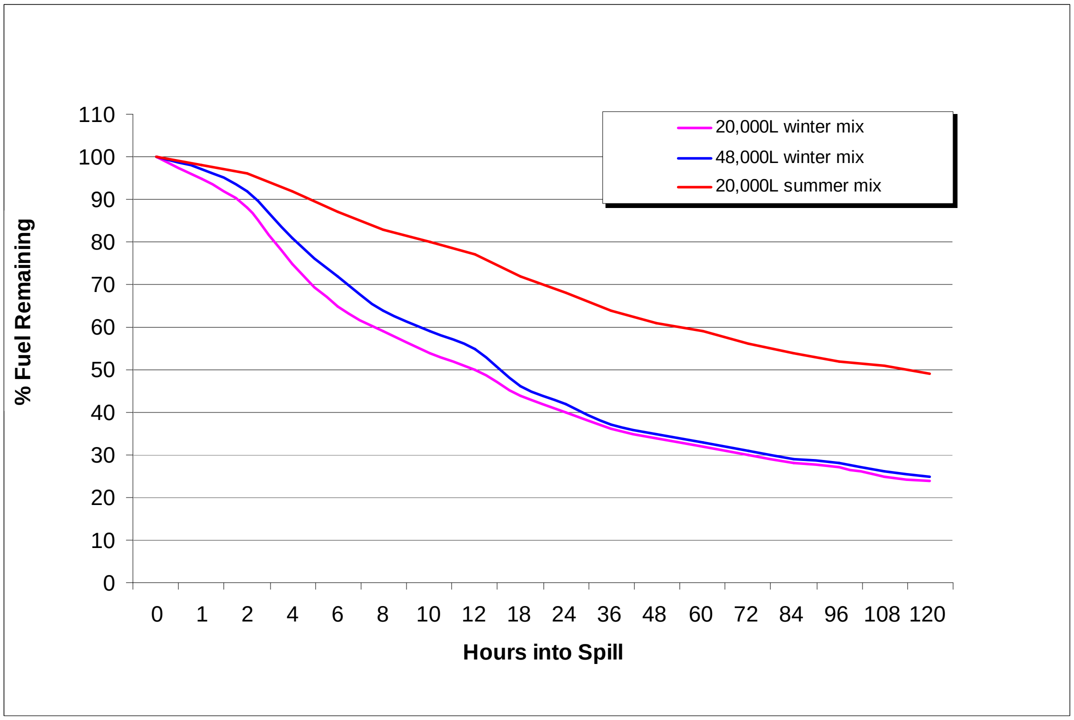

Figure 4.4.5-1.
Dissipation rates of 20,000 L and 48,000L Winter Mix Diesel Spills in Cold Water (10°C) and 20,000 L Summer Mix Fuels in Cold Water (10°C)

Heavier fractions of diesel fuel, found in summer mix fuels, do not evaporate as quickly and therefore persist for a longer period of time in the environment. However, northern fuel mixes are typically winter mixes and do not contain as high a proportion of heavier fractions in order to be usable during cold periods; therefore, the fuel types used in the Inuvik and Tuktoyaktuk communities typically would dissipate faster than the fuels used in more southerly climates.

4.4.5.3 Spill Mitigation

With the application and implementation of the preventative and mitigation measures within the spill contingency plan, no large (i.e. > 1,000 litres) fuel, chemical or other product spills are expected to occur. However, for the purposes of the worst case scenario, a brief description of the spill contingency plan is provided.

The spill contingency plan focuses on response, containment and recovery (INAC 2007, Appendix E). It is noted that response times will vary depending on the severity of crash, ability of the truck operator to respond to the spill (e.g., they may be injured and unable to respond), time it takes for assistance to arrive on the scene, and distance from either Inuvik or Tuktoyaktuk.

The creek crossings with the greatest potential to be affected (due to their location along the Highway) and their ability to convey spilled fuel to the Husky Lakes (due to their close proximity to Husky Lakes and high peak flow rates) include crossings:

- 29a (at KM 55.5);
- 30a (Hans Creek, at KM 56.5);
- 35a (at KM 89.5); and
- 39 (at KM 109).

Hans Creek's average peak discharge rate is approximately 14 m^3/s (Environment Canada 2011). None of these watercourses are within the 1 km setback from Husky Lakes.

According to Canadian Petroleum Association (CPA) and Independent Petroleum Association of Canada (IPAC), fuel in water will move at the same speed as the surface current; therefore, an effort must be made to slow this movement for recovery to be successful (CPA and IPAC 1989). Once spill responders are on the scene, booms would be typically deployed to divert or deflect fuel to an area for containment and recovery. Typically, conventional booms deployed from one shoreline to the other on an angle of 10 to 45 degrees toward a recovery area and integrated with a skimmer will create a system which is reliable under most conditions, even fast moving streams (Exxon 1992; CPA and IPAC 1989). Recovery typically occurs by direct suction of diesel from the surface. Final clean-up and recovery of remaining small amounts of fuel include the use of absorbents to "mop up" diesel soiled stream banks (Exxon 1992; CPA and IPAC 1989).

4.4.5.4 Vehicle Accident Mitigation

According to the GNWT DOT, there were 861 vehicle collisions in 2008, 179 or 21% of which occurred on highways in the NWT, the remaining accidents were in urban centres or involved all-terrain vehicles (GNWT DOT 2009a, 2009b).

Safety measures to prevent vehicle accidents on the proposed Highway have been and will continue to be incorporated into the Highway design. Measures to avoid, or minimize, accidents, particularly those which may occur at or near a watercourse crossing, will include posted speed limits, adequate signage alerting drivers to Highway curves and upcoming bridges. Bridge design will incorporate guardrails to prevent a vehicle from going off the Highway and into a watercourse in the event of an accident.

4.4.5.5 Fishing Effects and Compensation Values

This section identifies the compensation value related to the potential loss of fishing due to a fuel spill.

While it is noted that year-round fishing is of cultural importance to the communities in the region, the risk of environmental damage from an accidental diesel fuel spill is negligible during periods where watercourses and the Husky Lakes area are covered by snow and ice (i.e., between October and May of each year). Fishing during winter and spring are typically done using a hook and lure or gill nets set under the ice (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011; IOL et al. 2004; Joint Secretariat 2003; Roux et al. 2010). Due to the nature of the worst case scenario, fishing information presented here will be specific to harvests occurring during the open water season defined as the period of June to September.

In the open water season from June to September, only a few people use gill nets to fish (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). Data obtained from the Inuvialuit Harvest Study indicated that between 1988 and 1997 there were on average between 3 and 22 Inuvik residents and between 3 and 55 Tuktoyaktuk residents fishing for the period of June to September of any given year throughout the ISR. The differences in the number of people fishing relates to the target species of fish, with more people fishing for broad whitefish, lake whitefish and inconnu and fewer people fishing for burbot and lake trout.

The species selected to determine the value of the summer fish harvest include those mentioned above. They were selected based on their availability during the summer period, their potential to occur within the Husky Lakes, and the available data on past harvest rates. Recent information indicated that summer subsistence fishing using gill nets is typically carried out by one to three residents of Tuktoyaktuk (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011).

To identify the compensation values related to a loss of fishing, a cost per fish is required. In 1993 and 1997, the cost to purchase a fish was $12.18 (1993) and $12.22 (1997) (IOL et al. 2004). This monetary value of harvested fish was based on a calculation of the cost of replacing harvested fish, based on the Inuvik food price index (IOL et al. 2004). Another assessment of fish value from the public review of the WesternGeco Mackenzie Delta Marine 2D Seismic Program in 2003 stated that $25.00 per fish was acceptable based on the 1987 Wildlife Compensation Agreement between the IGC and Gulf Canada Resources Ltd. (EIRB 2003). Final determination of the estimated value of fish also included information from Mr. J. Pokiak who stated that each fish can be worth between $20 and $50 depending on their size (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). An assumption was made that captures of large fish (valued at $50 per fish) are the exception rather than the norm and the range of all fish values influenced the final determination that the value of $25 per fish was a reasonable replacement cost estimate.

Table 4.4.5-2 identifies average annual harvest from 1988 to 1997 for the open water season defined as June through September (4 months) based on the Inuvialuit Harvest Study for Inuvik and Tuktoyaktuk (Joint Secretariat 2003).

TABLE 4.4.5-2: AVERAGE FISH HARVESTS FROM JUNE TO SEPTEMBER IN INUVIK AND TUKTOYAKTUK (1988-1997)

Fish Species	Price per Fish	Inuvik		Tuktoyaktuk	
		Average Harvest	Income per species	Average Harvest	Income per species
Burbot	$25	93	$2,325	38	$950
Inconnu	$25	759	$18,975	1,818	$45,450
Lake Trout	$25	49	$1,225	92	$2,300
Broad Whitefish	$25	4,020	$100,500	9,025	$225,625
Lake Whitefish	$25	2,178	$54,450	1,009	$25,225
Total		$177,475		$299,550	

Source: Joint Secretariat (2003)

Based on an average price per fish of $25, as described by Mr. J. Pokiak (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011) and EIRB (2003), the estimated fish harvesting loss should the worst case scenario occur (i.e., no fish harvested from June to September) would be $477,025 for the residents of Inuvik and Tuktoyaktuk.

Mr. J. Pokiak also indicated that the few residents, on average two or three people, who currently fish the Husky Lakes in the summer period, do so with multiple gill nets, and that gill nets can cost anywhere from $250 to $500 (depending on the net length and mesh size) and average approximately $300 per net (J. Pokiak, former President, Tuktoyaktuk HTC, pers. comm., January 7, 2011). Because gill nets are deployed perpendicular to the shoreline with one end above the high water mark and the other submerged, it is assumed that floating diesel would likely contact the shoreline and the exposed portion of each net.

Assuming that each person had all of their nets deployed along the shores of Husky Lakes, the total loss (liability) must also incorporate the replacement value of soiled or tainted nets resulting from the worst case scenario. It is therefore assumed that at least 10 nets per person will be in use and potentially soiled by a diesel spill. At an average cost of $300 per net, the total cost to replace all nets would be ($300/net x 10 nets/person x 3 people) $9,000. Added to the above cost the total potential loss equals $486,025.

The Developer acknowledges, however, that this amount does not account for the possible effects on the psyche, spiritual or cultural values of the people who use and enjoy the Husky Lakes area.

4.4.5.6 Final Worst Case Scenario Determination

In summary, the worst case scenario for the construction and operation of the proposed Highway would involve environmental damage to the Husky Lakes and effects to traditional activities and harvesting, caused by a fuel supply truck crash on the Highway, resulting in a fuel spill of greater than 10,000 litres into an open watercourse, which is a direct tributary to the Husky Lakes.

The worst case scenario was further defined to assume that:

- The fuel supply truck crash occurs during spring freshet when water levels, discharge and velocity are at their yearly peak and the potential for the greatest number of available pathways for conveyance downstream to the Husky Lakes is present;
- The spill of diesel fuel into a fish-bearing watercourse and ultimately into Husky Lakes would result in residents avoiding consumption of fish because of the perception that the fuel would taint the fish;
- The fish harvest season from Husky Lakes would be lost as a result of the diesel fuel input to Husky Lakes; and
- The fouling of fishing gear would result in replacement costs.

Following a detailed analysis of this worst case scenario, the threat of the worst case scenario occurring is considered low due to the short open water period, small number of fuel truck deliveries during the open water season, relatively short duration of persistence of diesel in the environment, mitigation measures such as spill contingency plans employed by transport delivery trucks to avoid spills, and safe Highway and bridge design to reduce the likelihood of accidents.

However, to estimate the potential liability of the developer for impacts of the proposed Highway development as a result of the worst case scenario, the perceived monetary loss of an entire summer season of fishing from the Husky Lakes for all residents involved in fish harvesting was determined to be $486,025. This figure does not, however, account for the possible effects on the psyche, spiritual or cultural values of the people who use and enjoy the Husky Lakes area.

4.5 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

There are potential for effects of the environment on the Project. These effects have been considered during the planning and engineering of the Project to integrate into its environmental surroundings and operate safely and reliably over its life. The potential physical and biological changes in the environment that could have implications for the Project are considered in the following subsections.

4.5.1 Climate Change

During the last half of the twentieth century, meteorological data indicate that mean annual air temperatures in the western Arctic have increased by more than 1.5˚C. This warming trend in the northern high latitudes is anticipated to continue in this century. Many adverse impacts are anticipated, including the degradation of permafrost and its attendant effects (Woo et al. 2007).

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.

To protect the permafrost terrain along the proposed Highway alignment, typical 'cut and fill' techniques commonly employed in southern areas of the Northwest Territories and elsewhere will not be used for this Project. Such traditional construction methods cut into protective layers of surface vegetation and organics, with the possible result of thawing in the permafrost below. Therefore, the current design includes only fills. This approach will protect the permafrost layer below the Highway surface.

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.

ey 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 geotextile fabric to assist in maintaining the integrity of the Highway embankment;
- The use of culverts to balance seasonal overland surface flows as necessary; 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.

4.5.2 Seismic Activity

Geotechnical hazards were reviewed during the planning stage of the Project, including fault zones and active seismic areas. The seismic hazard within the Project area is considered low based on the 2005 Seismic Hazard Map produced by the Geological Survey of Canada (NRC 2010b).

4.5.3 Landslides

Thaw flow slides are characterized by landslides that occur only in ice-rich soils in permafrost regions. Retrogressive thaw flows develop in ice-rich, fine-grained sediments and result from the thawing and subsequent flow of water-saturated ground. These failures can occur on very gentle slopes and hundreds of these features line the river banks and tundra lakes in the Project area. These landslides are typically relatively small, but over time can retreat some distance back from the rim and from the escarpment. Such a slide could potentially impact the Highway if one were to occur. The likelihood of a retrogressive thaw slide impacting the Highway has been reduced by purposely routing away from existing slides and steeper slopes that would be susceptible to failure. Figure 3.1.1-4 compares the distribution of recorded landslides on the Tuktoyaktuk Peninsula (Aylsworth et al. 2001) to the proposed route options.

4.5.4 Wildfire

Wildfire can affect the permafrost layer by removing the insulating protection provided by the organic layer, without which the rate of permafrost melting increases. Melting of permafrost can result in substantial thaw settlement, the loss of the soil structural integrity, and potentially affect the Highway foundation.

The potential for Project related activities to cause a wildfire is greatly reduced as the majority of the Highway embankment construction will be undertaken during the winter. Summer construction activities will include compacting and grading the Highway embankment, installation of certain culverts (to protect fish habitat) or adjustments to culverts installed in the previous winter. Dust suppression equipment, such as water trucks, will be on site during the summer construction period and if required could be used to combat a wildfire.

Relatively few fires have occurred in the RSA. Figure 3.1.8-5 identifies three fires that have occurred in 1968, 1974, 2003, and 2007, with the largest occurring in 1968, below the treeline, near Inuvik. Figure 3.1.8-3 identifies the post-fire land cover within this area.

Several points of fire ignition from 1988 to 2007 are also identified on Figure 3.1.8-5. The primary cause of ignition is lightning, followed by resident, recreation and unknown. It should be noted that although there are several points of fire ignition shown, these did not become fires. Very few fires have occurred in the RSA, since most of the RSA is located above the treeline and tundra fires are relatively rare.

5.0 CUMULATIVE EFFECTS ASSESSMENT

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" (Canadian Environmental Assessment Agency 2003). Overall cumulative effects are effects of all land or water uses on a Valued Ecosystem Component (VEC) or Valued Socio-economic component (VSC), including effects caused by the Project.

An assessment of cumulative effects provides a more complete understanding of what might happen to VCs 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.

As noted in the Environmental Effects and Mitigation Measures section of this Environmental Impact Statement (Section 4.0 and 6.0, respectively), it has been determined that, with the application of proposed mitigation measures, for all environmental and socio-economic VCs, the residual environmental effects associated with the construction and future operation of the Inuvik to Tuktoyaktuk Highway are anticipated to be low in magnitude and local in extent.

However, while individually no significant effects are anticipated, the purpose of the cumulative effects assessment (CEA) is 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.

In accordance with the EISC/EIRB guide for conducting cumulative effects assessments in the Inuvialuit Settlement Region (Kavik-Axys Inc. 2002), this assessment considers and addresses 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?

5.1 SPATIAL BOUNDARIES

For purposes of this cumulative effects assessment (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 shown in Figure 4.3.8-1). 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.

The Regional Study Area (RSA) for the Project has been determined as the area within 15 km of the Highway (30 km total width). The Local Study Area (LSA) for the Project has been determined as the area within 0.5 km of the Highway (1 km total width) and the Project footprint is defined as the area directly under the Highway alignment and the area used during borrow source activities (Figure 4.1.3-1).

5.2 TEMPORAL BOUNDARIES

For purposes of this CEA, the temporal (time frame) for the assessment will be the next four (4) to ten (10) years, during which time construction of the proposed Highway is anticipated to be completed and the Highway will have been in operation for up to six (6) 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.

5.3 OTHER PAST, PRESENT AND FUTURE PROJECTS / ACTIVITIES CONSIDERED

Other potential past, present and future projects/activities that could influence the cumulative effect of the Project are as follows (from IOL et al. 2004):

- Settlements – communities, private land, medical facilities, police facilities and military sites;
- Transportation infrastructure – all weather roads, limited use roads, airstrips, seaplane bases, barge landings, fuel caches, docks and wharves;
- Industry (non-oil and gas) – forestry operations, sawmills, mining, quarries, grazing, herding, power lines, telecommunications lines, outfitting camps, lodges, cabins and camp sites;

- Industry (oil and gas) – exploration leases, significant discovery leases, seismic lines, pipelines, artificial islands, well sites and other facilities;
- Designated areas – bird sanctuaries, national parks, international biophysical program sites, historical sites, points of interest, wildlife sanctuary and other sites.
- Land uses – hunting and fishing, reindeer herding, and tourism and recreation.

These same land uses are applicable to assessing possible cumulative effects for the Inuvik to Tuktoyaktuk Highway (IOL et al. 2004).

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 Northern Canada Power Commission (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
- 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 4.3.8-1 shows existing land use in the general vicinity of the proposed Highway.

5.3.1 Past and Existing Projects

5.3.1.1 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 4.3.8-1).

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 the *Canadian Environmental Assessment Act*. 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 5.3.1-1). There are currently no geotechnical or 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 proposed 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 5.3.1-1
Right-of-way at the End of Navy Road

5.3.1.2 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.

Construction of the road was completed in 2010 by an experienced local 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 2.6.3-1, 2.6.3-2 and 2.6.3-3 in Section 2.6 of this Environmental Impact Statement 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 were 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 were implemented to mitigate these minor issues.

As part of the construction of the Inuvik to Tuktoyaktuk Highway, the current Tuktoyaktuk to Source 177 Access Road will require upgrading 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 any management restrictions 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.

5.3.1.3 Winter Access Trails

Since the introduction of snowmachines, 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 4.3.8-1).

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 4.3.8-1).

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 snowmachines 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.

With the application of the planned mitigation measures there will be no opportunity for a potentially significant adverse cumulative environmental effect to occur.

5.3.1.4 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 2009b). The route of this former power line is shown in Figure 4.3.8-1.

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 and no significant cumulative environmental effect is expected to occur as a result of this former power line.

5.3.1.5 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.

5.3.1.6 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 1970s. The number of these wells, compared to the size of the regional study area is considered to be minimal and combined with proposed Project are not expected to result in significant adverse environmental effects.

5.3.2 Potential Future Projects/ Activities

5.3.2.1 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 4.3.8-2). 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) interconnects 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 biophysical and socio-economic components, including:

- 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; and
- The economy (including demographics); infrastructure and community services; individual, family and community wellness; non-traditional land and resource use; and heritage resources (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 socio-economic assessment determined that there would be a temporary and marginal increased potential for in-migration of people from outside the study area to the regional and commercial centres. Effects on transportation, recreation, energy or utility, and public wellness, health, and protection service providers are expected to be minor. Use of borrow sites will result in a cumulative reduction in total granular resources and a net increase in the accessible granular resources for use by local communities and other developments (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 biophysical or socio-economic cumulative effects.
- There were no significant overall cumulative effects.
- The project could contribute to two potential cumulative effects of management concern, direct grizzly bear mortality and competition for qualified northern goods, services and labour[13], which could be addressed with diligent monitoring and management by responsible parties.

[13] Some of the projects identified as competing for qualified northern goods, services and labour are underway or completed at this time and would no longer create competition. Project include: Deh Cho Corporations proposed Mackenzie River bridge at Fort Providence, Devon Canada Corporation's proposed Beaufort Sea Exploration Drilling

- The demand for qualified northern content in projects is expected to use all available northern capacity, which will limit the extent of both potential increased benefit and social costs among northern residents. However, it could marginally increase the temporary attraction of speculative in-migration, and associated social costs in the regional and commercial centres of Inuvik and Norman Wells.
- 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 are not yet available; and
- Based on the project footprint, the project would disturb a negligible proportion of the regional study area.
- 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.

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. 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).

The project recently received approval from the National Energy Board and the federal cabinet. The Mackenzie Gas Project partners have until December 31, 2013 to decide whether they will go ahead with the construction of the $16.2-billion project. 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.

Program, GNWT Mackenzie winter road bridges between Wrigley and Fort Good Hope, De Beers Snap Lake underground diamond mine.

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.

5.3.2.2 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 4.3.8-1). 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 4.3.8-1). 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.

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.

5.3.2.3 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 tonnes 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.

5.3.2.4 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.

The Inuvialuit Land Administration has also created a draft Husky Lakes Special Cultural Area Criteria: ILM Special Area Plan (ILA 2010). Although in draft format, this Plan identifies the boundary of the Husky Lakes Special Cultural Area, which is in addition to other Husky Lakes management areas. If approved, the ILA will employ the use of these criteria to review proposed projects. The Primary 2009 Route, Alternative 1 (2009 Minor Realignment), Alternative 2 (Upland Route), and Alternative 3 (2010 Minor Realignment) are all partially located within the cultural area. Therefore, if approved, the Project will be required to address the performance criteria and management goals identified in the draft ILM Special Area Plan.

In addition, under the *Inuvialuit Final Agreement*- Annex D, the Husky Lakes have two management designations, Area 1 and Area 2. Area 1 does not allow dredging or marine development. Area 2 does not allow dredging or marine development, and has other terrestrial criteria that must be conformed to. The proposed Highway is not located within Area 1 or Area 2.

As confirmed during the October 2009 and January 2010 community consultations and previous consultations for the Tuktoyaktuk to Source 177 Access Road, 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. 2008) 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 3.2.9-1 and 3.2.9-2).

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. Based on the feedback from community members, the Project is unlikely to cause a significant adverse residual effect over and above existing effects.

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.

5.4 VALUED COMPONENTS AND THE PROJECT

The valued components for this Project have been identified in Section 4.1 of this EIS. The major VECs which were identified include: terrain, geology, soils, permafrost, air quality, noise, water quality and quantity, fish and fish habitat, vegetation, wildlife and wildlife habitat, birds and bird habitat. The major socio-economic VSCs that were identified include demographics, regional and local economies, education and training, infrastructure and institutional capacity, human health and wellness, socio-cultural patterns, harvesting, land use and archaeological resources.

The cumulative effects assessment focuses only on adverse effects of the Project remaining after the application of mitigation measures. For this Project, residual effects identified in Section 4.2 and 4.3 are carried forward into the cumulative effects assessment, and are summarized in Table 5.4-1.

TABLE 5.4-1: RESIDUAL EFFECTS FOR VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS	
VEC/VSC	**Description of Residual Effect**
Valued Ecosystem Components	
Terrain, Geology, Soil and Permafrost	Residual effects on the terrain are expected as a borrow source will leave some mark on the land. Mitigation measures are intended to minimize the footprint of a single borrow source and minimize the number of borrow sources that are opened for the construction phase.
Noise	Following the implementation of mitigation, residual effects from noise emissions during construction and operations phases are negligible.
Water Quality, Quantity and Hydrological Regime	Following the implementation of mitigation, the Project is not expected to result in adverse residual effects on water quality, water quantity, or flow patterns.
Fish and Fish Habitat	Following the implementation of mitigation, the Project is not expected to result in adverse residual effects on fish or fish habitat.
Vegetation	Within the LSA, the removal or burial of vegetation types and plant species/groups will occur during construction and the effects will remain so long as the Highway is in place. The effect is considered of high magnitude and of moderate, localized consequence. The effects of borrow source development on vegetation types and plant species/groups during construction results in high magnitude, but reversible effects, with overall low consequence residual effects. The effect of dust, invasive plant species introduction and alteration of local hydrology are considered to be of low magnitude and low consequence. In the context of the regional study area, residual effects have been determined to be negligible.
Wildlife (Caribou)	Residual effects are anticipated to be negligible with the exception of potential vehicular impact and increased hunting. The effects of potential vehicular impact and increased hunting are predicted to be low magnitude effects with a moderate (vehicle collisions) to low (hunting) level of consequence based on duration.
Wildlife (Grizzly Bear)	The net habitat and disturbance effects from the proposed development are expected to be limited to the local grizzly populations and are therefore low in consequence at the local population level. The overall impacts of the proposed Highway and operational activities are considered to be low to moderate within the LSA, and negligible within the RSA.
Wildlife (Moose)	Residual effects are anticipated to be negligible with the exception of potential vehicular impact and increased hunting. The effects of potential vehicular impact and increased hunting are predicted to be low magnitude effects with a moderate (vehicle collisions) to low (hunting) level of consequence based on duration.
Wildlife (Furbearers)	The net habitat and disturbance effects from the proposed development are expected to be limited to the local furbearer populations and are therefore low in consequence at the local population level. The overall impacts of the proposed Highway and operational activities are considered to be low to moderate within the LSA, and negligible within the RSA.
Birds	Following the implementation of mitigation, the Project is not expected to result in adverse residual effects on birds and bird habitat.

TABLE 5.4-1: RESIDUAL EFFECTS FOR VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS	
VEC/VSC	**Description of Residual Effect**
Valued Socio-Economic Components	
Harvesting	With effective management of harvesting activities by users of the Highway, residual effects of harvesting on the wildlife and fish populations of the area are expected to be minimal.
Land Use	The Highway, as a linear development, will result in a localized residual effect on land use.
Heritage and Archaeological Resources	Further archaeological impact assessments are required to determine if archaeological resources are present and to prepare site-specific mitigation measures to ensure that effects on archaeological resources will be negligible within the LSA and RSA.

Based on results of the effects assessment completed in Section 4.0, VECs/VSCs that are likely to experience residual *adverse* effects include vegetation, wildlife, harvesting and land use. These specific VECs/VSCs are discussed further in the following subsections.

5.4.1 Significance Determination for the Highway in Relation to Past, Present and Future Projects

The effects assessment or discussion for the each of the past, present and future projects determined that none of those projects are likely to result in residual effects. The effects assessment completed for this Project identified vegetation, wildlife and land use as VEC's/VSC's where residual effects may be a concern.

The EIRB guidance document provides the following guidance on estimating thresholds where they are not readily available from standards, regulations, or directives:

- During consultations with HTCs and community residents, discuss how CCPs and the community's needs and desires can contribute to an evaluation of significance;
- In the absence of established thresholds or standards, use standards and thresholds from other jurisdictions, with the proviso that geographic, ecological and social differences are taken into account;
- Use best professional judgement, including peer review and consensus; and
- Keep up-to-date and informed of ongoing work by industry, government and non-government organizations regarding resource management and cumulative effects.

These recommendations have been incorporated into the significance determination provided in Table 5.4.1-1.

Table 5.4.1-1 is adapted from the EIRB's cumulative effects assessment guide (Kavik-Axys Inc. 2002). The table presents the Project components with residual effects and their potential interaction with past, present and future projects (which were not anticipated to have residual effects on their own).

Table 5.4.1-1 summarizes residual effects that have been identified following the effects assessment completed in Section 4.2 and 4.3. As mentioned previously, the VECs/VSCs identified as having residual effects included vegetation, wildlife and land use. For each of these components the screening matrix looked at what are the key anticipated effects and mitigation measures used to address those effects at a local and regional scale. Mitigation applied at a local scale is often sufficient to address effects at a regional scale as well. Following the application of these mitigation measures, the matrix includes determinations, based on the effects assessment and professional judgement of the possible significance of an effect. The significance determination includes a ranking as Class 1, 2 or 3. These classes are typically based on thresholds but because the VECs/VSCs don't include readily measurable or quantifiable parameters, the Classes are used as a general guideline to rank effects.

Based on the effects identified for each of the VECs/VSCs and the associated mitigation measures and class of effects, the cumulative effects assessment resulted in a determination of no significant effects for all but one component. The magnitude of effects for all components was deemed to be low with the exception of vegetation removal for the right of way which was deemed to be low to moderate. For vegetation and wildlife effects at the local scale and land use at a regional scale, the residual effects are unlikely to result in significant cumulative effect over the long term. Significance was determined for land use at the local scale, as the Highway will affect land use in this area and will provide all weather access to new parts of the region. The land use effect is considered to have both positive and negative aspects, and the benefit of the new Highway will likely overshadow the low magnitude of effects of the Highway on land use.

The developer is committed to participating with other parties in a cumulative effects monitoring program.

Based on this effects assessment and the mitigation measures proposed, the residual effects identified for Vegetation, Wildlife and Land Use may influence the Project area at a local scale but are not expected to have a significant influence or effect at the regional level. No additive or synergistic relationships between the Project and other existing or proposed projects were found to result in a significant cumulative effect on VECs or VSCs.

TABLE 5.4.1-1: SCREENING MATRIX FOR CUMULATIVE EFFECTS TO VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS AT A LOCAL AND REGIONAL SCALE

VEC/VSC	Project Specific Effect	Is there a possible overlap with other projects/activities?		Is there a potential cumulative effect on the VC?	Effects Management		Probable Trends of VEC/ VSC	Effect Type	Magnitude of Effect	Class of Effect	Significance
	Description	Spatial	Temporal		Project Specific	Regional					
Terrain, Geology, Soil and Permafrost	Borrow source activities	Yes	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -minimize borrow source footprint -minimize number of borrow sources -follow TAC's guidelines for *Development and Management of Transportation Infrastructure in Permafrost Regions* -conduct progressive remediation of borrow sources	Participate in ISR cumulative effects initiatives	Negative	Project	Low to Moderate	Class 2	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
Vegetation	Removal of vegetation for Highway right-of-way	Yes	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -reclaim to viable and self-sustaining vegetation types	Participate in ISR cumulative effects initiatives	Negative	Project	Low to Moderate	Class 2	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	Removal of vegetation for borrow sources	No	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -reclaim to viable and self-sustaining vegetation type	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3 (because areas will establish vegetation over time)	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	Dust, invasive species and altered hydrology	Yes	Yes	Yes	-see mitigation measures discussed in 4.2.6.6 -apply dust suppressants, as per the GNWT *Guideline for Dust Suppression* (GNWT 1998) -ensure machinery and equipment is clean prior to use -Periodic monitoring of roadsides for invasive species -Design tailored appropriately to accommodate unique environmental conditions; -adequate drainage in wet lowland areas through the use of appropriately designed culverts -appropriate spill management	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
Wildlife	-potential interaction with caribou and caribou habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	-potential interaction with grizzly bear and grizzly bear habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 -design route through less sensitive habitats -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes - If active bear 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.	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant

TABLE 5.4.1-1: SCREENING MATRIX FOR CUMULATIVE EFFECTS TO VALUED ECOSYSTEM COMPONENTS AND VALUED SOCIO-ECONOMIC COMPONENTS AT A LOCAL AND REGIONAL SCALE

VEC/VSC	Project Specific Effect	Is there a possible overlap with other projects/activities?		Is there a potential cumulative effect on the VC?	Effects Management		Probable Trends of VEC/ VSC	Effect Type	Magnitude of Effect	Class of Effect	Significance
	Description	Spatial	Temporal		Project Specific	Regional					
	-potential interaction with moose and moose habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 -minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	-potential interaction with furbearer and furbearer habitat	Yes	Yes	Yes	-see specific mitigation measures discussed in 4.2.7 --minimize footprint and avoid sensitive vegetation types/areas -restrict off-site activities -implement wildlife management plan -minimize traffic during construction phase -carefully manage wastes - If active 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 and depending on the species in question	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
	-wildlife/vehicle interactions over the life of the Project	Yes	Yes	Yes	-relatively minimal (150-200 vehicles per day) traffic reduces the risk of potential traffic-related mortality -Post signage warning of potential wildlife crossings in areas where wildlife are known to frequent (i.e. known migration corridors)	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant
Land Use	-footprint of all-weather Highway across landscape	Yes	Yes	Yes	-prohibit off-site activities of construction crews -prohibit recreational use of Highway by Project staff during construction	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 2	Significant
							Negative	Regional	Low	Class 3	Not Significant
Harvesting	-temporary disruption of access to harvesting areas during construction and increased access to harvesting areas following construction	Yes	Yes	Yes	-design of route options away from Husky Lakes area -comply with wildlife harvesting regulations -contribute to education program/ signage along Highway for Highway users, in collaboration with wildlife management organizations	Participate in ISR cumulative effects initiatives	Negative	Project	Low	Class 3	Not Significant
							Negative	Overall	Low	Class 3	Not Significant

Source: Kavik-Axys Inc. (2002)

Class 1 Effect: The predicted trend in the measurable parameter under projected levels of development could threaten the sustainability of the VEC in the study area, and should be considered of management concern. Research, monitoring and/or recovery initiatives should be considered under an integrated resource management framework. Any negative change in VEC value of greater than 25% from benchmark is considered to be a Class 1 effect, regardless of VEC trend at the time of the assessment.

Class 2 Effect: The predicted trend in a measurable parameter under projected levels of development will likely result in a decline in the VEC to lower-than baseline but stable levels in the study area after Project closure and into the foreseeable future. Regional management actions such as research, monitoring and/or recovery initiatives may be required if additional land use activities are proposed for the study area before Project closure.

Class 3 Effect: The predicted trend in the measurable parameter under projected levels of development may result in a decline in the VEC in the study area during the life of the Project, but VEC levels should recover to baseline after Project closure. No immediate management initiatives, other than requirements for responsible industrial operational practices, are required.

6.0 MITIGATION AND REMEDIATION SUMMARY

A goal of the EIRB, as set out in the IFA, is to determine whether potential negative effects to wildlife, wildlife habitat, and wildlife harvesting can be minimized to acceptable levels using mitigative and remedial measures (EIRB 2010). This section of the EIS summarizes mitigative and remedial strategies that will be implemented to avoid or minimize potential effects to the Valued Components (VCs) identified through the environmental assessment process, to ultimately avoid affecting wildlife, wildlife habitat and wildlife harvesting.

Table 6-1 provides a summary description of the proposed mitigation strategies that will be implemented to avoid or minimize potential effects to the Valued Components (VCs) identified for this Project. VCs were selected for this EIS based on a combination of the directions provided in the EIRB Terms of Reference (2010), the Developer's understanding of the biophysical and socio-economic components, traditional knowledge as specified in the CCPs, the *Inuvialuit Final Agreement* and information gathered through consultation. Potential effects have been predicted for each VC, particularly related to the role of the VC in the ecosystem and to the Inuvialuit community. Table 6-1 summarizes the mitigation measures and strategies described in the effects assessment (Sections 4.2 and 4.3) of the EIS. Mitigation strategies for this Project include: Highway design, route location options, construction timing, additional field studies and monitoring, adaptive management, and contingency plans.

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
Noise	Construction and Operations: • Blasting • Heavy equipment • Vehicle traffic	Wildlife Effects: • Sensory disturbance • Behaviour alteration / avoidance	• Construction timing to avoid sensitive periods • Follow noise guidelines • Noise reduction planning, and implementation • Equipment will be properly maintained to ensure noise is minimized	• Based on advice from wildlife experts, the proximity of construction activities may be limited during sensitive periods, in accordance with relevant guidelines • Vehicle movements will be managed to minimize construction traffic • Machinery will be maintained to minimize resulting noise • Borrow sources will be selected to minimize haul distance • Operations will be adaptively managed, in consideration of potential noise effects to VCs	• Project location is remote and construction noise effects will be temporary • Potential effects during construction and operation are expected to be minimal	• DFO (1998) *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* • INAC (2010d) *Northern Land Use Guidelines: Pits and Quarries, and Access Roads and Trails*	• Noise monitoring plan if required	Developer / Contractor
Terrain, Geology, Soil and Permafrost	Construction: • Blasting • Heavy equipment • Borrow source activity • Highway construction Operation: • Borrow pit activity • Highway operation	• Change in drainage and surface hydrology • Thaw slumps • Melting of ice-rich ground • Slope and soil instability • Erosion • Subsidence in permafrost • Permafrost thaw and Differential Settlement	• Winter construction, hauling, and stockpiling • Summer access via embankment • Protect permafrost by Highway alignment, embankment, and borrow pit design • Ensure proper drainage • Use appropriate materials for embankment • Borrow pits will be reclaimed upon decommissioning • Adaptive management	• Construct embankment during winter • Access and haul from borrow sources in winter • Conduct summer activities only where accessible by existing embankment • Stockpile materials on existing embankment • Minimize surface area of open cut • Grade slopes to minimize slumping • Grade storage and work areas to promote drainage • Grade slopes and replace overburden during borrow source reclamation • Design and construct embankments based on terrain type • Design Highway alignment to avoid unfavourable terrain • Install sufficient cross-drainage • Conduct spring and fall drainage inspections	• Similar techniques were used successfully on other road construction projects in the ISR • Vegetation and soil remain intact during construction with ground temperatures maintained; avoiding permafrost melting • Maintain drainage and surface hydrology	• INAC (2010d) *Northern Land Use Guidelines: Pits and Quarries, and Access Roads and Trails* • Transportation Association of Canada (2010) *Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions*	• Pit development plans • Environmental monitoring plan	Developer / Contractor
Water Quality and Quantity	Construction: • Borrow source construction • Highway construction Operation: • Borrow pit operation • Highway operation	• Reduced water quality or quantity • Contamination of surface water due to spills, erosion, sedimentation • Reduced water quantity • Changes to surface water flow regimes • Effects to fish and/or fish habitat • Effects on human health	• Construction timing • Highway, and in particular stream crossing, design • Erosion and sediment control strategies • Environmental Management and Spill Contingency Planning • Consultation and direction from DFO regarding fish habitat protection and/or compensation • Environmental monitors during construction • Adaptive management	• Erosion and sediment control measures • Primarily winter construction timing • Dust suppression during construction and operation • Adequate emergency spill planning and personnel training will be implemented • Activities that disturb soil and vegetation will be limited and monitored • Designate areas for refuelling and servicing vehicles and equipment • Environmental monitoring will occur throughout Project construction • Equip all vehicles and equipment with spill kits during construction • Minimize clearing and vegetation removal	• Similar techniques were used successfully on other road construction projects in the ISR	• DFO *Operational Statement for Culvert Maintenance* • DFO *Operations Statement for Temporary Stream Crossings* • DFO (2005) *Protocol for Winter Water Withdrawal in the Northwest Territories* • Conditions of Water License • DFO (1993) *Land Development Guidelines for the Protection of Aquatic Habitat* • CCME (2007) *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table* • GNWT (1993) *Guideline for Dust Suppression*	• Erosion and sediment control plan • Environmental management plan • Spill contingency plan	Developer / Contractor

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
Changes to Hydrological Regime	Construction: • Culvert installation • Temporary and permanent stream crossings	• Effects on fish and fish habitat • Effects to downstream users • Flooding of habitat • Disrupted, reduced or eliminated flow • Wetland backfilling	• Construction timing • Highway routing and design • Infrastructure design and effectiveness • Monitoring for effects during and after construction • Consultation and direction from DFO regarding fish habitat protection and/or compensation • Environmental monitors during construction • Adaptive management • Regular culvert maintenance during operations, as required	• Design Project to accommodate site hydrology • Avoid sensitive areas during construction • Install and maintain crossing structures • Manage site drainage properly • Select culvert sizes appropriate to conditions, including maximum flow conditions • Monitor culverts after installation, to ensure flow • Select infrastructure to allow fish passage where necessary	• Similar techniques were used successfully on other road construction projects in the ISR	• DFO (1993) *Land Development Guidelines for the Protection of Aquatic Habitat* • DFO *Operational Statement for Culvert Maintenance* • INAC *Northern Land Use Guidelines for Roads and Trails* (2010c)	• Construction environmental management plan • Post-construction monitoring plan • Habitat monitoring program for fish • Erosion and sediment control plan	Developer / Contractor
Species at Risk and Species of Special Status or Management Concern	Construction: • Highway • Borrow pit • Blasting • Heavy equipment Operation: • Highway • Borrow pit	• Mortality or injury • Sensory disturbance • Displacement • Habituation and attraction • Interference with migration • Population effects • Increased harvest pressure • Habitat loss or degradation	• Project design and planning • Construction timing • Wildlife management plan • Construction environmental management plan • Spill Contingency Plan • Waste management plan • Progressive reclamation of borrow sources • Consultation and direction from regulatory agencies • Adaptive management • Public education • Wildlife monitors during construction	• Conduct field studies prior to construction, as necessary • Monitor for wildlife and birds during construction • Project routing will avoid sensitive locations and periods, where possible • Construction personnel will receive wildlife training • Encourage public education through signage for wildlife crossings and regarding hunting restrictions during operations • Regulation, monitoring and enforcement of harvest will be implemented • Wildlife deterrent mechanisms • Document, report and avoid wildlife and wildlife dens and bird nests during construction • Setbacks will be used to protect sensitive wildlife features • Lighting will be installed and managed, to reduce harm	• Current harvesting restrictions in place • No-hunting corridors have been successfully established along the Liard and Mackenzie Highways and the Ingraham Trail (Highway 4).	• *Species At Risk Act*	• Spill contingency plan • Wildlife management plan • Construction environmental management plan	• Developer/ Contractor • Stakeholders • ILA, HTC, ITC, WMAC, and GNWT ENR
Land and Resource Use by Inuvialuit	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved access to areas used for hunting and fishing • Potential increased hunting pressure on wildlife • Potential alteration to wildlife distribution patterns	• Cooperation with regulatory agencies • Public education	• Construction crews will be required to stay on authorized access roads and within the construction area at all times • During the operations phase, install signage and educational materials to encourage Highway users to stay on the designated Highway • Minimum 1 km setback from Husky Lakes area	• Results of community consultations • Land and resource use is a valued part of the Inuvialuit identity • Special management areas must be	• Draft *Husky Lakes Special Cultural Area Criteria: ILM Special Area Plan* (ILA 2010) • EIRB (2002) *Husky Lakes Criteria* • *Husky Lakes Integrated Management Planning Study* (2001) • Tuktoyaktuk CCP • Inuvik Inuvialuit CCP	• Wildlife monitoring during construction	• Developer/ Contractor • GNWT ENR, FJMC, IGC, HTC, ILA • Highway Users

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS

Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
					managed according to various Inuvialuit legislation, plans, and guidelines. • Similar adaptive management techniques were used successfully on other road construction projects in the ISR	• *Inuvialuit Final Agreement*		
Areas of Special Ecological and Cultural Importance	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved access to or near areas of ecological and cultural importance • Potential construction-related effects • Potential effects from Highway users	• Project planning and route selection to avoid areas of importance • Setbacks from areas of importance • Public education • Consultation and guidance from ILA	• Highway is located a minimum of 1 km from the Husky Lakes • Construction vehicles will stay on access roads or the construction site at all times • Recreational use of all-terrain vehicles and snowmachines by construction personnel while working on the Highway will not be permitted • Recreational use of the Highway by Project staff during construction will not be permitted • Signage will be installed encouraging Highway users to stay on the Highway	• Results of community consultations • Special management areas must be managed according to various Inuvialuit legislation, plans, and guidelines. • Similar adaptive management techniques were used successfully on other road construction projects in the ISR	• Draft *Husky Lakes Special Cultural Area Criteria: ILM Special Area Plan* (ILA 2010) • EIRB's *Husky Lakes Criteria* (EIRB 2002) • *Husky Lakes Integrated Management Planning Study* (2001) • Tuktoyaktuk CCP • Inuvik Inuvialuit CCP • *Inuvialuit Final Agreement*	• Environmental management plan	• Developer/ contractor • ILA • Highway Users
Land Designation Areas (as per IFA and CCPs)	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved access to special management areas • Potential construction-related effects • Potential effects from Highway users	• Project planning and route selection to avoid areas of importance • Setbacks from areas of importance • Public education • Consultation and guidance from ILA	• Construction vehicles will stay on access roads or the construction site at all times • Recreational use of all-terrain vehicles and snowmachines by construction personnel while working on the Highway will not be permitted • Recreational use of the Highway by Project staff during construction will not be permitted • Signage will be installed encouraging Highway users to stay on the Highway	• Results of community consultations • Special management areas must be managed according to various Inuvialuit legislation, plans, and guidelines. • Similar adaptive management techniques were used successfully on other road construction projects in the ISR	• Tuktoyaktuk CCP • Inuvik Inuvialuit CCP • *Inuvialuit Final Agreement*	• Environmental management plan	• Developer/ contractor • Highway Users
Tourism, Commercial and Public Recreational Use	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Improved tourism and recreational use • Increased opportunities for commercial ventures • Potential effects to tourist attractions during	• Project planning and route selection • Setbacks from areas of ecological and cultural importance • Construction timing	• Primarily winter construction • Accommodating winter construction crews in camps and not in tourist accommodations • Hiring northern workers and contractors to support the local economy, without displacing tourists	• Results of community consultations			• Developer/ contractor • Local Communities

TABLE 6-1: SUMMARY OF MITIGATION STRATEGIES FOR IDENTIFIED VALUED COMPONENTS								
Valued Component: Biophysical Component	Project Phase or Component	Potential Effect	Key Mitigation Measures[1]	Implementation Methods	Rationale for Use	Guidelines/ BMPs	Management and/or Contingency Plan(s) Required	Responsible Party
		construction		• Develop infrastructure for increased access to Tuktoyaktuk for tourists and other uses • Develop infrastructure between Tuktoyaktuk and Inuvik for personal and recreational use				
Heritage and Archaeological Sites	Construction: • Highway • Borrow source Operation: • Highway • Borrow source	• Increased access to heritage sites • Potential effects to archaeological resources and sites	• Archaeological impact assessment prior to construction • Archaeological sites protection plan • Approved site-specific mitigation measures, as required, by the PNWHC • Route selection and final design • Worker education • Adaptive management plan • Construction environmental management plan	• Identify all known heritage and archaeological sites to be avoided during construction • PNWHC-approved mitigation measures will be implemented throughout the duration of the construction process • Comply with the heritage resource protection legislation and regulations	• Archaeological resources are protected through various federal, territorial and Inuvialuit legislation and regulations.	• The *Northwest Territories Archaeological Sites Regulations*, pursuant to the *Northwest Territories Act* • NWT Archaeologists Permit	• Archaeological site(s) protection plan • Construction environment management plan • Site-specific mitigation plans, as necessary	• Developer/ Contractor • Qualified archaeologist • Prince of Wales Northern Heritage Centre

Note:
1 – detailed mitigation measures are described in the applicable effects sections.

7.0 FOLLOW-UP AND MONITORING

Several monitoring programs will be implemented during the construction and operations phases to monitor biophysical and socio-economic effects and regulatory compliance. This typically involves the collection of repetitive and repeatable measurements of parameters that characterize valued components.

To the extent possible, baseline information was presented in Section 3.0 for use as a baseline or benchmark in setting targets. Because of the scale of the Project, a phased approach to establishing further baseline conditions has been proposed. Prior to each construction season field surveys will be undertaken prior to the construction of that section of Highway. Examples of these surveys include:

- Wildlife surveys (including species at risk);
- Vegetation surveys (including rare plants and ecosystems);
- Wetlands and Aquatic Resources; and
- Archaeological impact assessments.

As discussed in previous sections of the document, environmental management plans will be developed for several Project components. The EMPs will clearly define compliance monitoring requirements, responsibilities, requirements for training, and reporting during construction. Contractors will be required to comply with the EMP.

Monitoring plans generally contain the following information:

- Policy objective – goals, commitments, outcomes to achieve
- Standards to be met – the specifications of a particular activity or process and how it will be carried out.
- Specific measures to be implemented – including equipment, materials, specific schedule or timing requirements
- Responsibility of tasks – clearly identify who is doing the activity
- Scheduling – anticipated length of activity and timing (season)
- Monitoring and reporting requirements – independent monitoring/inspection of activities and reporting mechanisms
- Contingency plans – procedures to be followed in the event accident or malfunction

Examples of a typical construction phase environmental management plan and wildlife management plan are included in Appendix E.

Compliance and effects monitoring activities will be conducted to ensure that the terms and conditions set out in regulatory approvals, licences and permits, and in the commitments are met, and to check the effectiveness of mitigation measures in avoiding or minimizing potential effects. To that end, the Developer will prepare an effects monitoring table and an inspection table prior to construction. The effects monitoring table will describe the indicators and parameters to be monitored and the target or management goal. The inspections table will describe the types of inspections required, the frequency of the inspections, and which phase of the Project the inspection will occur.

Monitoring frequency will vary depending on the activity, the proximity and sensitivity of potentially affected valued components, and occurrence of incidents. Issues may be recorded in daily reports maintained by on-site workers and later reviewed by the environmental monitor.

Compliance monitoring will be carried out to the extent, frequency and duration required by regulators and according to the results of baseline surveys and specific management plans. Generally, compliance monitoring is conducted on a part-time basis unless activities are occurring in a sensitive area. Monitoring frequency will be determined once the EMP is finalized.

An important feature of effective monitoring programs is the concept of "adaptive management". Both natural and social systems are dynamic and complex. While predicted effects are based on similar past projects and probable reactions, the interaction of a community or ecosystem with Project activities is largely unpredictable and the way in which these systems respond to mitigation measures is also unpredictable.

Adaptive management evaluates and adjusts management decisions (i.e., mitigation measures) to reflect the actual interactions. Therefore, management plans must remain flexible and dynamic throughout the entire life of the Project. Management and monitoring will be refined and revised as necessary.

The following subsections describe the Project's biophysical and socio-economic monitoring that will be conducted during construction and operations phases and the responsible parties, and the minimal monitoring overlap between the NWT Cumulative Impacts Monitoring Program and the Highway's monitoring program.

7.1 BIOPHYSICAL MONITORING

7.1.1 Construction

Environmental and wildlife monitoring will be done by third party monitors supplied by the ILA (environmental monitors) and the HTCs (wildlife monitors). The cost of supplying these monitors will be paid by the Developer/ construction contractor, as was done for the Tuktoyaktuk to Source 177 Access Road.

In-stream monitoring in connection with bridge construction and installation of culverts in fish-bearing streams may be required, particularly if a Fisheries Authorization is needed. Monitoring programs will be conducted during bridge and culvert installations, and conducted by professional consultants working on behalf of the Developer/ construction contractor.

7.1.2 Operations

Long-term monitoring of environmental conditions in the Mackenzie Delta are and will remain the responsibility of the natural resource management agencies including GNWT ENR, DFO, Environment Canada, WMAC, and FJMC. The Developer is willing to cooperate with these agencies in their monitoring activities.

7.2 SOCIO-ECONOMIC MONITORING

7.2.1 Construction

The Developer will require the contractor(s) to report on various parameters related to their activities. Parameters include:

- ISR hiring/contract preferences;
- Employment:
  - Number of workers employed;
  - Employee gender;
  - Location of employee residence; and
  - Wages paid.
- Training:
  - Types of training provided;
  - Number of employees trained;
  - Employee gender; and
  - Location of employee residence.

The Developer is willing to provide this information to related monitoring programs, upon request.

7.2.2 Operations (Long-term)

Long-term socio-economic monitoring is the responsibility of social development agencies, including IRC agencies, NWT Bureau of Statistics, GNWT ITI, GNWT MACA, and GNWT ECE.

7.3 NWT CUMULATIVE IMPACT MONITORING PROGRAM (CIMP)

The Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP) identifies thirteen valued components of the biophysical environment that are regularly monitored. Table 7.3-1 provides a comparison of the NWT CIMP VCs and the VCs in this EIS. The NWT CIMP focuses on the biophysical environment while the Project assessment also identifies potential effects to valued socio-economic components. There is some overlap between the CIMP VCs and the Project's valued ecological components.

TABLE 7.3-1: COMPARISON OF NWT CIMP COMPONENTS AND PROJECT VALUED COMPONENTS

NWT CIMP Valued Components	Project Valued Components
Snow, Permafrost and Ground Ice	Terrain, Geology, Soils and Permafrost
Water Quantity	Water Quality and Quantity Changes to Hydrological Regime
Water and Sediment Quality	
Fish Habitat, Population and Harvest	
Fish Quality	-
Moose	Species of Concern, Special Status or Management
Caribou	
Terrestrial Mammals	
Avian Wildlife	
Marine Mammals	-
Vegetation	-
Climate	-
Air Quality	Air Quality
-	Noise
Human Environment Components	
-	Land and Resource Use by the Inuvialuit
-	Land Designation Areas (CCPs and IFA)
-	Tourism, Commercial and Public Recreational Use
-	Heritage and Archaeological Sites

REFERENCES

Adamczewski, J., Boulanger, B., Croft, B., Cluff, D., Elkin, B., Nishi, J., Kelly, A., D'Hont, A.D., Nicolson, C. 2009. *Decline in the Bathurst Caribou Herd 2006-2009: A Technical Evaluation of the Field Data and Modeling. Draft Technical Report, December 2009*. Government of the Northwest Territories, Department of Environment and Natural Resources.

AECOM. 2009, October 28. *2007 Hamlet of Tuktoyaktuk Annual Water Licence Report.* Prepared by AECOM for the Hamlet of Tuktoyaktuk. Retrieved March 21, 2011 from http://www.nwtwb.com/0714_AR_2007.pdf

Alberta Energy and Utilities Board (Alberta EUB). 2007. *Directive 038: Noise Control.* Calgary, Alberta.

Allen, W.T.R. 1977. *Freezup, Breakup, and Ice Thickness in Canada.* Fisheries and Environment Canada, Atmospheric Environment.

Allen, A.W. 1984. *Habitat Suitability Index Models: Marten. FWS/OBS-82/10.11.* (Revised). Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service.

Allen, L. 2003. *Alberta Natural Heritage Information Centre Preliminary Plant Community Tracking List.* Edmonton, Alberta: Alberta Community Development.

AMEC Americas Limited. 2005. *Mackenzie Gas Project: Effects of Noise on Wildlife.* Prepared for Imperial Oil Resources Ventures Limited.

AMEC Earth and Environmental. 2009. *Assessment of Drilling Waste Disposal Options in the Inuvialuit Settlement Region.* Prepared for Environmental Research Funds, Report No. 173. Calgary, AB.

Andersland, O.B., and Ladanyi, B. 2004. *Frozen Ground Engineering* (Second Edition*)* (pp. 38-39). John Wiley & Sons, Inc.

Anderson, L.E. 1995. Economic Potential of the Mackenzie Delta Broad Whitefish Exploratory Fishery. *Can. Manuscr. Rep. Fish. Aquat. Sci.* 2319: IV + 17p.

Anderson, R., Linnell, J.D., and Langvatn, R. 1996. Short term behavioural and physiological response of moose *Alces alces* to military disturbance in Norway. *Biol. Conserv.* 77:179-176.

Anema, C., Hecky, R.E., Fee, E.J., Nernberg, D., and Guildford, S.J. 1990a. Water Chemistry of Some Lakes and Channels in the Mackenzie Delta and on the Tuktoyaktuk Peninsula, NWT, 1985. *Canadian Data Report of Fisheries and Aquatic Sciences No. 726*.

Anema, C., Hecky, R.E., Himmer, S., and Guildford, S.J. 1990b. Water Chemistry of Some Lakes and Channels in the Mackenzie Delta and on the Tuktoyaktuk Peninsula, NWT, 1985. *Canadian Data Report of Fisheries and Aquatic Sciences No. 729.*

Angold, P.G. 1997. The Impact of a Road Upon Adjacent Heathland Vegetation: Effects on Plant Species Composition. *Journal of Applied Ecology, 34*: 409-417.

Archibald, W.R., Ellis, R., and Hamilton, A. N. 1987. Responses of grizzly bears to logging truck traffic in the Kimsquit River Valley, British Columbia. *Int. Conf. Bear Res. and Manage, 7*: 251-257.

Athropolis. 2005. *Facts: Cold, Icy, and Arctic -Inuit History: 3000-5000 Years Ago -Paleo-Eskimo Period*. Retrieved February 1, 2011 from http://www.athropolis.com/arctic-facts/fact-paleo-eskimo.htm

Auditor General of Canada. 2005. Chapter 6 Indian and Northern Affairs Canada – Development of Non-Renewable Resources in the Northwest Territories. In *2005 April Report of the Auditor General.*

Auerbach, N.A., Walker, M.D., and Walker, D.A. 1997. Effects of Roadside Disturbance on Substrate and Vegetation Properties in Arctic Tundra. *Ecological Applications, 7* (1), 218-235.

Aune K., Madel, M., and Hunt, C. 1986. *Rocky Mountain Front grizzly bear monitoring and investigation*. U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Forest Service, Montana Dept. Fish, Wildlife and Parks.

Wildlife Information Network. 2011. *Avian Malaria in Waterfowl*. Retrieved February 8, 2011 from http://wildlife1.wildlifeinformation.org/Lists_Diseases/Disease.htm

Aurora College. 2009. *Home Page*. Retrieved December 22, 2010 from http://www.auroracollege.nt.ca/_live/pages/wpPages/home.aspx

Aylsworth, J.M., Traynor, J.A., and Krusynski, G. 2001. *Landslide inventory, Mackenzie Delta and adjacent Beaufort Sea Coast, Northwest Territories-Yukon; Open File 3915.*

Aylsworth, J.M., Burgess, M.M., Desrochers, D.T., Duk-Rodkin, A., Robertson, T., and Traynor, J.A. 2000. In (Eds.) L.D. Dyke and G.R. Brooks *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, Geological Survey of Canada, Bulletin 547*, 41-48.

Bader, M. 1989. Habituation in Yellowstone's grizzly bears: a special problem in wildlife management. *Western Wildlands 25*, 29.

Banci, V. 1994. Wolverine. In (Eds.) L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx and Wolverine in the Western United States General Technical Report RM-254* (pp. 99-127). Ft. Collins, CO: U.S Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Banci, V., and Moore, S. 1997. *1996 Wildlife studies, Lac de Gras, Northwest Territories*. Prepared for BHP Diamonds Inc. by Rescan Environmental Services. Vancouver, BC.

Banfield, A. 1974. *The mammals of Canada*. Toronto, Canada: University of Toronto Press.

Bangs, E.E., and Fritts, S.H. 1996. Reintroducing the gray wolf to central Idaho and Yellowstone National Park. *Wildl. Soc. Bull. 24*:402-13.

Bangs, E.E., Bailey, T.N. and Portner, M.F. 1989. Survival rates of adult female moose on the Kenai Peninsula, Alaska. *J. Wildl. Manage. 53* (3):557-63.

Barichello, N. 1998. *NWT Species Monitoring Infobase*. Yellowknife, NWT: Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Retrieved November 2009 from http://www.nwtwildlife.com/monitoring/speciesmonitoring/default.htm

Beanlands, G.E., and Duinker, P.N. 1983. *An ecological framework for environmental impact assessment in Canada*. Halifax: Dalhousie University, Institute for Resource and Environmental Studies. 132 pp.

Beauchamp, D.A. 1990. Movements, Habitat Use, and Spawning Strategies of Arctic Grayling in a Sub-alpine Lake Tributary. *Northwest Science 64*(4): 195-207.

Beaufort-Delta Education Council. ND. *Our Schools*. Retrieved December 22, 2010 from http://www.bdec.nt.ca/our-schools/index.shtml.

Beaufort-Delta Health and Social Services (BDHSS). ND. *Community Services*. Retrieved December 22, 2010 from http://bdhssa.nt.ca/community-services/index.html

Beaufort-Delta Health and Social Services (BDHSS). 2010a. *Tuktoyaktuk Community Services*. Retrieved December 17, 2010 from http://bdhssa.nt.ca/community-services/tuktoyaktuk/index.html

Beaufort-Delta Health and Social Services (BDHSS). 2010b. *Hospital Services*. Retrieved December 17, 2010 from http://bdhssa.nt.ca/hospital-services/index.html

Beaufort-Delta Health and Social Services (BDHSS). 2010c. *Inuvik Community Services*. Retrieved December 22, 2010 from http://bdhssa.nt.ca/community-services/inuvik/index.html

Beaufort-Delta Health and Social Services (BDHSS). 2010d. *Regional Services: Telehealth*. Retrieved January 25, 2011 from http://bdhssa.nt.ca/regional-services/index.html#telehealth

Beaufort-Delta Health and Social Services (BDHSS). 2010e. *Tuktoyaktuk Community Facts*. Retrieved December 22, 2010 from http://bdhssa.nt.ca/community-services/tuktoyaktuk/community.html

Beaufort-Delta Health and Social Services (BDHSS). 2010f. *Inuvik Community Facts*. Retrieved March 31, 2011 from http://bdhssa.nt.ca/community-services/inuvik/community.html

Begon, M., Harper, J.L., and Townsend, C.R. 1990. *Ecology: Individuals, Populations and Communities* (Second Edition). Boston, MA: Blackwell Scientific Publications.

Belant, J.L. 1995. Moose collisions with vehicles and trains in northeastern Minnesota. *Alces 31*:45-52.

Bellrose, F.C. 1976. *Ducks, Geese, and Swans of North America*. Harrisburg, PA: Stackpole Books. 544 pp.

Berg, W.E., and Kuehn, D.W. 1982. Ecology of wolves in north-central Minnesota. In (Ed.) F.H. Harrington and P.C. Paquet *Wolves of the world: perspectives of behavior, ecology, and conservation* (pp. 4-11). Park Ridge, NJ.

Betts, M. 2008. Subsistence and Culture in the Western Canadian Arctic. *Canadian Museum of Civilization Mercury Series Archaeology Paper 169*. Ottawa.

BHP Billiton (BHBP). 2007. Ekati Diamond Mine *2006 Wildlife Effects Monitoring Program*. Prepared by Rescan™ Environmental Services Ltd. for BHP Billiton Diamonds Inc.

Bider, J.R., and Pimlott, D.H. 1973. Access to hunting areas from major urban centres and big game kills in Quebec. *Ninth North American Moose Conference Workshop*, 59-80.

Birtwell, I.K. 1999. The Effects of Sediment on Fish and Their Habitat. *Cdn. Stock Assessment Secretariat Research Document 99/139, Fisheries and Oceans Canada*.

Blett, T., Geiser, L., and Porter, E. 2003. *Air Pollution-Related Lichen Monitoring in National Parks, Forests, and Refuges: Guidelines for Studies Intended for Regulatory and Management Purposes*. Colorado and Oregon: U.S. Department of the Interior and U.S. Department of Agriculture.

Blix, A.S., and Lentfer, J. W. 1992. Noise and Vibration Levels in Artificial Polar Bear Dens as Related to Selected Petroleum Exploration and Developmental Activities. *Arctic 45*, 20-24.

Bockstoce, J. 1986. *Whales, Ice, and Men: the History of Whaling in the Western Arctic*. Seattle, Washington: University of Washington Press.

Borek Air. ND. *Scheduled Flights from Tuktoyaktuk*. Retrieved January 3, 2011 from http://www.borekair.com/index.php/schedule/tuktoyaktuk

Boer, A.H. 1990. Spatial distribution of moose kills in New Brunswick. *Wildl. Soc. Bull. 18*, 431-434.

Bradshaw, C.J.A., Boutin S., and Hebert, D.M. 1998. Energetic Implications of Disturbance Caused by Exploration to Woodland Caribou. *Canadian Journal of Zoology 76*, 1319-1324.

Brown, L. 2001. Overview of research on the effects of noise on wildlife. *In Proceedings of the Effects of Noise on Wildlife Conference, Happy Valley-Goose Bay.*

Burgess, M.M., and Smith, S.L. 2000. Shallow ground temperature. In (Ed.) L.D. Dyke and G.R. Brooks *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, Geological Survey of Canada, Bulletin 547*, 89-103.

Burn, C.R. 2003. *Climate Change Scenarios for Mackenzie Gas Project. Internal Paper*. Prepared for Indian and Northern Affairs Canada (INAC). 11 pp.

Burn, C.R., Barrow, E., and Bonsal, B. 2004. Climate Change Scenarios for Mackenzie River Valley. *Session 7A - 57th Canadian Geotechnical Conference.*

Burn, C.R., and Kokelj, S.V. 2009. The Environment and Permafrost of the Mackenzie Delta Area. *Permafrost and Periglacial Processes 20*, 83-105.

Burn, C.R., Mackay, J.R., and Kokelj, S.V. 2009a. The Environment and Permafrost of the Mackenzie Delta Area. *Permafrost and Periglacial Processes 20*, 83-105.

Burn, C.R., Mackay, J.R., and Kokelj, S.V. 2009b. The Thermal Regime of Permafrost and its Susceptibility to Degradation in Upland Terrain near Inuvik, N.W.T. *Permafrost and Periglacial Processes 20*, 221-227.

Buskirk, S.W., and Powell, R.A. 1994. Habitat Ecology of Fishers and American Martens. In (Eds.) S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell *Martens, Sables, and Fishers: Biology and Conservation* (pp. 283-296). Ithaca and London, Ontario: Comstock Publishing Associates, Cornell University Press

Cadman, M.D., and Page, A.M. 1994. *NWT Species Monitoring Infobase*. Yellowknife, NWT: Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Retrieved November, 2009 from http://www.nwtwildlife.com/monitoring/speciesmonitoring/default.htm

Cameron, R.D., Reed, D.J., Dau, J.R., and Smith, W.T. 1992. Redistribution of calving caribou in response to oil field development on the Arctic Slope of Alaska. *Arctic 45*, 338-342.

Cameron, R.D., Smith, W.T., White, R.G., and Griffith, B. 2005. Central Arctic Caribou and Petroleum Development: Distributional, Nutritional, and Reproductive Implications. *Arctic 58* (1), 1-9.

Canada Housing and Mortgage Corporation (CHMC). ND. *Technical Series 94-221: Transportation in the North.* Retrieved January 5, 2011 from ftp://ftp.cmhc-schl.gc.ca/cmhc/94_221.html

Canadian Boreal Initiative. 2007. *Seeking a Balance: Assessing the Future Impacts of Conservation and Development in the Mackenzie Watershed.* ISBN 978-0-9733409-6-9.

Canadian Broadcasting Corporation. 2010, December 25. *Arctic Bound Mosque Makes Barge to Inuvik.* Retrieved from http://www.cbc.ca/news/canada/manitoba/story/2010/09/10/north-mosque-inuvik-barge.html

Canadian Cooperative Wildlife Health Centre. 1996. *Newsletter Vol. 4-1*, June 1996.

Canadian Council of Ministers of the Environment (CCME). 2002. *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table, Updated 2002.* Retrieved from http://www.ccme.ca/assets/pdf/aql_summary_7.1_en.pdf

Canadian Council of Ministers of the Environment (CCME). 2003. *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.* Retrieved from http://www.ccme.ca/assets/pdf/pn_1326_eng.pdf

Canadian Council of Ministers of the Environment (CCME). 2007a. *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary table. Updated December 2007.* Retrieved from http://ceqg-rcqe.ccme.ca/

Canadian Council of Ministers of the Environment (CCME). 2007b. *Guidance Document on Continuous Improvement (CI) and Keeping-Clean-Areas-Clean (KCAC): Canada-wide Standards for Particulate Matter and Ozone.* Retrieved December 16, 2010 from http://www.ccme.ca/assets/pdf/1389_ci_kcac_e.pdf

Canadian Environmental Assessment Agency. 2003, May. *Reference Guide: Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects.*

Canadian Environmental Assessment Agency. 2006. *Screenings under the Canadian Environmental Assessment Act. Catalogue No. En106-63/2006E.* Public Works and Government Services Canada.

Canadian Environmental Assessment Agency. 2010, December. *Notice of Approval: Substitution for Review Panel Process, Inuvik to Tuktoyaktuk Highway Project.* Retrieved March 1, 2011 from http://www.ceaa.gc.ca/050/details-eng.cfm?evaluation=58081&ForceNOC=Y

Canadian Wildlife Service, (Waterfowl Committee). 2007. Population Status of Migratory Game Birds in Canada: November 2007. *CWS Migratory Birds Regulation Report No. 22.*

Canadian Wildlife Service. 2009. *Migratory Birds Conservation. Monitoring and Report. Northern Pintail.* Retrieved February 18, 2011 from:
http://www.cws-scf.ec.gc.ca/mgbc/trends/index.cfm?lang=e&go=info.bird&speciesid=1430

Carlson, M.L., and Shephard, M. 2007. Is the spread of non-native plants in Alaska accelerating? In (Eds.) B. R. Harrington and S.H. Reichard *Meeting the challenge: invasive plants in Pacific Northwest ecosystems, General Technical Report, PNW-GTR-694* (pp. 111-127). Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Carrière, S. 2000. *NWT Species Monitoring Infobase*. Yellowknife, NWT: Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Retrieved November, 2009 from http://www.nwtwildlife.com/monitoring/speciesmonitoring/default.htm

Carruthers, D.R., Ferguson, S.H., Jakimchuk, R.D., and Sopuck, L.G. 1986. Distribution and Habitat Use of the Bluenose Caribou Herd in Mid-winter. *Rangifer, Special Issue (1),* 57.

Centre for Indigenous Peoples' Nutrition and Environment. NDa. *Benefits of Traditional Foods*. Retrieved November 23, 2010 from www.mcgill.ca/cine/research/Canada/food/benefits

Centre for Indigenous Peoples' Nutrition and Environment. NDb. *Contaminants in Traditional Foods*. Retrieved November 23, 2010 from: http://www.mcgill.ca/cine/research/canada/food/contaminants/

Chapman, R.C. 1977. *The Effects of Human Disturbance on Wolves*. (M.Sc. Thesis). Fairbanks, Alaska: University of Alaska.

Chatalain, E.F. 1950. Bear-Moose Relationships on the Kenai Peninsula. In (Eds.) T.W. Clark, E. Anderson and C. Douglas *Transactions of the North America Wildlife Conference 15*, 224-234.

Cinq-Mars, J., and Pilon, J.L. (Eds.). 1991. NOGAP Archaeology Project: An Integrated Archaeological Research and Management Approach. *Canadian Archaeological Association Occasional Paper 2*.

Clark, J. 2003. *Invasive Plant Prevention Guidelines*. Bozeman, Montana: Centre for Invasive Plant Management.

Clark, T.W., Anderson, E., and Douglas, C. 1987. Martes americana. *Mammalian Species Number 289,* 8. American Society of Mammalogists.

Clarke, G., Balls, V., Dalmer, D., Bouchet-Bert, L., and Mason, A. 2004. *Heritage Resources Focused Reconnaissance of the Mackenzie Gas Project. Northwest Territories Permit No. 2003-933*. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife, NWT.

Clarkson, P., and Liepins, I. 1989a. Inuvialuit Wildlife Studies: Grizzly Bear Research Progress Report 1987-1988. *Wildlife Management Advisory Council Technical. Report No.3,* 47. Inuvik, NWT.

Clarkson, P., and Liepins, I. 1989b. Inuvialuit Wildlife Studies: grizzly bear research progress report 1988-1989. *Wildlife Management Advisory Council Technical. Report No.8,* 25. Inuvik, NWT.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. *Assessment and Update Status Report on the Wolverine Gulo gulo in Canada*. Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2006. *Assessment and Status Report on the Rusty Blackbird Euphagus carolinus in Canada*. Ottawa. vi + 28 pp.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2007. *Update COSEWIC Status Report on Peregrine Falcon Falco peregrinus*. Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2009. Wildlife Species Search. *Committee on the Status of Endangered Wildlife in Canada*. Retrieved December 10, 2009 from http://www.cosewic.gc.ca

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011a. *Committee on the Status of Endangered Wildlife in Canada*. Retrieved from http://www.cosewic.gc.ca/eng/sct2/sct2_9_1_e.cfm

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2011b. *Database of wildlife species assessed by COSEWIC*. Updated February 3, 2011. Retrieved February 8, 2011 from http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm

Community of Inuvik, Wildlife Management Advisory Council and Joint Secretariat. 2000, June. *Inuvik Inuvialuit Community Conservation Plan: A Plan for the Conservation and Management of Renewable Resources and Lands within the Inuvialuit Settlement Region in the Vicinity of Inuvik, Northwest Territories.*

Community of Inuvik, Wildlife Management Advisory Council and Joint Secretariat. 2008, November. *Inuvik Inuvialuit Community Conservation Plan: A Plan for the Conservation and Management of Renewable Resources and Lands within the Inuvialuit Settlement Region in the Vicinity of Inuvik, Northwest Territories.* Retrieved January 8, 2011 from http://www.screeningcommittee.ca/pdf/ccp/Inuvik_CCP.pdf

Community of Tuktoyaktuk and Wildlife Management Advisory Council, NWT. 1993. *Tuktoyaktuk Conservation Plan: A Plan for the Conservation and Management of Renewable Resources and Lands around Tuktoyaktuk, Northwest Territories.*

Community of Tuktoyaktuk, Wildlife Management Advisory Council and Joint Secretariat. 2000, June. *Tuktoyaktuk Community Conservation Plan: A Plan for the Conservation and Management of Renewable Resources and Lands within the Inuvialuit Settlement Region in the Vicinity of Tuktoyaktuk, Northwest Territories.*

Community of Tuktoyaktuk, Wildlife Management Advisory Council and Joint Secretariat. 2008, April. *Tuktoyaktuk Community Conservation Plan: A Plan for the Conservation and Management of Natural Resources and Lands within the Inuvialuit Settlement Region in the Vicinity of Tuktoyaktuk, Northwest Territories.*

ConocoPhillips Canada (North) Limited (ConocoPhillips). 2004, October 7. ConocoPhillips Canada (North) Limited *Development Plan Application Pursuant to the Canada Oil and Gas Operations Act ("COGOA").* Submitted to National Energy Board.

ConocoPhillips Canada (North) Limited and ExxonMobil Canada Properties (ConocoPhillips and ExxonMobil). 2004, August. *Application for Approval of the Development Plan for Parsons Lake Field: Project Description*. Submitted to National Energy Board.

Copeland, J.P. 1996. *Biology of the Wolverine in Central Idaho*. (M.Sc. Thesis). University of Idaho.

Cornell Lab of Ornithology. 2011. Birds of North America Online. *Cornell Lab of Ornithology*. Retrieved February 4, 2011 from http://bna.birds.cornell.edu/BNA/

Cott, P.A., Monita, D.M.A., Majewski, A.R., Hanna, B.W., and Bourassa, K.J. 2005. Application of the NWT Winter Water Withdrawal Protocol with Bathymetric Profiles of Select Small Lakes in the Mackenzie Delta Region. Canadian. *Manuscript Report for Fisheries and Aquatic Sciences 2731*, (vii). 73 pp.

Cott, P.A., Sibley, P.K., Gordon, A.M., Bodaly, R.A., Mills, K.H., Somers, W.M., and Fillatre, G.A. 2008a. Effects of Water Withdrawal from Ice-covered Lakes on Oxygen, Temperature, and Fish. *Journal of the American Water Resources Association 44*(2), 328-342.

Cott, P.A., Sibley, P.K., Somers, W.M., Lilly, M.R., and Gordon, A.M. 2008b. A Review of Water Level Fluctuations on Aquatic Biota with an Emphasis on Fishes in Ice-covered Lakes. *Journal of the American Water Resources Association 44*(2), 343-359.

Curatolo, J. A., and Murphy, S. M. 1986. The Effects of Pipelines Roads and Traffic on the Movements of Caribou Rangifer-Tarandus. *Canadian Field-Naturalist, 100* (2), 218-224.

Dau, J.R., and Cameron, R.D. 1986. Effects of a Road System on Caribou Distribution during Calving. *Rangifer, Special Issue No. 1*, 95-101.

Davis, R.A., and Wiseley, A.N. 1974. Normal behaviour of snow geese on the Yukon-Alaska North Slope and the effects of aircraft-induced disturbance on this behaviour. September 1973. Chapter 2. In (Eds.) W.W.H. Gunn, W.J. Richardson, R.E. Schweinsburg and T.D. Wright Studies on Snow gees and Waterfowl in the Northwest Territories, Yukon Territory and Alaska, 1973. *Biological Report Series Vol. 27*. 85 pp.

Del Frate, G.G., and Spraker, T.H. 1991. Moose vehicle interactions and an associated public awareness program on the Kenai Peninsula, Alaska. *Alces 27*, 1-7.

De Vos, A. 1949. Timber wolves killed by cars on Ontario highways. *Journal of Mammalogy, 30*(1), 197.

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 1993. *Land Development Guidelines for the Protection of Aquatic Habitat*. Retrieved from http://www.dfo-mpo.gc.ca/Library/165353.pdf

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 1995. *Freshwater Intake End-of-Pipe Fish Screen Guidelines*. 27 pp.

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 1998. *Stock Status Report D5-04. Central and Arctic Region*. Retrieved from: http://www.grrb.nt.ca/pdf/fisheries/MackenzieRiverInconnu.pdf

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2005. *Protocol for Winter Water Withdrawal in the Northwest Territories*. Yellowknife, NWT. 3 pp.

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2008. *Temporary Stream Crossings. Northwest Territories Operational Statement*. Version 1.0. Retrieved from http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo23-eng.htm

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2009a, September. *Northwest Territories In-Water Construction Timing Windows for the Protection of Fish Habitat. Northwest Territories Operational Statement*. Version 3.0. Retrieved from http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo21-eng.htm

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2009b, September. *Clear Span Bridges*. . *Northwest Territories Operational Statement*. Version 3.0. Retrieved from http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo05-eng.htm

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2009c, September. *Temporary Stream Crossing*. *Northwest Territories Operational Statement*. Version 1.0. Retrieved from http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo23-eng.htm

Department of Fisheries and Oceans/ Fisheries and Oceans Canada (DFO). 2010. *Culvert Maintenance Operational Statement*. Version 3.0. Retrieved from http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo07-eng.htm

Department of the Environment, Transport and the Regions (DETR). 2000. Controlling and mitigating the environmental effects of minerals extraction in England. *Mineral Planning Guidance Note 11, consultation paper*.

Devon Canada Corporation (Devon). 2004, August. *Devon Beaufort Sea Exploration Drilling Program – Comprehensive Study Report*. Submitted to the National Energy Board. Retrieved from http://www.neb.gc.ca/clf-nsi/rthnb/pblcrgstr/pblcrgstrsrchv/dvncndbfrts/cmprhnsvstd_c01_7-eng.pdf

Diavik Diamond Mines Inc. (Diavik). 1998. *Environmental Effects Report, Wildlife*.

Diocese of the Arctic. 2010a. *Tuktoyaktuk Parish*. Retrieved January 11, 2011 from: http://www.arcticnet.org/~tuk/clergy

Diocese of the Arctic. 2010b. *Inuvik Parish*. Retrieved January 11, 2011 from: http//www.arcticnet.org/~ascension/

Ducks Unlimited. 2011. *Nature Notes. Northern Pintail*. Retrieved February 18, 2011 from: http://www.ducks.ca/resource/general/naturenotes/pintail.html

Dussault, C., Courtois, R., Ouellet, J. P., and Girard, I. 2005. Space use of moose in relation to food availability. *Canadian Journal of Zoology 83*, 1431-1437.

E. Gruben's Transport Ltd. (Gruben's). 2004. *Oil Pollution Emergency Plan*.

Earth Tech. 2005, October 1. *Draft Sewage Treatment Facility: Operation and Maintenance Document*. Submitted to the Hamlet of Tuktoyaktuk. Retrieved December 1, 2010 from http://www.nwtwb.com/0714_Operation_and_Maintanence_Sewage_Facility_October_2005.pdf

Earth Tech Canada Inc. 2008. *Town of Inuvik, Unit Cost of Water, 2006*. Prepared for the Town of Inuvik. Retrieved from http://inuvik.ca/wp-content/uploads/TownofInuvik_UnitCostofWater_final.pdf

Eaton, S. 2000. *Construction Noise*. Vancouver, BC: Workers' Compensation Board of British Columbia, Engineering Section.

EBA Engineering Consultants Ltd. (EBA). 1976. *Evaluation of Potential Rock Quarries: Rocky Hill – Campbell Lake Area, NWT*. Report Submitted to the Land Management Division, Department of Indian and Northern Affairs (DIAND).

EBA Engineering Consultants Ltd. (EBA). 1983a. *Granular Resource Development and Management Plan – Tuktoyaktuk, NWT*. Report submitted to Indian and Northern Affairs Canada (INAC).

EBA Engineering Consultants Ltd. (EBA). 1983b. *Evaluation of Potential Sources of Quarry Rock for Beaufort Marine Structures*. Report prepared for Indian and Northern Affairs Canada (INAC).

EBA Engineering Consultants Ltd. (EBA). 1987a. *Inuvialuit Settlement Sand and Gravel Inventory and Recommendations for Development – Inuvik, NWT*. Report submitted to Indian and Northern Affairs Canada (INAC).

EBA Engineering Consultants Ltd. (EBA). 1987b. *Inuvialuit Settlement Sand and Gravel Inventory and Recommendations for Development – Tuktoyaktuk, NWT*. Report submitted to Indian and Northern Affairs Canada (INAC).

Ecological Stratification Working Group. 1996. *A National Ecological Framework for Canada*. Ottawa/Hull: Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research, and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch. Retrieved from http://sis.agr.gc.ca/cansis/references/1996ew_a.html

Ecosystem Classification Group. 2007, revised 2009. *Ecological Regions of the Northwest Territories – Taiga Plains*. Prepared for the Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT, Canada. Retrieved from http://www.enr.gov.nt.ca/_live/documents/content/Taiga_Plains_Report_Section_1_2009.pdf
Edwards, M.A., Nagy, J.A., and Derocher, A.E. 2008. Using Subpopulation Structure for Barren-ground Grizzly Bear Management. *Ursus 19* (2), 91-104.

Edwards, M.A. 2009. *Spatial Ecology of Grizzly Bears (Ursus arctos) in the Mackenzie Delta, Northwest Territories, Canada*. (MSc. Thesis). Edmonton, Alberta: University of Alberta.

Edwards, M.A., Derocher, A.E., Hobson, K.A., Branigan, M., Nagy, J.A. 2010. Fast Carnivores and Slow Herbivores: Different Foraging Strategies Among Grizzly Bears in the Canadian Arctic. *Oecologia* 165 (4), 887-889.

Egeland, G.M. 2010. *Inuit Health Survey 2007 – 2008*. Retrieved December 23, 2010 from http://www.irc.inuvialuit.com/publications/pdf/ihs-report-final.pdf

Eller, B.M. 1977. Road dust induces increase of leaf temperature. *Environmental Pollution, 13*, 99-107.

Environment Canada. 1996. *Hinterland Who's Who. Bird Fact Sheets: Mallard.*

Environment Canada. 1997a. *The Canada Country Study: Climate Impacts and Adaptation – Canadian Arctic Summary.*

Environment Canada. 1997b. *Responding to Global Climate Change in Canada's Arctic: Volume II of the Canada Country Study: Climate Impacts and Adaptation.*

Environment Canada. 1998. *Hinterland Who's Who. Bird Fact Sheets: Tundra Swan.*

Environment Canada. 2003. *Hinterland Who's Who. Bird Fact Sheets: Canada Goose.*

Environment Canada. 2004. *Canadian Climate Normals 1971-2000: Tuktoyaktuk, Northwest Territories*. Retrieved November 6, 2009 from: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/results_e.html?StnID=1700&autofwd=1&pageid=2&lang=FRE&

Environment Canada. 2006. *Trail Valley Creek near Inuvik (10ND002): 1977-2006*. Retrieved from http://scitech.pyr.ec.gc.ca/waterweb/fullgraph.asp

Environment Canada. 2008. *National Pollutant Release Inventory Online Data Search*. Retrieved from January 19, 2011 from http://www.ec.gc.ca/pdb/websol/querysite/query_e.cfm

Environment Canada. 2009a. *Global Climate Models*. Retrieved February 7, 2011 from http://atlas.nrcan.gc.ca/site/english/maps/climatechange/4/

Environment Canada. 2009b. *Hans Creek above Eskimo Lakes (10ND004): 1988 to 2009*. Retrieved from http://www.wsc.ec.gc.ca/applications/H2O/graph-eng.cfm?station=10ND004&report=daily&year=2009

Environment Canada. 2010a. *Canadian Climate Normals 1971-2000 Inuvik-A, Northwest Territories*. Retrieved from http://climate.weatheroffice.gc.ca/climate_normals/stnselect_e.html

Environment Canada. 2010b. *Canadian Climate Data Inuvik-A, Northwest Territories*. Retrieved from http://climate.weatheroffice.gc.ca/climateData/canada_e.html

Environment Canada. 2010c. *Canadian Climate Normals 1971-2000 Tuktoyaktuk-A, Northwest Territories*. Retrieved from http://climate.weatheroffice.gc.ca/climate_normals/stnselect_e.html

Environment Canada. 2010d. *Canadian Climate Data Tuktoyaktuk-A, Northwest Territories*. Retrieved from http://climate.weatheroffice.gc.ca/climateData/canada_e.html

Environment Canada. 2010e. *Canadian Climate Normals or Averages 1971-2000*. Retrieved February 3, 2011 from http://climate.weatheroffice.gc.ca/climate_normals/index_e.html

Environment Canada. 2010f. *About the National Pollutant Release Inventory (NPRI)*. Retrieved January 19, 2011 from http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=CA8D2224-1

Environment Canada. 2011. *Air*. Retrieved March 29, 2011 from: http://www.ec.gc.ca/Air/default.asp?lang=En&n=14F71451-1

Environmental Impact Review Board (EIRB). 2002. *Criteria for Establishing Environmental Standards and Criteria for Evaluating a Developer's Standard of Performance in the Husky Lakes Area. (Area Number 2, Annex D, Inuvialuit Final Agreement).*

Environmental Impact Review Board (EIRB). 2003. *Public Review of WesternGeco Mackenzie Delta Marine 2D Seismic Program 2003*. Inuvik, NWT.

Environmental Impact Review Board (EIRB). 2009. *Draft Criteria for Establishing Environmental Standards and Criteria for Evaluating a Developer's Standard of Performance in the Husky Lakes Area (Area Number 2, Annex D, Inuvialuit Final Agreement)*. Inuvik, NWT.

Environmental Impact Review Board (EIRB). 2010, November 3. *Environmental Impact Statement Terms of Reference for the Environmental Impact Review of the Hamlet of Tuktoyaktuk, Town of Inuvik and GNWT – Construction of the Inuvik to Tuktoyaktuk Highway, Northwest Territories Development Proposal.*

Environmental Impact Screening Committee (EISC). 2004, November. *EISC Operating Guidelines and Procedures*. Inuvik, Northwest Territories.

Environmental Impact Screening Committee (EISC). 2009. *EISC Decision Letter re Submission Number (12/08-02) – GNWT/Tuk Hamlet (Batchelor/Gruben) Tuktoyaktuk to Granular Source 177 All-Weather Access Road, Tuktoyaktuk, NWT.*

Explore North. 2010. *A Guide to Tuktoyaktuk, NWT*. Retrieved January 5, 2011 from http://explorenorth.com/library/communities/canada/tuktoyaktuk.html

Exponent. 2007, November. *DMTS Fugitive Dust Risk Assessment Volume I – Report*. Prepared for Teck Cominco Alaska Incorporated, Anchorage, Alaska. Bellevue, WA: Exponent

Exxon Production Research Company (Exxon). 1992. *Oil Spill Response Field Manual*. U.S.A.

F.F. Slaney and Co. Ltd. 1973a. Part 3 - Wildlife. *Interim Report 1972 Environmental Field Program, Taglu-Richards Island, Mackenzie Delta*. Prepared for Imperial Oil Limited. Calgary, Alberta.

F.F. Slaney and Co. Ltd. 1973b, January. Part 5 – Meteorology and Climate. *Interim Report – 1972 Environmental Field Program - Taglu-Richards Island, Mackenzie Delta*. Prepared for Imperial Oil Limited. Calgary, Alberta.

F.F. Slaney and Co. Ltd. 1973c, January. Part 6 – Pollution Testing. *Interim Report – 1972 Environmental Field Program - Taglu- Richards Island, Mackenzie Delta*. Prepared for Imperial Oil Limited. Calgary, Alberta.

F.F. Slaney and Co. Ltd. 1974a. Volume 5. Mammals. *1972-1974 Environmental Program, Mackenzie Delta, N.W.T., Canada*. Prepared for Imperial Oil Ltd., Gulf Oil Canada Ltd., Shell Canada Ltd., Canadian Arctic Gas Study Ltd.

F.F. Slaney and Co. Ltd. 1974b. Impact Assessment. *1972-1974 Environmental Program, Mackenzie Delta, N.W.T., Canada.* Prepared for Imperial Oil Ltd., Gulf Oil Canada Ltd., Shell Canada Ltd., Canadian Arctic Gas Study Ltd.

F.F. Slaney and Co. Ltd. 1974c. Land Forms and Vegetation. *1972-1974 Environmental Program, Mackenzie Delta, N.W.T., Canada*. Prepared for Imperial Oil Ltd., Gulf Oil Canada Ltd., Shell Canada Ltd., Canadian Arctic Gas Study Ltd.

F.F. Slaney and Co. Ltd. 1975. *Grizzly Bear Denning Survey, Mackenzie Delta, N.W.T., Canada, Spring 1975*. Prepared for Imperial Oil Ltd., Gulf Oil Canada Ltd., Shell Canada Ltd.

Farmer, A.M. 1993. The effects of dust on vegetation — a review. *Environmental Pollution, 79*, 63-75.

Ferguson, S.H., and McLoughlin, P.D. 2000. Effect of energy availability, seasonality, and geographic range on brown bear life history. *Ecography 23*, 193–200.

Follmann, E.H., and Hechtel, J.L. 1990. Bears and pipeline construction in Alaska. *Arctic 43*(2), 103-109.

Forbes, G.J., and Theberge, T.B. 1995. Influences of a migratory deer herd on wolf movements and mortality in and near Algonquin Park, Ontario. *Ecology and Management of Wolves in a Changing World* (pp. 303-313).

Fournier, M.A., and Hines, J.E. 1999. *Breeding ecology of the Horned Grebe Podiceps auritus in subarctic wetlands. Occasional Paper No. 99*. Canadian Wildlife Service. 32 pp.

Franklin, J., and Richardson, J. 1824. *Narrative of a Journey to the Shores of the Polar Sea in the Years 1819-1820, 1821, and 1824*. London: J. Murray

Franklin, J. 1828. *Narrative of a Second Expedition to the Shores of the Polar Sea in the years 1825, 1826, and 1827. Including an Account of the Progress of a Detachment to the Eastward by John Richardson*. Edmonton, Alberta: Reprinted in 1971 by M.G. Hurtig Ltd.

Fraser, D., and Thomas, E.R. 1982. Moose-vehicle accidents in Ontario: relation to highway salt. *Wildl. Soc. Bull. 10* (3), 261-5.

Fuller, T.K. 1989. Population dynamics of wolves in north-central Minnesota. *Wildl. Monogr. 105*, 1-41.

Fujino, J.T. 1993. Regional Borrow Deposits Inventory: Mackenzie Delta Region. *Granular Resource Requirements for Proposed Mackenzie Valley Pipelines: Technical Papers and Workshop Proceedings*. Sponsored by: Northern Oil and Gas Action Program (NOGAP) Project A4: Granular Resources Inventory and management.

Gibeau, M.L., and Heuer, K. 1996. Effects of transportation corridors on large carnivores in the Bow River Valley, Alberta. In (Eds.) G.L. Evink, P. Garrett, D. Zeigler, and J. Berry *Trends in Addressing Transportation Related Wildlife Mortality: Proceedings of the Transportation Related Wildlife Mortality Seminar*. Tallahassee, Florida: State of Florida, Department of Transportation, Environmental Management Office.

Gibeau, M.L., Clevenger, A.P., Herrero, S., and Wierzchowski, J. 2002. Grizzly bear response to human development and activities in the Bow River Watershed, Alberta, Canada. *Biol. Conserv. 103*, 227-236.

Godfrey, W.E. 1986. *NWT Species Monitoring Infobase*. Yellowknife, NWT: Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Retrieved November 2009 from http://www.nwtwildlife.com/monitoring/speciesmonitoring/default.htm

Goodrich, J.M., and Berger, J. 1994. Winter recreation and hibernating black bears Ursus americanus. *Biological Conservation 67*, 105-110.

Government of Canada. 2009. *Species at Risk: A to Z Species Index*. Retrieved October 29, 2009 from http://www.sararegistry.gc.ca/sar/index/default_e.cfm

Government of Canada, National Energy Board (NEB). 2010. *Part 2 Production, Gathering and Processing Systems*. Retrieved January 6, 2011 from http://www.neb-one.gc.ca/clf-nsi/rthnb/pplctnsbfrthnb/mcknzgsprjct/rfd/rfdv1p2-eng.html#cont

Government of Canada, National Energy Board (NEB). 2011. *Glossary of Terms*. January 31, 2011. Retrieved March 16, 2011 from http://www.neb-one.gc.ca/clf-nsi/rpblctn/ctsndrgltn/flngmnl/flngmnl-eng.html#glssr

Government of the Northwest Territories (GNWT). 1998. *Guideline for Dust Suppression*. Retrieved from http://www.enr.gov.nt.ca/library/pdf/eps/dustsupression.pdf

Government of the Northwest Territories (GNWT). 2004. *Population Status Reports*. Retrieved from http://www.nwtwildlife.rwed.gov.nt.ca/publications/populationstatusreports/populationrpts.html

Government of the Northwest Territories (GNWT) and NWT Biodiversity Team. 2010. *Northwest Territories State of the Environment – 2010 Biodiversity Special Edition*. Yellowknife, Northwest Territories: Department of Environment and Natural Resources, Government of the Northwest Territories. 36 pp.

Government of the Northwest Territories Board Forum. ND. *Resource Management for the GNWT: Partners*. Retrieved February 1, 2011 from http://GNWTboardforum.com/partners/the-big-picture/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 1994. *Labour Force Profiles for NWT Communities*. Retrieved January 15, 2010 from http://www.stats.gov.nt.ca/Statinfo/Labour/labourforce/_lfsdata.html

Government of the Northwest Territories (GNWT Bureau of Statistics). 1999. *Labour Force Survey*. Retrieved May 2011 from http://www.stats.gov.nt.ca/recent_surveys/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2002. *2002 GNWT Regional Employment & Harvesting Survey, Summary of Results*. Retrieved January 5, 2011 from http://www.stats.gov.nt.ca/recent_surveys/Reg_Harvesting/REHS_LFS_2002.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2004a. *Food Price Index*. Retrieved January 5, 2010 from: http://www.stats.gov.nt.ca/Statinfo/PricesIncome/prices/FoodPriceIndex.html

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2004b. *NWT Community Survey*. Retrieved May 2011 from http://www.stats.gov.nt.ca/recent_surveys/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2005. *Living Cost Differentials, Northwest Territories Federal Isolated Post Living Cost Differentials, by Community*. Retrieved from http://www.stats.gov.nt.ca/Statinfo/PricesIncome/prices/Hist_LCD.html

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2008a. *Tuktoyaktuk – Statistical Profile*. Retrieved October 29, 2009 from: http://www.stats.gov.nt.ca/Profile/Profile%20PDF/Tuktoyaktuk.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2008b. *Inuvik – Statistical Profile*. Retrieved October 29, 2009 from: http://www.stats.gov.nt.ca/Profile/Profile%20PDF/Inuvik.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2008c. *Summary of GNWT Income Statistics*. Retrieved December 21, 2010 from http://www.stats.gov.nt.ca/labour-income/income/Summary_of_GNWT_Income_Statistics-2008.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2008d. *Traditional Activities*. Retrieved January 18, 2011 from: http://www.stats.gov.nt.ca/Traditional%20Activities/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2008e. *2007 Family Violence Survey*. Retrieved February 3, 2011 from http://www.executive.gov.nt.ca/offices/womensadvisory/13-03 2009%2007%20Family%20Violence%20Report-2.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2009a. *Tuktoyaktuk – Statistical Profile*. Retrieved December 3, 2010 from http://www.stats.gov.nt.ca/community-data/Profile%20PDF/Tuktoyaktuk.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2009b. *Inuvik – Statistical Profile*. Retrieved December 3, 2010 from http://www.stats.gov.nt.ca/community-data/Profile%20PDF/Inuvik.pdf

Government of the Northwest Territories (GNWT Bureau of Statistics). 2009c. *NWT Community Survey*. Retrieved May 2011 from http://www.stats.gov.nt.ca/recent_surveys/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010a. *Summary of GNWT Community Statistics*. Retrieved December 10, 2010 from http://www.stats.gov.nt.ca/publications/summary_comm_stats/Summary%20of%20GNWT%20Statistics%202010.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010b. *GNWT Data Portal*. Retrieved December 9, 2010 from http://www.stats.gov.nt.ca/dataportal/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010c. *New Stats Consumer Price Index 2010*. Retrieved December 14, 2010 from http://www.stats.gov.nt.ca/prices-expenditures/cpi/Oct10cpi.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010d. *Community Price Index 2010*. Retrieved December 14, 2010 from http://www.stats.gov.nt.ca/prices-expenditures/community-price-index/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010e. *GNWT Community Survey Housing Component*. Retrieved December 16, 2010 from http://www.stats.gov.nt.ca/Housing/housing-conditions/2009_Housing.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010f. *Gross Domestic Product*. Retrieved December 17, 2010 from http://www.stats.gov.nt.ca/economy/gdp/index.otp

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010g. *Traditional Activities*. Retrieved December 20, 2010 from http://www.stats.gov.nt.ca/Traditional%20Activities/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010h. *GNWT Labour Force Activity*. Retrieved December 22, 2010 from http://www.stats.gov.nt.ca/labour-income/labour-force-activity/Annual_Reports/2009%20Annual%20LFS.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010i. *Statistics Quarterly Northwest Territories*. Retrieved January 4, 2011 from http://www.stats.gov.nt.ca/publications/statistics-quarterly/sqsep2010.pdf

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010j. *Inflation Rate Canada and Yellowknife*. Retrieved February 3, 2011 from http://www.stats.gov.nt.ca/prices-expenditures/cpi/historical_cpi/index.html

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics) 2010k. *Tuktoyaktuk Statistical Profile*. Retrieved April 27, 2011 from http://www.stats.gov.nt.ca/community-data/infrastructure/Tuktoyaktuk.html

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010l. *Inuvik Statistical Profile*. Retrieved April 27, 2011 from http://www.stats.gov.nt.ca/community-data/infrastructure/Inuvik.html

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010m. *Vital Statistics*. Retrieved April 27, 2011 from http://www.stats.gov.nt.ca/population/vital-statistics/

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010n. *Table 1b – NWT Employment by Industry and Occupation, 2001 to 2010*. Retrieved March 2011 from http://www.stats.gov.nt.ca/labour-income/labour-force-activity/index.otp

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010o. *Table 1a – NWT Labour Force Activity, 2001 to 2010*. Retrieved March 2011 from http://www.stats.gov.nt.ca/labour-income/labour-force-activity/index.otp

Government of the Northwest Territories, Bureau of Statistics (GNWT Bureau of Statistics). 2010p. *Police Reported Crime*. Retrieved May 2011 from http://www.stats.gov.nt.ca/justice/police-reported-crime/index.html

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2005. *Towards Excellence a Report on Post-Secondary Education in the GNWT*. Retrieved December 22, 2010 from: http://www.ece.gov.nt.ca/PDF_File/Towards%20Excellence/Towards%20Excellence%2005.pdf

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2007. *Income Security, Breaking Down the Barriers of Poverty, Promoting Self Reliance*. Retrieved December 14, 2010 from: http://www.ece.gov.nt.ca/Divisions/Income_support_NPV1/IS%20PDF/BreakingDowntheBarriers.pdf

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2008. *Towards Literacy: A Strategy Framework 2008-2018*. Retrieved March 27, 2011 from http://www.ece.gov.nt.ca/PDF_File/NWT%20Literacy%20Strategy%20(2).pdf

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2009. *Building on Our Success: Strategic Plan 2005-2015, Progress Report as of March 31, 2009*. Retrieved February 2, 2011 from:

http://www.ece.gov.nt.ca/PDF_File/ECE%20Strategic%20Plan%20Progress%20Report/ECE%20Strategic%20Plan%20_2010_webready.pdf

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2010a. *Jobs North*. Retrieved December 14, 2010 from http://www.jobsnorth.ca/

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2010b. *Education, Culture and Employment*. Retrieved February 1, 2011 from http://www.ece.gov.nt.ca/

Government of the Northwest Territories, Department of Education, Culture and Employment (GNWT ECE). 2010c. *GNWT Aboriginal Languages Plan: A Shared Responsibility*. Retrieved February 1, 2011 from http://www.ece.gov.nt.ca/Divisions/ECE_News/Aboriginal%20Lang%20Plan-%20Final%20Doc%20-%20%2022%20OCTOBER%202010.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). NDa. *State of the Environment Report*. Retrieved December 20, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_conservation_sustainable_use.aspx#top

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). NDb. *Arctic Fox*. Retrieved from: http://www.enr.gov.nt.ca/_live/pages/wpPages/Arctic_Fox.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). NDc. *Red Fox*. Retrieved from: http://www.enr.gov.nt.ca/_live/pages/wpPages/red_fox.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). NDd. *Wolves in the NWT*. Retrieved from: http://www.enr.gov.nt.ca/_live/pages/wpPages/Wolves.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). NDe. *Action Plan, Boreal Woodland Caribou Conservation in the Northwest Territories, 2010-2015*.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). NDf. *NWT Species Monitoring Infobase, Woodland Caribou (Boreal)*. Retrieved from http://www.enr.gov.nt.ca/_live/pages/wpPages/Infobase.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources, Species At Risk Secretariat (GNWT ENR). NDg. *NWT Woodland Caribou (Rangifer tarandus caribou), Boreal population / Northern Mountain population*. Retrieved from http://nwtspeciesatrisk.ca/tiki/tiki-index.php?page=WoodlandCaribou

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2002. *Guideline for Ambient Air Quality Standards in the Northwest Territories: Sulphur Dioxide*

(SO2), Ground Level Ozone (O3), Total Suspended Particulate (TSP), Fine Particulate Matter (PM2.5). Retrieved December 19, 2010 from: http://www.enr.gov.nt.ca/_live/documents/content/air_quality_standards_guideline.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005a. *Moose in the NWT*. Retrieved October 27, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Moose.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005b. *Black Bears* (*Ursus Americanus*). Retrieved October 27, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/black_bears.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005c. *NWT Wolverines* (*Gulo gulo*) – *Western Population*. Retrieved October 27, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Wolverine.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005d. *Marten in the NWT*. Retrieved October 27, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Marten.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005e. *Arctic fox in the NWT*. Retrieved January 13, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Arctic_fox.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005f. *Red fox in the NWT*. Retrieved January 13, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/red_fox.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005g. *Wolves in the NWT*. Retrieved January 13, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Wolves.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005h. *Muskox in the NWT*. Retrieved January 13, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Muskox.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2005i. *State of the Environment Report: Use of Renewable Resources*. Retrieved January 8, 2011 from http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_conservation_sustainable_use.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2006a. *Cape Bathurst Herd*. Retrieved October 26, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Cape_Bathurst_herd.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2006b. *Bluenose-West Herd*. Retrieved October 26, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Bluenose-West_herd.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2006c. *NWT Resident Hunter Harvest Surveys*. Retrieved January 14, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Resident_Hunter_Harvest_Surveys.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2006d. *Species at Risk – Peregrine Falcons and Other Raptor Species*. Technical Report submitted to the Mackenzie Gas Project Joint Review Panel. 17 pp.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2007a. *Barren Ground Grizzly Bear*. Technical Report and Presentation

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2007b. *Summary: 2007 Barren-ground Caribou Calving Distribution Surveys, Northwest Territories and Nunavut*.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2008. *Northwest Territories Summary of Hunting Regulations July 1, 2008 to June 30, 2009*.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2008a. *Air Quality Report*. Retrieved from http://www.enr.gov.nt.ca/_live/documents/content/2008_Air_Quality_Report.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2008b. *Public Discussion Draft, Action Plan, Boreal Woodland Caribou Conservation in the Northwest Territories, 2009-2014*.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2009a. *2009 Northwest Territories State of the Environment Report*. Retrieved January 20, 2011 from http://www.enr.gov.nt.ca/_live/documents/content/NWT2009State_Enviro_ReportFINAL.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2009b. *NWT Species Monitoring Infobase*. Yellowknife, NWT. Retrieved November, 2009 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Infobase.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2009c. *Harvest Regulation Changes for Barren-ground Caribou*. Retrieved January 14, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/whats_new.aspx?ind=266

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2009d. *Grizzly Bear Den Survey, All Season Access Road Tuktoyaktuk to Source 177, Spring 2009*. Presentation.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2009e. *2009 Northwest Territories Air Quality Report*. Retrieved January 6, 2011 from http://www.enr.gov.nt.ca/_live/documents/content/2009_Air_Quality_Report.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2009f. *Keeping an Eye on Our Air: 2009 Northwest Territories Air Quality Report Summary*. Retrieved January 6, 2011 from:
http://www.enr.gov.nt.ca/_live/documents/content/2009_Keeping_an_Eye_on_Air_Report.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010a. *Demography – Humans in the Northwest Territories*. Retrieved January 4, 2011 from http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_demography.aspx#1

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010b. *Caribou Forever – Our Heritage, Our Responsibility*. Retrieved January 6, 2011 from http://www.enr.gov.nt.ca/_live/documents/content/Caribou_forever_our_heritage_our_responsibility.pdf

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010c. *Waste Reduction and Recycling Initiatives*. Retrieved December 17, 2010 from http://icarenwt.ca/beverage-container-program/find-your-depot

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010d. *State of the Environment Report*. Retrieved December 17, 2010 from http://www.enr.gov.nt.ca/_live/pages/wpPages/soe_solid_waste.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010e. *Hazardous Materials Spill Database*. Retrieved from www.enr.gov.nt.ca/_live/pages/wpPages/Hazardous_Materials_Spill_Database.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010f. *Species at Risk in the Northwest Territories*.

Government of the Northwest Territories, Department of Environment and Natural Resources, Environmental Division (GNWT ENR). 2010g. *Fire at the Inuvik Beverage Container Depot and Processing Centre*. Retrieved from http://icarenwt.ca/news/show/9/fire-inuvik-beverage-container-depot-processing-centre

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2010h. *Summary of Harvest Data for Species under Quota in the Inuvialuit Settlement Region July 2005 to June 2010*. Department of Environment and Natural Resources, Inuvik Region.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2011a. *NWT Species Monitoring Infobase*. Yellowknife, NWT. Retrieved January, 2011 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Infobase.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2011b. *Our Wildlife: Red Fox*. Retrieved March, 2011 from http://www.enr.gov.nt.ca/_live/pages/wpPages/red_fox.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2011c. *Our Wildlife: Moose*. Retrieved March, 2011 from http://www.enr.gov.nt.ca/_live/pages/wpPages/Moose.aspx

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2011d. *Ecosystem Classification Group Shapefile*.

Government of the Northwest Territories, Department of Environment and Natural Resources (GNWT ENR). 2011e. *A Guide to Spill Contingency Planning and Reporting Regulations*. Updated March 2011.

Government of the Northwest Territories, Department of Finance (GNWT Finance). 2006. *Performance and Accountability Report*. Retrieved December 17, 2010 from: http://www.fin.gov.nt.ca/documents/budgetdocuments/results/2005-06results.pdf

Government of the Northwest Territories, Department of Finance (GNWT Finance). 2010a. *Capital Estimates: 2011-2012*. Retrieved January 8, 2011 from: http://www.fin.gov.nt.ca/documents/budgetdocuments/mains/Capital%20Estimates%202011-12.pdf

Government of the Northwest Territories, Department of Finance (GNWT Finance). 2010b. *Main Estimates: 2010-2011*. February 1, 2011 from: http://www.fin.gov.nt.ca/documents/budgetdocuments/mains/Main%20Estimates%202010-11.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2005. *Early Childhood Development Report for 2004/2005*. Retrieved December 31, 2010 from http://www.hlthss.gov.nt.ca/pdf/reports/children_and_youth/2006/english/2004_05_ecd_report_part_5.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2006a. *Northwest Territories Addiction Survey*. Retrieved February 3, 2011 from: http://www.hlthss.gov.nt.ca/pdf/reports/mental_health_and_addictions/2006/english/nwt_addiction_survey.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2006b. *Health Promotion Strategy*. Retrieved December 31, 2010 from http://www.hlthss.gov.nt.ca/features/Initiatives/health_promotion/default.asp

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2009. *Community Handbook and Tools for Brighter Futures Projects in the GNWT: Guide for Inuvialuit Communities*. Retrieved February 1, 2011 from: http://www.hlthss.gov.nt.ca/pdf/manuals/2009/brighter_futures_guide_for_inuvialuit_communities.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2010a. *Long term care centre (Inuvik)*. Retrieved December 22, 2010 from: http://www.hlthss.gov.nt.ca/english/services/long_term_care/facilities/long_term_care_centre.htm

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2010b. *Brighter Futures*. Retrieved February 2, 2011 from: http://www.hlthss.gov.nt.ca/pdf/manuals/2009/brighter_futures_guide_for_inuvialuit_communities.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2010c. *Northwest Territories Health and Social Services System Strategic Plan*. Retrieved February 2, 2011 from http://www.hlthss.gov.nt.ca/pdf/reports/health_care_system/2010/english/report_on_the_strategic_plan_2006_2010.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS) 2010d. *NWT Addictions Report*. Retrieved April 28, 2011 from: http://www.hlthss.gov.nt.ca/pdf/reports/mental_health_and_addictions/2010/english/nwt_addictions_report.pdf

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2010e. *Physician Visits by Select Conditions Inuvik and Tuktoyaktuk*.

Government of the Northwest Territories, Department of Health and Social Services (GNWT HSS). 2010f. *Sexually Transmitted Infections Inuvik and Tuktoyaktuk*.

Government of the Northwest Territories, Department of Industry, Tourism & Transportation (GNWT ITI). ND. *Benefits – Genuine Mackenzie Valley Furs (GMVF) Program*. Retrieved January 6, 2011 from http://www.iti.gov.nt.ca/publications/2008/FursFishingAgriculture/GMVFFactSheet.pdf

Government of the Northwest Territories, Department of Industry, Tourism & Transportation (GNWT ITI). 2007. *GNWT Fur Harvest 2007/2008*. Retrieved January 5, 2011 from http://www.iti.gov.nt.ca/publications/2008/FursFishingAgriculture/FurHarvest0708.pdf

Government of the Northwest Territories, Department of Industry, Tourism & Transportation (GNWT ITI). 2008. *Economic Review NT Regions*. Retrieved January 28, 2011 from http://www.iti.gov.nt.ca/Publications/2007/businesseconomicdevelopment/EconomicReviewNTRegions2007.pdf

Government of the Northwest Territories, Department of Industry, Tourism and Investment (GNWT ITI). 2009. *Economic Review Northwest Territories*. Retrieved January 5, 2011 from http://www.iti.gov.nt.ca/publications/2009/businesseconomicdevelopment/EconomicReview.pdf

Government of the Northwest Territories, Department of Industry, Tourism and Investment (GNWT ITI). 2010. *2009/10 Results Report: Grants and Contributions Programs*. Retrieved February 1, 2011 from http://www.iti.gov.nt.ca/Publications/2010/BusinessEconomicDevelopment/COMPLETE2009-10ITI_Grants_ContReport20101029.pdf

Government of the Northwest Territories, Department of Public Works and Services, Technical Support Services, Asset Management Division. 2001. *Town of Inuvik, NWT: Granular Resource Appraisal Material Evaluation Report*. Town of Inuvik and GNWT Department of Municipal and Community Affairs.

Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development (GNWT DRWED). 2002. *Air Quality Code of Practice, Upstream Oil and Gas Industry, Consultation Draft*. Yellowknife, NWT.

Government of the Northwest Territories, Department of Transportation (GNWT DOT). ND. Northwest Territories *Airport Information Brochure*. Retrieved January 3, 2011 from http://www.dot.gov.nt.ca/_live/documents/content/Airports%20Brochure%202007.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 1990. *Northwest Territories, Transportation Strategy*.

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 1993. *Highway Maintenance Manual*.

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 1995, May. *Northwest Territories, Transportation Strategy Update, 1994*.

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 1999, October. *Summary Report of the Highway Strategy*. Retrieved from: http://www.dot.gov.nt.ca/_live/documents/content/Highway%20Strategy%20-%20Summary%20Report.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2000, November. *Investing in Roads for People and the Economy: A Highway Strategy for the Northwest Territories*. Retrieved from http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Highway%20Strategy%20-%20Investing%20in%20Roads%20for%20People%20and%20the%20Economy.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2002, May. *Corridors for Canada: An Investment in Canada's Economic Future. A Proposal for Funding Under the Strategic Infrastructure Fund Government of Canada*. Retrieved from http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Corridors%20for%20Canada.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2005a, September. *Corridors for Canada II: Building on Our Success. A Proposal for Investment in Strategic Transportation Infrastructure*. Retrieved from http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Corridors%20for%20Canada%20II%20-%20Building%20on%20our%20Success.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2005b, November. *Connecting Canada Coast to Coast to Coast: A Proposal to Complete the Mackenzie Valley Highway to the Arctic Coast*. Retrieved from http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Connecting%20Canada.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2005c. *Tuktoyaktuk Airport Profile*. Retrieved January 3, 2011 from http://www.dot.gov.nt.ca/_live/pages/wpPages/Tuktoyaktuk_Profile.aspx

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2005d. *Inuvik Airport Profile*. Retrieved January 3, 2011 from http://www.dot.gov.nt.ca/_live/pages/wpPages/Inuvik_Profile.aspx

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2007. *A Field Guide to Ice Construction Safety*. Retrieved March 25, 2011 from http://www.dot.gov.nt.ca/_live/documents/content/Ice%20Construction%20Field%20Guide%20web.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2008a. *2008 Highway Traffic Report*. Retrieved December 23, 2011 from http://www.dot.gov.nt.ca/_live/documents/content/HighwayTrafficStats_2008.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2008b, February. *Northern Connections: A Multi-Modal Transportation Blueprint for the North*. Retrieved from http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Northern%20Connections%20final.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2009a. *2009 NWT Traffic Collision Facts – Department of Transportation Road Licensing and Safety Division*. Retrieved from http://vancouver.projects.eba.ca/sites/projects/V23201322/004/Traffic%20Info/2008%20NWT%20Traffic%20Collision%20Facts%20Report.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2009b. *Traffic Counts from NWT Highway Traffic 2008*. Retrieved from http://www.dot.gov.nt.ca/_live/documents/content/HighwayTrafficStats_2008.pdf

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2009c, March. *Wildlife Management Plan. Tuktoyaktuk to Granular Source 177 Access Road.* Prepared by the Government of Northwest Territories, Department of Transportation for the Environmental Impact Screening Committee.

Government of the Northwest Territories, Department of Transportation, Planning Division (GNWT DOT). 2010a, June 8. *Inuvik to Tuktoyaktuk All-Weather Road Economic Analysis*.

Government of the Northwest Territories, Department of Transportation (GNWT DOT). 2010b. *Draft Environmental Policy*.

Government of the Northwest Territories, Municipal and Community Affairs (GNWT MACA). NDa. *Northwest Territories Drinking Water Quality Database: Community Descriptions*. Retrieved December 1, 2010 from http://www.maca.gov.nt.ca/operations/water/commsys.htm

Government of the Northwest Territories, Municipal and Community Affairs (GNWT MACA). NDb. *Tuktoyaktuk*. Retrieved December 7, 2010 from

Government of the Northwest Territories, Municipal and Community Affairs (GNWT MACA). 2009. *Active After School Funding*. Retrieved December 20, 2010 from http://www.maca.gov.nt.ca/resources/newsroom/news_2009/Active_After_School_Funding.html

Government of the Northwest Territories, Municipal and Community Affairs (GNWT MACA). 2010. *GNWT Report on Drinking Water*. May 2010. Retrieved December 1, 2010 from http://www.maca.gov.nt.ca/resources/GNWT_Report_on_Drinking_Water_2010.pdf

Government of the Northwest Territories, Premiers Office (GNWT Premiers Office). 2010. *Creating Our Future Together: Inuvik Roundtable August 31, 2010*. Retrieved January 10, 2011 from http://www.creatingourfuture.ca/wp-content/uploads/2010/10/Inuvik-Round-Table-Report.pdf

Government of the Northwest Territories, Seniors' Society (GNWT Seniors' Society). 2009. *Notes from the Workshop on the Abuse of Older Adults, Ingamo Hall, Inuvik, NT*. Retrieved December 22, 2010 from http://www.GNWTseniorssociety.ca/pdf/2009/Final%20report%20on%20the%20Inuvik%20Workshop%20on%20the%20Abuse%20of%20Older%20Adults%2023&24%20June%2009.pdf

Grindal, S.D. 1998. *Behavioural monitoring of barren-ground caribou during spring migration (1997) for the Diavik Diamonds Project, Lac de Gras, Northwest Territories. Final Report.* Prepared for Diavik Diamond Mines Inc., and Aber Resources Ltd., by AXYS Environmental Consulting Ltd. Vancouver, BC.

Gunn, A. 1998. *Effect of Gravel Road and Tailing Pond Dust on Tundra Plant Communities near Lupin Mine, NWT*. Final report submitted to West Kitikmeot Slave Study Society.

Gunn, A., and Miller, F.L. 1986. Traditional Behaviour and Fidelity to Caribou Calving Grounds by Barren-Ground Caribou. *Rangifer, Special Issue (1)*, 151.

Gunn, A., Dragon, J., Papik, S., Panayi, D., Svoboda, M., Sutherland, M., and D'Entremont, M. 1998. *Summer Behaviour of Bathurst Caribou at Mine Sites and Response of Caribou to Fencing and Plastic Deflectors*. Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Final report to submitted to the West Kitikmeot/Slave Study.

Gunson, J.R. 1995. Analysis of grizzly bear mortalities in Alberta during 1972-1994. *Occasional Paper #16*. Edmonton, Alberta: Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division. 101 pp.

Haber, E. 1997. *Guide to Monitoring Exotic and Invasive Plants*. Ontario: National Botanical Services. Prepared for Ecological Monitoring and Assessment Network, Environment Canada.

Hanna, D. 2002. *Mackenzie Delta Heritage Resource Survey – Final Report (Permit 2001-910)*. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife, NWT.

Hanson, W.C. 1981. Caribou (*Rangifer tarandus*) encounters with pipelines in northern Alaska. *Can. Field-Nat. 95*, 57-62.

Harding, L.E., and Nagy, J.A. 1978. Responses of Grizzly Bears to Hydrocarbon Exploration on Richards Island, Northwest Territories, Canada. *Canadian Journal of Zoology. 54*(8), 1357-1363.

Harding, L., and Nagy, J.A. 1980. Responses of grizzly bears to hydrocarbon exploration on Richards Island, Northwest Territories, Canada. *Int. Conf. Bear Res. and Manage. 4*, 277-80.

Hardy Associates (1978) Ltd. 1979. *Granular Materials Inventory: Phase III – Tuktoyaktuk Harbour, NWT*. Report prepared for the Department of Indian Affairs and Northern Development (DIAND).

Hardy Associates (1978) Ltd. 1980. *Granular Materials Inventory – Tuktoyaktuk, NWT, Sources 160 and 161*. Report prepared for the Department of Indian Affairs and Northern Development (DIAND).

Hardy BBT Ltd. 1986. *Interim Report – Phase II: Field Reconnaissance Community Granular Management Plan, Tuktoyaktuk, NWT*. Report prepared for the Government of the Northwest Territories, Department of Public Works, Highways Division.

Hardy BBT Ltd. 1987a. *Phase III – Final Comparison of Potential Sources – Community Granular Management Plan: Tuktoyaktuk, NWT*. Report prepared for the Government of the Northwest Territories, Department of Public Works, Highways Division, Yellowknife, NWT.

Hardy BBT Ltd. 1987b. *Interim Report – Phase III: Winter Drilling Program – Deposit 155, Community Granular Management Plan, Tuktoyaktuk, NWT*. Report prepared for the Government of the Northwest Territories, Department of Public Works, Highway Division.

Hardy BBT Ltd. 1989a. *Source 155 North, Development Plan, Community Granular Management Plan: Tuktoyaktuk, NWT*. Report prepared for the Government of the Northwest Territories, Department of Public Works, Yellowknife, NWT.

Hardy BBT Ltd. 1989b. *Proposed Geotechnical Investigation Plan, Potential Sand and Gravel Reserves, Inuvialuit Settlement Region*. Report prepared for the Department of Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. 1988c. *Plan for the Reservation and Development of Granular Materials in the Vicinity of Aklavik N.W.T.*Report prepared for Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. 1990a. *Geotechnical Investigation of Potential Sand and Gravel, Inuvialuit Settlement Region 155 South Deposit, Tuktoyaktuk, Northwest Territories*. Report prepared for the Department of Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. 1990b. *Geotechnical Investigation of Potential Sand and Gravel Reserves, Inuvialuit Settlement Region 1407 (Caribou Hills) Deposit, Inuvik, Northwest Territories*. Report prepared for the Department of Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. 1990c. *Geotechnical Investigation of Potential Sand and Gravel Reserves Inuvialuit Settlement Region Deposit 467 (Willow River) Aklavik N.W.T.* Report prepared for the Department of Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. 1991. *Report on Granular Resource Potential; Mackenzie Delta Region*. Report prepared for Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. and Avati Associates. 1988a. *Plan for the Reservation and Development of Granular Materials in the Vicinity of Inuvik, NWT*. Report prepared for the Department of Indian and Northern Affairs Canada (INAC).

Hardy BBT Ltd. and Avati Associates. 1988b. *Plan for the Reservation and Development of Granular Materials in the Vicinity of Tuktoyaktuk, NWT*. Report prepared for the Department of Indian and Northern Affairs Canada (INAC).

Hatler, D.F. 1972. Food Habits of Black Bears in Interior Alaska. *Canadian Field Naturalist 86*, 17-31.

Hayssen, V. 2011. Mammalian Species, Mammalian Species Accounts. *Smith College - Clark Science Center.* Northampton, MA. Retrieved January, 2011 from http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/msiaccounts.html

Health Canada. 2006. *Regulations Related to Health and Air Quality*. Retrieved January 19, 2011 from http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/reg-eng.php#a3

Health Canada. 2010. *Process for Development of National Ambient Air Quality Objectives or Canada-wide Standards for Air Pollutants.* Retrieved January 19, 2011 from http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/diagram-eng.php

Heginbottom, J.A. 2000. Permafrost distribution and ground ice in surficial materials. In (Eds.) L.D. Dyke and G.R. Brooks *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, Geological Survey of Canada, Bulletin 547*, 31-39.

Hegmann, G., Cocklin, C., Creasey, R., Dupuis, S., Kennedy, A., Kingsley, L., Ross, W., Spaling, H. and Stalker, D. 1999. *Cumulative Effects Assessment Practitioners Guide*. Prepared by AXYS Environmental

Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec.

Herrero, S. 1978. A Comparison of Some Features of the Evolution, Ecology, and Behavior of Black and Grizzly/Brown bears. *Carnivore 1*, 7-16.

Horizon North Logistics Inc. 2008. *Marine Services*. Retrieved January 4, 2011 from http://www.horizonnorth.ca/index.php/page/show/134

Hoyt, A. 2001. Husky Lakes: *Integrated Management Study. Summary Report*. Inuvik, NWT. 4 pp.

Huber, D., Kusak, J., and Frkovic, A. 1995. Traffic kills of brown bears in Gorski Kotar, Croatia (abstract). *Int. Conf. Bear Res. and Manage*, 10.

IEG Environmental. 2006, February. *Sewage Lagoon Discharge Assessment, Tuktoyaktuk, Northwest Territories*. Prepared by IEG Environmental for Government of Northwest Territories Municipal and Community Affairs. IEG Project 20213. Retrieved December 7, 2010 from http://www.GNWTwb.com/0714_Discharge_Assessment_Report_2004.pdf

IMG-Golder Corporation. 2009a. *Draft Report Archaeological Impact Assessment*. Prepared for GNWT Department of Transportation.

IMG-Golder Corporation. 2009b. *Assessment of Fisheries Potential of the Tuktoyaktuk to Source 177 All-Weather Road Impact Area*. Prepared for GNWT Department of Transportation.

Imperial Oil Resources Ventures Limited (IOL). 2006, February 8. *Mackenzie Gas Project Joint Review Panel Round 4 Intervenor Information Request Response*. Submitted to Environment Canada.

Imperial Oil Resources Ventures Limited Partnership, ConocoPhillips Canada (North) Limited, ExxonMobil Canada Properties, Shell Canada Limited and Mackenzie Valley Aboriginal Pipeline Limited (IOL et al.). 2004. *Environmental Impact Statement for the Mackenzie Gas Project*. Submitted to the National Energy Board.

Imperial Oil Resources Ventures Limited Partnership, ConocoPhillips Canada (North) Limited, ExxonMobil Canada Properties, Shell Canada Limited and Mackenzie Valley Aboriginal Pipeline Limited (IOL et al.). 2005, September. *ISR Private Lands ILA Application Report*. Retrieved January 9, 2011 from http://www.ngps.nt.ca/ppa/isr/Documents/ISR_Private_Section_8A.pdf

Indian and Northern Affairs Canada (INAC). 1997, November. *Jurisdictional Responsibilities for Land Resources, Land Use and Development in the Yukon Territory and Northwest Territories*. Retrieved January 11, 2011 from http://www.ainc-inac.gc.ca/enr/lds/pubs/jrlr/b2nwt-eng.pdf

Indian and Northern Affairs Canada (INAC). 2003. *Canadian Arctic Contaminant Assessment Report – Phase II (CACAR –II)*. Retrieved from http://www.ainc-inac.gc.ca/nth/ct/ncp/pub-eng.asp#ncp

Indian and Northern Affairs Canada (INAC). 2004a. *Inuvialuit Final Agreement Implementation Coordinating Committee - Annual Report 2003-2004*. Retrieved February 1, 2011 from http://www.ainc-inac.gc.ca/al/ldc/ccl/fagr/inu/anro0304/anro0304-eng.asp

Indian and Northern Affairs Canada (INAC). 2004b. *Northwest Territories Contaminants Fact Sheets. Berries*. Retrieved from http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/index-eng.asp#Contaminants

Indian and Northern Affairs Canada (INAC). 2004c. *Northwest Territories Contaminants Fact Sheets. Ptarmigan and Grouse.* Retrieved from http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/index-eng.asp#Contaminants

Indian and Northern Affairs Canada (INAC). 2004d. *Northwest Territories Contaminants Fact Sheets. Waterfowl.* Retrieved from http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/index-eng.asp#Contaminants

Indian and Northern Affairs Canada (INAC). 2006. *Funding Summary 2005-2006*. Retrieved February 1, 2011 from http://www.ainc-.gc.ca/ai/scr/nt/ntr/pubs/acs-eng.asp

Indian and Northern Affairs Canada (INAC). 2007a. *Northwest Territories Contaminants Fact Sheets. Caribou.* Retrieved from http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/index-eng.asp#Contaminants

Indian and Northern Affairs Canada (INAC), Water Resources Division. 2007b. *Guidelines for Spill Contingency Planning.* Retrieved from http://www.ainc-inac.gc.ca/ai/scr/nt/pdf/SCP-EUD-eng.pdf

Indian and Northern Affairs Canada (INAC). 2010a. *Mackenzie Gas Project Backgrounder*. Retrieved January 5, 2011 from http://www.ainc-inac.gc.ca/ai/mr/is/mgp-eng.asp

Indian and Northern Affairs Canada (INAC). 2010b. *2010 Water Quality Sampling Results.* Unpublished data.

Indian and Northern Affairs Canada (INAC). 2010c, January. *Northern Land Use Guidelines - Access: Roads and Trails*. Volume 5. Retrieved January 10, 2011 from http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/nlug5-eng.asp#sub4_4_2

Indian and Northern Affairs Canada (INAC). 2010d, January. *Northern Land Use Guidelines Access: Pits and Quarries*. Volume 07. Retrieved March 15, 2011 from http://www.ainc-inac.gc.ca/ai/scr/nt/pdf/nlug7-eng.pdf

Indian and Northern Affairs Canada (INAC). 2011a, January 26. *Devolution Agreement-in-Principle Signed for the Northwest Territories.* Retrieved March 14, 2011 from http://www.ainc-inac.gc.ca/ai/mr/nr/j-a2011/23456-eng.asp

Indian and Northern Affairs Canada (INAC). 2011b. *Northern Land Use Guidelines: Camp and Support Facilities.* Volume 06. Retrieved from http://publications.gc.ca/collections/collection_2011/ainc-inac/R2-226-6-2011-eng.pdf

Indian and Northern Affairs Canada (INAC). 2011c. *Northern Land Use Guidelines: Northwest Territories Hydrocarbon Exploration*. Volume 07.

Intera Environmental Consultants Ltd. 1973. *Whitecourt Environmental Study - 1973*. Calgary, Alberta.

International Development Research Centre (IDRC). ND. *Aboriginal People and Resource Co-Management.* Prepared by L.N. Binder and B. Hanbidge. Retrieved December 12, 2009 from http://www.idrc.ca/en/ev-84417-201-1-DO_TOPIC.html

Inuuvik Community Corporation, Tuktuuyaqtuuq Community Corporation and Aklarvik Community Corporation (ICC et al.) 2006, August. *Inuvialuit Settlement Region Traditional Knowledge Report.* Submitted to Mackenzie Project Environmental Group, Calgary, Alberta. Retrieved November 14, 2010 from http://www.ngps.nt.ca/Upload/Letters%20of%20Comment/Inuvik%20Community%20Corporation/ICC-ISR_TK_Study/ICC_TK_Study.html

Inuvialuit Communications Society (ICS). 2008. *Inuvialuktun Nursery Rhymes*. Retrieved January 11, 2011 from http://issuu.com/zoeho/docs/nrummarfinalebk

Inuvialuit Communications Society (ICS). 2009. *The Inuvialuit Year: A Showcase of Contemporary Inuvialiut Culture and Life*. Retrieved January 11, 2011 from http://inuvialuitcommunicationssociety.wordpress.com/

Inuvialuit Communications Society (ICS). 2010. *Welcome page*. Retrieved January 11, 2011 from http://inuvialuitcommunicationssociety.wordpress.com/

Inuvialuit Environmental and Geotechnical Inc. (IEG). 2002. *Vegetation Classification and Wildlife Habitat Suitability Modeling in the Mackenzie Delta Region*. Prepared for the Operators and the Wildlife Management Advisory Council in the Mackenzie Delta Region, NWT.

Inuvialuit Land Administration (ILA). 2009. *Inuvialuit Land Administration - About Us*. Retrieved December 1, 2009 from http://www.inuvialuitland.com/

Inuvialuit Land Administration (ILA). 2010. *Draft Husky Lakes Special Cultural Area Criteria: ILMS Special Area Plan*. May 2010.

Inuvialuit Regional Corporation (IRC). 1987. *The Western Arctic Claim: Inuvialuit Final Agreement, As Amended*. Retrieved December 1, 2009 from http://www.inuvialuitland.com/resources/Inuvialuit_Final_Agreement.pdf

Inuvialuit Regional Corporation (IRC). 2007a. *Inuvialuit Cultural Resource Centre*. Retrieved January 11, 2011 from http://www.irc.inuvialuit.com/community/cultural.htm

Inuvialuit Regional Corporation (IRC). 2007b. *Inuvialuit Culture*. Retrieved January 11, 2011 from http://www.irc.inuvialuit.com/culture/

Inuvialuit Regional Corporation (IRC). 2007c. *Inuvialuit Child Care Programs*. Retrieved January 11, 2011 from http://www.irc.inuvialuit.com/community/childcare.html

Inuvialuit Regional Corporation (IRC). 2007d. *Inuvialuit Communities*. Retrieved January 26, 2011 from http://www.irc.inuvialuit.com/culture/communities.html

Inuvialuit Regional Corporation (IRC). 2007e. *Inuvialuit Communities*. Retrieved January 31, 2011 from http://www.irc.inuvialuit.com/about/community.html

Inuvialuit Regional Corporation (IRC). 2007f. *Inuvialuit Investment Corporation*. Retrieved February 1, 2011 from http://www.irc.inuvialuit.com/corporate/investment.html

Inuvialuit Regional Corporation (IRC). 2007g. *IFA Summary*. Retrieved February 1, 2011 from http://www.irc.inuvialuit.com/about/ifasummary.html

Inuvialuit Regional Corporation (IRC). 2007h. *Inuvialuit Business List*. Retrieved December 13, 2010 from http://www.irc.inuvialuit.com/corporate/ibl/

Inuvialuit Regional Corporation (IRC). 2007i. *Inuvialuit Final Agreement*. Retrieved February 2, 2011 from http://www.irc.inuvialuit.com/about/finalagreement.html

Inuvialuit Regional Corporation (IRC). 2007j. *Modern Inuvialuit Culture*. Retrieved December 10, 2010 from http://www.irc.inuvialuit.com/culture/

Inuvialuit Regional Corporation (IRC). 2007k. *Foods*. Retrieved December 10, 2010 from http://www.irc.inuvialuit.com/culture/foods.html

Inuvialuit Regional Corporation (IRC). 2009. *IRC Annual Report*. Retrieved January 10, 2011 from http://www.irc.inuvialuit.com/publications/pdf/2009%20IRC%20Annual%20Report%20-%20Combined.pdf

Inuvialuit Regional Corporation (IRC). 2010. *IRC Board Summary Vol. 15, Issue 4*. Retrieved January 8, 2010 from http://www.irc.inuvialuit.com/publications/pdf/2010-04-December.pdf

Inuvik Drum. 2010, December 23. A Fine Feast. *Inuvik Drum, Vol. 46*, Issue 43. Retrieved January 11, 2011 from http://nnsl.com/archive/pdf-archives/in122310.pdf

Inuvik Photos. 2010. *Inuvik Food Bank*. Retrieved January 14, 2011 from http://inuvikphotos.ca/2010/12/03/inuviks-food-bank/

Investopedia. 2010. *Nominal GDP*. Retrieved December 17, 2010, from http://www.investopedia.com/terms/n/nominalgdp.asp

Jalkotzy, M.G., Ross, P.I., and Nasserden, M.D. 1997. *The Effects of Linear Developments on Wildlife: A Review of Selected Scientific Literature*. Prepared for Canadian Association of Petroleum Producers by Arc Wildlife Services Ltd. Calgary. 115 pp.

Jenness, D. 1991. *Arctic Odyssey: The Diary of Diamond Jenness 1913-1916*. (Ed.) S. Jenness. Ottawa, Ontario: Canadian Museum of Civilization.

Johnstone, R.M. 1997. *NWT Species Monitoring Infobase*. Yellowknife, NWT: Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Retrieved November 2009 from http://www.nwtwildlife.com/monitoring/speciesmonitoring/default.htm

Joint Review Panel. 2009, December. *Foundation for a Sustainable Northern Future: Report of the Joint Review Panel for the Mackenzie Gas Project*. Retrieved January 12, 2011 from http://www.ngps.nt.ca/report.html

Joint Secretariat. 2003, March. *Inuvialuit Harvest Study: Data and Methods Report 1988-1997*. Inuvik, NWT. Retrieved November 10, 2009 from http://www.jointsecretariat.ca/pdf/js/IHS10yrDataMethodsReport.pdf

Joint Secretariat. 2010a. *Joint Secretariat Description*. Retrieved February 1, 2011 from http://www.jointsecretariat.ca/

Joint Secretariat. 2010b. *Co-Management Brochure*. Retrieved February 1, 2011 from http://www.jointsecretariat.ca/pdf/js/Co-Managment%20Bro_rvsd.pdf

Jonkel, C. 1978. Black, Brown (Grizzly) and Polar Bears. In (Eds.) J.L. Schmidt and D.L. Gilbert *Big-game of North America: Ecology and Management* (pp. 227-248). Harrisburg, PA: Stackpole.

Kavik-Axys Inc. 2002. *Cumulative Effects Assessments in the Inuvialuit Settlement Region: Current and Potential Capability*. Prepared for The Environmental Impact Screening Committee and The Environmental Impact Review Board.

Kavik-Axys Inc. 2007, January. *Review of the Ikhil Gas Development and Pipeline Regulatory and Environmental Process: Lessons Learned*. Prepared for Environmental Studies Research Fund. ESRF Solicitation No. 05-057.

Kiggiak-EBA Consulting Ltd (Kiggiak-EBA). 2002. *Evaluation of Six Granular Borrow Prospects in the Mackenzie Delta Area Phase 1: Assessment of Investigation Program Requirements*. Report prepared on behalf of the Inuvialuit Land Administration.

Kiggiak-EBA Consulting Ltd. (Kiggiak-EBA). 2008. *Project Description Screening Tuktoyaktuk to Granular Source 177 Access Road, Tuktoyaktuk, NT*. Prepared on behalf of the Government of the Northwest Territories Department of Transportation and the Hamlet of Tuktoyaktuk, for the Environmental Impact Screening Committee.

Kiggiak-EBA Consulting Ltd. (Kiggiak-EBA). 2010a. *Project Description Report for Construction of the Inuvik to Tuktoyaktuk Highway, Government of the Northwest Territories.* Prepared on behalf of the Government of the Northwest Territories Department of Transportation and the Hamlet of Tuktoyaktuk, for the Environmental Impact Screening Committee.

Kiggiak-EBA Consulting Ltd. (Kiggiak-EBA). 2010b. *Spring 2010 Aquatic Field Program Results for the Inuvik to Tuktoyaktuk Highway, Northwest Territories*. Prepared on behalf of the Hamlet of Tuktoyaktuk, Town of Inuvik, and the Government of the Northwest Territories.

Kuhnlein, H.V., and Receveur, O. 2007, April. Local cultural animal food contributes high levels of nutrients for Arctic Canadian Indigenous adults and children. *Journal of Nutrition 137*(4), 1110-4. PMID: 17374689

Lambden, J., Receveur, O. and Kuhnlein, H. 2007. *Traditional Food Attributes Must Be Included in Studies of Food Security in the Canadian Arctic.* Centre for Indigenous Peoples' Nutrition and Environment and School of Dietetics and Human Nutrition, McGill University.

Lamprecht, R., and Graber, W. 1996. Modeling Dry Deposition of Dust Along the Dalton Highway. In (Eds) J.F. Reynolds and J. D. Tenhunen *Landscape Function and Disturbance in Arctic Tundra, Ecological Studies Volume 120*, 325-346. New York, NY: Springer-Verlag Publishers.

Larkin, R.P., Margoliash, D., and Kogan, J. A. 1996. Recognition of the utterances of terrestrial wildlife: a new approach. *The Journal of the Acoustical Society of America 99* (4 pt. 2), 2532.

Latour, P., MacLean, N., and Poole, K. 1992. Progress *Report on the Study of Movements of Marten in the Mackenzie Valley – Sahtu District. Manuscript Report No. 57*. Norman Wells, NWT: Government of the Northwest Territories, Department of Renewable Resources. 24 pp.

Lawford, R.G., and Cohen, S.J. 1989. The Impacts of Climatic Variability and Change in the Mackenzie Delta. *Journal of the Arctic Institute of North America, Vol. 42*, No. 1.

Le Blanc, R. 1994. The Qugyuk Site (ObRw-1) and the Archaeology of the Eastern Mackenzie Delta. In (Ed.) J.L. Pilon Bridges Across Time: The NOGAP Archaeology Project (pp. 193-212). *Canadian Archaeological Association Occasional Paper 2,* Volume 2.

LeFranc, M.N., Beth, M.M., Patnode, K.A., and William, C. (Eds.). 1987. *Grizzly bear compendium*. Interagency Grizzly Bear Committee. 540 pp.

Linnell, J.D.C., Swenson, J.E., Andersen, R., and Barnes, B. 2000. How Vulnerable are Denning Bears to Disturbance? *Wildlife Society Bulletin, 28*, 400-413.

Lloyd, D.S., Koenings, J.P., and LaPerriere, J.D. 1987. Effects of Turbidity in Fresh Water of Alaska. *N. Am. Journal of Fish. Mgmt. 7*, 18-33.

Lobdell, J. 1986. The Kuparuk Pingo Site: A Northern Archaic Hunting Camp of the Arctic Coastal Plain, North Alaska. *Arctic 39*(1), 47-51.

Lynch, G.M. 1973. Influence of hunting on an Alberta moose herd. *Trans. N. American Moose Conf. and Workshop 9*, 123-135.

Lyons, N. 2009. Inuvialuit Rising: The Evolution of Inuvialuit Identity in the Modern Era. *Alaskan Journal of Anthropology 7*(2), 70-74.

Macdonald, D.W. (Ed.) 2009. *The Princeton Encyclopedia of Mammals*. Princeton, NJ: Princeton University Press. 976 pp.

Mace, R.D., Waller, J.S., Manley, T.L., Lyon, L.J., and Zuuring, H. 1996. Relationships among grizzly bears, roads and habitat in the swan mountains, Montana. *J. Appl. Ecol. 33*, 1395-1404.

Mackay, J. 1963. *Mines and Technical Surveys, Geographical Branch: Memoir 8*. Ottawa, ON.

Mackay, J.R. 1986. The first 7 years (1978-85) of ice wedge growth, Illisarvik experimental drained lake, western Arctic coast. *Can. J. Earth Sci.* 23: 1782-95.

Mackenzie Delta-Beaufort Sea Regional Land Use Planning Commission (MD-BSRLUPC). 1991, October. *A Community-Based Regional Land Use Plan for the Mackenzie Delta-Beaufort Sea Region: A Land Use Plan*. Retrieved January 11, 2011 from http://pubs.aina.ucalgary.ca/gran/49884.pdf

Mackenzie Gas Project (MGP). ND. *Gathering System*. Retrieved January 6, 2011 from http://www.mackenziegasproject.com/theProject/projectDescription/gatheringSystem/index.html

Mackenzie Gas Project (MGP). 2005a. *ISR Application for a Type A Water License*. Retrieved January 4, 2011 from http://www.mackenziegasproject.com/theProject/.../WL_ISR_Section_3S2.pdf

Mackenzie Gas Project (MGP). 2005b. Section 6: Socio-economic Effects Summary. *Environmental Impact Statement for the Mackenzie Gas Project: Volume 1: Overview and Impact Summary*. Retrieved February 1, 2011 from: http://www.mackenziegasproject.com/theProject/regulatoryProcess/applicationSubmission/Documents/MGP_EIS_Vol1_Section_6_S.pdf

Mackenzie Valley Environmental Review Board (MVERB). 2007. Chapter 2. *Socio-Economic Impact Assessment Guidelines* (Second edition). Yellowknife, NWT. Retrieved from http://www.reviewboard.ca/upload/ref_library/SEIA_Guidelines_Chapter_2.pdf

MacInnes, C.D., and Misra, R.K. 1972. Predation on Canada goose nests at McConnell River, Northwest Territories. *Journal of Wildlife Management 36*, 414 – 422.

Markert, B (Ed). 1993. *Plants as Biomonitors: indicators for heavy metals in the terrestrial environment*. New York and Weinheim: VCH Publishers Inc. and VCH Verlagsgesellschaft.

Marsden, J.E., and Chotkowski, M.A. 2001. Lake Trout Spawning on Artificial Reefs and the Effect of Zebra Mussels: Fatal Attraction. *Journal of Great Lakes Research, 27*, 33-43.

Marshall, K. 2001. Part-time by choice. *Perspectives on Labour and Income. Vol. 13*, no. 1, 20 -27. Statistics Canada Catalogue no. 75-001-XPE.

Martell, A.M., Dickinson, D.M., and Casselman, L.M. 1984. Wildlife of the Mackenzie Delta Region. *Occasional Paper No. 15, Boreal Institute for Northern Studies, University of Alberta*. Edmonton, AB. 214 pp.

Mathiassen, T. 1930. Archaeological Collections from the Western Eskimos. *Report of the Fifth Thule Expeditions 1921-24, 10* (1). Gyldendalske Boghandel, Nordisk Forlag, Copenhagen.

Matthews, S., Carrière, S., Hodgson, K., and Doyle, F. 2006. Appendix One. *2005 Mackenzie Valley, NWT – Peregrine Falcon Survey. Updated.* Technical Report submitted to Mackenzie Gas Project Joint Review Panel.

McCourt, K.H., Feist, J.D., Doll, D., and Russell, J.J. 1974. Disturbance studies of caribou and other mammals in the Yukon and Alaska, 1972. *Arctic Gas Biological Report Series, Volume 5*. Prepared by Renewable Resources Consulting Services Ltd. for Canadian Arctic Gas Study Ltd. and Alaskan Arctic Gas Study Co. Sydney, BC.

McGhee, R. 1974. *Beluga Hunters: An Archaeological Reconstruction of the History and Culture of the Mackenzie Delta Kittegaryumiut*. Hull, Quebec: Canadian Museum of Civilization.

McGhee, R. 1978. *Canadian Arctic Prehistory*. Ontario: Van Nostrand Reinhold Ltd.

McJannet, C.L., Argus, G.W., Edlund, S.A., and Cayouette, J. 1993. *Rare vascular plants in the Canadian Arctic*. Ottawa, Ontario: Canadian Museum of Nature. 79 pp.

McJannet, C.L., Argus, G.W., and Cody, W.J. 1995. *Rare vascular plants in the Northwest Territories*. Ottawa, Ontario: Canadian Museum of Nature. 104 pp.

McLean, B.D. 1992. Abundance and Distribution of Caribou on Banks Island, NWT, July 1987. *Government of the Northwest Territories, Department of Renewable Resources, File Report No. 95*. Retrieved from http://www.enr.gov.nt.ca/_live/documents/documentManagerUpload/Abundance_and_distribution_of_caribou.pdf

McLean, B.D., and Jackson, F. 1992. Spring Classification Counts of the Bluenose Caribou Herd, March 1988. *Government Northwest Territories, Department of Renewable Resources, Manuscript Report No. 64*. Retrieved from http://www.enr.gov.nt.ca/_live/documents/documentManagerUpload/spring_counts_bluenose_caribou.pdf

McLeay, D.J., Birtwell, I.K., Harman, G.F., and Ennis, G.L. 1987. Responses of Arctic Grayling (*Thymallus arcticus*) to Acute and Prolonged Exposure to Yukon Placer Mining Sediment. *Can. J. Fish. Aquat. Sci. 44*, 658-673.

McLellan, B.N. 1990. Relationships between human industrial activity and grizzly bears. *Int. Conf. Bear Res. and Manage., 8,* 57-64.

McLellan, B.N., and Mace, R.D. 1985. *Behavior of grizzly bears in response to roads, seismic activity and people.* Vancouver, BC: Canadian Border Grizzly Project, University of British Columbia. 53 pp.

McLellan, B.N., and Shackleton, D.M. 1988. Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography. *Journal of Applied Ecology 25*, 451-460.

McLellan, B.N., and Shackleton, D.M. 1989. Grizzly bears and resource-extraction industries: habitat displacement in response to seismic exploration, timber harvesting and road maintenance. *Journal of Applied Ecology 26*, 371-80.

McLoughlin, P.D. 2000. *The spatial organization and habitat selection patterns of barren-ground grizzly bears in Nunavut and the Northwest Territories, Canada*. (Ph.D. dissertation). Saskatoon, Saskatchewan: University of Saskatchewan. 151 pp.

Medicine Net. 2011a. *Definition of Mortality*. Retrieved February 1, 2011 from http://www.medterms.com/script/main/art.asp?articlekey=19649

Medicine Net. 2011b. *Definition of Morbidity*. Retrieved February 1, 2011 from http://www.medterms.com/script/main/art.asp?articlekey=4430

Medic North Emergency Services Ltd. 2010. *Medevac Services in the GNWT*. Retrieved December 17, 2010 from http://medicnorth.com

Meininger, C.A., and Spatt, P.D. 1988. Variations of tardigrade assemblages in dust-impacted arctic mosses. *Arctic and Alpine Research 20*(1), 24-30.

Meyers Norris Penny LLP. October 12, 2007. *Mackenzie Valley All-Weather Road Opportunity Assessment*. Prepared for Mackenzie Aboriginal Corporation.

Michael Minor & Associates. ND. *Traffic Noise Background Information*. Retrieved January 27, 2011 from http://www.drnoise.com/PDF_files/Traffic%20Noise%20Primer.pdf

Miltenberger, Hon. M. 2009, October 21. Minister's Statement 9-16(4): Status of Barren Ground Caribou Herds in the Northwest Territories. *Legislative Assembly of the Northwest Territories*. Retrieved from: http://www.Assembly.Gov.Nt.Ca/_Live/Documents/Documentmanagerupload/Hn091021.Pdf

Morrison, D. 1987. The Middle Prehistoric Period and the Archaic Concept in the Mackenzie Valley. *Canadian Journal of Archaeology 11*, 49-74.

Morrison, D., and Arnold, C. 1994. The Inuktuiut of Eskimo Lakes. In (Ed.) J.L. Pilon Bridges Across Time: The NOGAP Archaeology Project. *Canadian Archaeological Association Occasional Paper 2,* Volume 2 (pp. 193-212).

Morrison, D., and Swayze, K. 1991. *Archaeological Excavation and Survey in the Eskimo Lakes Area: 1991 Field Season. Northwest Territories Permit No. 1991-696*. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife, NWT.

Mueller, F.P. 1995. *Tundra esker systems and denning by grizzly bears, wolves, foxes, and ground squirrels in the central arctic, Northwest Territories*. Yellowknife, Northwest Territories, Canada: Government of the Northwest Territories, Department of Renewable Resources.

Mueller, C.M. 2001. *Distribution of subadult and adult grizzly bears in relation to human development and human activity in the Bow River watershed, Alberta.* (M.Sc. Thesis). Calgary, Alberta: University of Calgary.

Mulders, R. 2000. *Wolverine Ecology, Distribution and Productivity in the Slave Geological Province*. Final Report to the West Kitikmeot/Slave Study Society. Department of Resources, Wildlife and Economic Development. Government of the Northwest Territories. 92 pp.

Nagy, J., and Branigan, M. 1998. *Co-Management Plan for Grizzly Bears in the Inuvialuit Settlement Region*. Government of Northwest Territories, Department of Environment and Natural Resources

Nagy, J. A., and Haroldson, M. A. 1990. Comparisons of some home range and population parameters among four grizzly bear populations in Canada. *International Conference on Bear Research and Management 8*, 227-235.

Nagy, J.A., and Johnson, D. 2006. *Estimates of the Number of Barren-ground Caribou in the Cape Bathurst and Bluenose-West Herds and Reindeer/Caribou on the Upper Tuktoyaktuk Peninsula Derived Using Post Calving Photography, July 2006. Manuscript Report No.171*. Inuvik, NWT: Government of the Northwest Territories, Department of Environment and Natural Resources. 66 pp.

Nagy, J.L., Branigan, M., McLean, E., Larter, N., Veitch, A., and Popko, R. 1999. *Co-Management Plan for the Cape Bathurst, Bluenose-West and Bluenose-East Caribou Herds.* Inuvik and Sahtu Region, NWT: Government of the Northwest Territories Department of Resources, Wildlife and Economic Development.

Nagy, J.A., Pearson, A.M., and Russell, R.H. 1977. The Barren-ground Grizzly Bear. *1976 Canadian Wildlife Service Annual Report* (unpublished).

Nagy, J.A., Russell, R.H., Pearson, A.M., Kingsley, M.C., and Larsen, C.B. 1983. *A Study of Grizzly Bears on the Barren Grounds of the Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, 1974-1978*. Canadian Wildlife Service.

Nagy, J.A., Aurait, A., Wright, W., Slack, T., Ellsworth, I., Kienzler, M. 2005a. *Ecology of boreal woodland caribou in the Lower Mackenzie Valley, NT: April 2003-November 2004*.

Nagy, J.A., Wright, W.H., Slack, T.M., Veitch, A.M. 2005b. *Seasonal Ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East Barren Ground Caribou Herds.* Inuvik, NWT: Government of the Northwest Territories, Department of Resources, Wildlife, and Economic Development.

National Oceanic and Atmospheric Association (NOAA). 2006, November. *Small Diesel Spills (500 to 5000 gallons).* Retrieved January 20, 2011 from http://response.restoration.noaa.gov/book_shelf/974_diesel.pdf

Natural Resources Canada (NRC). 2007a. *Distribution of Permafrost in Canada*. Retrieved March 2, 2008 from http://gsc.nrcan.gc.ca/permafrost/wheredoes_e.php

Natural Resources Canada (NRC). 2007b. *Geological Survey of Canada: Permafrost, What is Permafrost?* Retrieved February 3, 2011 from http://gsc.nrcan.gc.ca/permafrost/whatis_e.php

Natural Resources Canada (NRC). 2010a. *Polar Continental Shelf Program, Tuktoyaktuk Remediation Project*. Retrieved February 1, 2011 from http://www.nrcan-rncan.gc.ca/com/deptmini/tuktoyaktuk-eng.php

Natural Resources Canada (NRC). 2010b. *Seismic Hazards in Canada*. Retrieved February 3, 2011 from http://earthquakescanada.nrcan.gc.ca/hazard-alea/simphaz-eng.php

Nesbitt, L., and Adamczewski, J. 2009. *Decline and Recovery of the Bathurst Caribou Herd: Workshops Oct. 1 & 2, 5 & 6, 2009*. Yellowknife, NWT.

Nichols Applied Management. 1999, March. *Benefit-Cost and Regional Economic Impact Analysis: Inuvik to Tuktoyaktuk Road (Final Report).* Prepared for Government of the Northwest Territories, Department of Transportation.

Nichols Applied Management and J. Knopp. 2010. *Socio-Economic Literature Review of the Impact of Linear Developments in the Northwest Territories*. Prepared for Fisheries and Oceans Canada

Nixon, F.M. 2000. Thaw-depth monitoring. In (Eds.) L.D. Dyke and G.R. Brooks *The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change. Geological Survey of Canada, Bulletin 547*, 119-126.

Nolan, J.W., Goski, B.C., and Wilde, G.W. 1973. Atlas of Dall Sheep and Grizzly Bear Habitat Maps. *Wildlife Habitat Inventory of the Mackenzie Valley and Northern Yukon*. Ottawa, Ontario: Canadian Wildlife Service

Northern Engineering Services Company Ltd. 1974. *Pipeline Related Borrow Studies*. Prepared for the Canadian Arctic Gas Study Limited.

Northern Engineering Services Company Ltd. 1977. 1975 *Pipeline Borrow Investigations – Fort Good Hope, NWT to Latitude 60 Degrees N: Volume III*. Prepared for the Canadian Arctic Gas Study Limited. Northern Transportation Company Ltd. (NTCL). 2009a. *Northern Transportation Company Route Map*. Retrieved January 4, 2011 from http://www.ntcl.com/booking/map.html

Northern Transportation Company Ltd. (NTCL). 2009b. *Northern Transportation Company Route 2010 Mackenzie-Western Arctic General Cargo Rate*. Retrieved January 4, 2011 from http://www.ntcl.com/upload/media_element/54/01/west-coast-2010-freight-rates.pdf

North of 60 Engineering Ltd. 2004, August. *Inuvik Gas pipeline Lessons Learned*. Prepared for Imperial Oil Resources Venture Limited by James C. McDougall.

Northwest Territories Literacy Council (NWTLC). ND. *Mission Statement*. Retrieved December 22, 2010 from http://www.nwt.literacy.ca/mission.htm

Northwest Territories Power Corporation (NTPC). 2009a. *Annual Report*. Retrieved December 17, 2010 from http://www.ntpc.com/documents/Annual%20Report_09.pdf

Northwest Territories Power Corporation (NTPC). 2009b. *History of the Corporation*. Retrieved November 10, 2009 from www.ntpc.com/about/history.html

Northwest Territories Power Corporation (NTPC). 2010. *Power Generation in Your Community*. Retrieved December 17, 2010 from http://www.ntpc.com/communities/powergeneration.html

Northwest Territories Tourism. ND. *MGM Bus Services*. Retrieved January 3, 2010 from http://www.spectacularnwt.com/operator/mgmbusservices

Noss, R. F., Quigley, H. B., Hornocker, M. G., Merril, T., and Paquet, P. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. *Conservation Biology*, *10* (4), 949-63.

Olsen, B., MacDonald, M., and Zimmer, A. 2001. *Co-management of Woodland Caribou in the Sahtu Settlement Area: Workshop on Research, Traditional Knowledge, Conservation and Cumulative Impacts. Special Publication No. 1*. Tulita, NWT: Sahtu Renewable Resource Board. 22 pp.

Oosenbrug, S.M., Mercer, E.W., and Ferguson, S.H. 1991. Moose-vehicle collisions in Newfoundland - management considerations for the 1990's. *Alces 27*, 220-5.

Ocean Studies Board (OSB). 2003. *Ocean Noise and Marine Mammals*. National Research Council, Division of Earth and Life Studies. Washington, DC: The National Academies Press.

Palmer, R.S. 1976. Vol. 2: Waterfowl. *Handbook of North American Birds*. New Haven, CT: Yale University Press. 560 pp.

Paquet, P.C. 1993. *Summary reference document--ecological studies of recolonizing wolves in the central Canadian Rocky Mountains*. Prepared by John/Paul & Assoc. Rep. for Can. Parks Serv. Banff, AB. 176 pp.

Parks Canada. 2009a. *Annual Report of Research and Monitoring in National Parks of the Western Arctic, 2001*. Retrieved from http://www.pc.gc.ca/docs/v-g/rs-rm2001/index.aspx

Parks Canada. 2009b. *First-ever comprehensive inventory of Inuvialuit traditional plant knowledge in the Western Arctic*. Retrieved January 11, 2011 from http://www.pc.gc.ca/docs/v-g/ie-ei/at-ag/sec7/page2.aspx

Pater, L. 2001. Defining auditory thresholds for animal species. *Proceedings of the Effects of Noise on Wildlife Conference, Happy Valley-Goose Bay, Labrador* (pp. 22-25). Institute for Environmental Monitoring and Research No. 2.

Pearson, A.M., and Nagy, J.A. 1976. *The Arctic Coastal Grizzly Bear and the Potential Impact of the Proposed Inuvik to Tuktoyaktuk Highway*. Edmonton, AB: Canadian Wildlife Service.

Percy, R., and Hoban, J. 1975. *A Preliminary Survey of the Fish Resource along the Inuvik – Tuktoyaktuk Portion of the Mackenzie Highway*. Report prepared for Public Works Canada.

Perrin, C.J. 2007. *Fish Species Distribution and Associated Water Chemistry Attributes in the Husky Lake and Sitidgi Lake System, NT.* Report prepared by Limnotek Research and Development Inc. for Fisheries and Oceans Canada. 16 pp.

Petitot, E. 1887. Among the Chiglit Eskimos. Translated by E. O. Hohn. *Boreal Institute for Northern Studies Occasional Publication 10,* 1981. Edmonton, AB.

Pienitz, R., Smol, J.P., and Lean, D.R.S. 1997. Physical and Chemical Limnology of 59 Lakes located between the Southern Yukon and the Tuktoyaktuk Peninsula, Northwest Territories (Canada). *Can. J. Aquat. Sci. 54*, 330-346.

Pilon, J.L. 1994a. The Inuvik Phase of the Arctic Small Tool Tradition. In (Eds.) D. Morrison and J.L. Pilon *Threads of Arctic Prehistory: Papers in Honour of William E. Taylor, Jr., Canadian Museum of Civilization Mercury Series Paper 149* (pp. 117-126). Ottawa, ON.

Pilon, J.L. 1994b. Bridges Across Time: The NOGAP Archaeology Project. *Canadian Archaeological Association Occasional Paper 2*.

Platt, J.B. 1976. Gyrfalcon Nest Site Selection and Winter Activity in the Western Canadian Arctic. *Canadian Field-Naturalist 90*, 338-345.

Polster, D.F. 2005. The role of invasive plant species management in mined land reclamation. *Canadian Reclamation, Summer/Fall*, 24-32

Pomeroy, J.W. 1985. An identification of environmental disturbances from road developments in subarctic muskeg. *Arctic, 38*(2), 104-111.

Porsild, A.E., and Cody, W.J. 1980. *Vascular Plants of Continental Northwest Territories, Canada*. Ottawa, Ontario: National Museum of Natural Sciences and National Museums of Canada. 667 pp.

Prince of Wales Northern Heritage Centre (PWNHC). ND. *Guidelines for Developers for the Protection of Archaeological Sites in the Northwest Territories.* Retrieved February 16, 2011 from http://pwnhc.learnnet.nt.ca/programs/downloads/guidelines_for_developers.pdf

Provincial Health Officer. 2003. *Every Breath You Take. Provincial Health Officer's Annual Report 2003. Air Quality in British Columbia, a Public Health Perspective*. Victoria, BC: Ministry of Health Services.

Public Works Canada (PWC). 1975, April. *Mackenzie Highway, NWT. Mile 970.95 to 1060.6 Inuvik to Tuktoyaktuk alignment review*. Edmonton, Alberta. ASTIS Record 35304.

Public Works Canada (PWC). 1976. *Geotechnical Investigation, Mile 970 (Inuvik) to Mile 1059 (Tuktoyaktuk), Mackenzie Highway*. Edmonton, Alberta. ASTIS Record 35303.

Public Works Canada (PWC). 1977. *Supplemental Report: Geotechnical Investigations, Mile 970 (Inuvik) to Mile 1059 (Tuktoyaktuk), Mackenzie Highway*. Submitted by R.D. Cook. Edmonton, Alberta. ASTIS Record 55207.

Public Works Canada (PWC). 1981a. *Materials Availability and Construction Alternatives, Inuvik to Tuktoyaktuk Highway*. Prepared by R.D. Cook. ASTIS Record 35007.

Public Works Canada (PWC). 1981b. *Geotechnical investigations, Mile 970 (KM 0) to Mile 1059 (KM 143), Mackenzie Highway: Combined Data 1976-1980*. ASTIS Record 55108.

Public Works Canada (PWC). 1982a. *Construction Report Test Embankment Inuvik to Tuktoyaktuk Highway, Inuvik, N.W.T.* Prepared by R.D. Cook.

Public Works Canada (PWC). 1982b. *Performance Report No. 1 Test Embankment Inuvik to Tuktoyaktuk Highway, Inuvik, N.W.T.* Prepared by R.D. Cook.

Public Works and Government Services Canada. 2010. *PWGSC Services*. Retrieved February 1, 2011 from http://www.tpsgc-pwgsc.gc.ca/comm/services-eng.html

Pyatt, F.B., and Haywood, W.J. 1989. Airborne particulate distribution and their accumulation in tree canopies. *Environmentalist, 9*, 291-298.

Rampton, V.N. 1979. Surficial Geology Mackenzie Delta, District of Mackenzie, Northwest Territories. *Geological Survey of Canada, Map 32-1979, scale 1:250,000*.

Rampton, V.N. 1987. Surficial Geology, Tuktoyaktuk Coastlands, Northwest Territories. *Geological Survey of Canada, Map 1647A, scale 1:500,000*.

Rasmussen, K. 1942. The Mackenzie Eskimos, after Knud Rasmussen's Posthumous Notes. In (Ed.) H. Ostermann *Report of the Fifth Thule Expeditions 1921-24, 10 (2)*. Gyldendalske Boghandel, Nordisk Forlag, Copenhagen.

Reid, Crowther & Partners. 1986. *Town of Inuvik Navy Road Evaluation*.

Rescan Environmental Services Ltd. (Rescan). 1995. *Bird Inventory and Habitat Assessment – 1995 Baseline Study Update*. Report prepared for BHP Diamonds Inc by Rescan Environmental Services Inc.

Rescan Environmental Services Ltd. (Rescan). 1999a. *Proposed Inuvik to Tuktoyaktuk Road: Environmental/ Socioeconomic Baseline Report*. Prepared for Government of the Northwest Territories Department of Transportation by Rescan Environmental Services Ltd. Yellowknife, NWT.

Rescan Environmental Services Ltd. (Rescan). 1999b. Wildlife Effects Monitoring Program. Prepared for BHP Diamonds Inc. by Rescan Environmental Services. Vancouver BC.

Resources Information Committee (RIC). 2001. *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures*. Version 2. Province of British Columbia.

Reynolds, H.V. 1981. *North Slope Grizzly Bear Studies*. Vol II. 27 pp.

Reynolds, P.E., Reynolds III, H.V., and Follmann, E.H. 1986. Responses of grizzly bears to seismic surveys in northern Alaska. *International Conference on Bear Research and Management, Proceedings 6*, 169-175.

Richardson, W.J., Greene Jr., C.R., Malme, C.I., and Thomson, D.H. 1995. *Marine Mammals and Noise*. New York, NY: Academic Press Inc.

Ripley, Klohn & Leonoff International Ltd. 1972. *Granular Materials Inventory, Zone I*. Prepared for the Department of Indian and Northern Affairs Canada (INAC).

Ripley, Klohn, and Leonoff International Ltd. 1972. *Granular Materials Inventory, Zone IV, V, VI*. Prepared for the Department of Indian Affairs and Northern Development (DIAND).

Ripley, Klohn, and Leonoff International Ltd. (RKL). 1972a. *Community Granular Materials Inventory, Tuktoyaktuk, NWT*. Prepared for Indian and Northern Affairs Canada (INAC).

Ripley, Klohn, and Leonoff International Ltd. (RKL). 1972b. *Community Granular Materials Inventory, Inuvik, NWT*. Prepared for Indian and Northern Affairs Canada (INAC).

R. M. Hardy and Ass. 1978. *Granular Materials Inventory; Yukon Coastal Plain and Adjacent Areas*. Prepared for the Department of Indian Affairs and Northern Development (DIAND).

Rolley, R.E., and Keith, L.B. 1980. Moose population dynamics and winter habitat use at Rochester, Alberta, 1965-1979. *Can. Field Nat. 94* (1), 9-18.

Roux, M., Harwood, L., and Sparling, P. 2010. *Husky Lakes Trout Monitoring and Ecological Assessment 2000 – 2004*. Submitted to Fisheries Joint Management Committee, Panel on Energy Research and Development, Devon Canada Corporation, Tuktoyaktuk Hunters and Trappers Committee and Inuvik Hunters and Trappers Committee. Preliminary Report (Inc.).

Ruediger, B. 1996, April 30. The relationship between rare carnivores and highways. In *Trends in Addressing Transportation Related Wildlife Mortality: Proceedings of the Transportation Related Wildlife Mortality Seminar, Orlando, Florida*. State of Florida: Department of Transportation, Environmental Management Office.

Russell, J. 1977. *Some overt responses of muskox and caribou to seismic activities, northeastern Banks Island, March and April, 1977*. Unpublished report. Yellowknife NWT: Government of the Northwest Territories, Wildlife Service.

Sadar, M.H. 1994. *Information Requirements and Tools for Screening and Preliminary Assessment. Environmental Assessment Training Course*. Retrieved from: http://www.frameweb.org/powerpoint/InfoRequirementsandTools2000.ppt+Sadar+1994&hl=en&ie=UTF-8

Santelmann, M. V., and Gorham, E. 1988. The Influence of Airborne Road Dust on the Chemistry of Sphagnum Mosses. *Journal of Ecology 76*, 1219-1231.

Scannell, P.O. 1988. *Effects of Elevated Sediment Levels from Placer Mining on Survival and Behaviour of Immature Arctic Grayling*. (M.Sc. Thesis). Alaska: University of Alaska Fairbanks. 93 p.

Schrader, B., and Hennon, P. 2005. *Assessment of Invasive Species in Alaska and its National Forests*. Anchorage, AK: USDA Forest Service, Regional Office.

Scott, W.B., and Crossman, E.J. 1973. Freshwater Fishes of Canada. *Fisheries Resources Board Canada Bulletin 184* (Reprinted 1990). 966 pp.

Seiler, A. 2001. *Ecological Effects of Roads. A Review*. Riddarhyttan, Sweden: Grimsö Wildlife Research Station, Department of Conservation Biology, University of Agricultural Sciences

SENES Consultants Ltd (SENES). 2005, December. *NWT Environmental Audit Status of the Environment Report*. Retrieved January 21, 2011 from http://www.ainc-inac.gc.ca/ai/scr/nt/pdf/SOEaq_eng.pdf

Shank, C. 1996. *NWT Species Monitoring Infobase*. Yellowknife, NWT: Government of the Northwest Territories, Department of Resources, Wildlife and Economic Development. Retrieved December, 2006 from http://www.nwtwildlife.com/monitoring/speciesmonitoring/default.htm

Sibley, D.A. 2003. *The Sibley Field Guide to Birds of Western North America*. New York: Alfred A. Knopf. 545 pp.

Smith, D. 1984. Mackenzie Delta Eskimo. In (Ed.) D. Damas *Handbook of North American Indians, Volume 5 Arctic*, (347-358). Washington D.C.: Smithsonian Institution

Spatt, P.D., and Miller, M.C. 1981. Growth conditions and vitality of *Sphagnum* in a tundra community along the Alaska Pipeline Haul Road. *Arctic 34*(1), 48-54.

Spellerberg, I.F., and Morrison, T. 1998. *The ecological effects of new roads – a literature review*. Wellington, NZ: Department of Conservation.

Stanley Associates Engineering Ltd. and Sentar Consultants Ltd. 1993. *Environmental Guidelines for the Construction, Maintenance, and Closure of Winter Roads in the Northwest Territories*. Report prepared for the Government of the Northwest Territories, Department of Transportation. Yellowknife, NWT.

Statistics Canada. 2006a. *Tuktoyaktuk Census of Population*. Retrieved January 13, 2011 from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/Page.cfm?Lang=E&Geo1=CSD&Code1=6107036&Geo2=PR&Code2=61&Data=Count&SearchText=Tuktoyaktuk&SearchType=Begins&SearchPR=61&B1=All&Custom

Statistics Canada. 2006b. *Inuvik Census of Population*. Retrieved January 13, 2011 from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=6107017&Geo2=PR&Code2=61&Data=Count&SearchText=Inuvik&SearchType=Begins&SearchPR=01&B1=All&Custom

Statistics Canada. 2006c. *Community Profiles – Occupation*. Retrieved January 13, 2011 from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page_Definitions.cfm?Lang=E&Geo1=CSD&Code1=6107036&Geo2=PR&Code2=61&Data=Count&SearchText=Tuktoyaktuk&SearchType=Begins&SearchPR=01&B1=All&Custom=&LineID=22000

Statistics Canada. 2006d. *Community Profiles – Management Occupations*. Retrieved January 13, 2011 from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page_Definitions.cfm?Lang=E&Geo1=CSD&Code1=6107017&Geo2=PR&Code2=61&Data=Count&SearchText=Inuvik&SearchType=Begins&SearchPR=01&B1=All&Custom=&LineID=22001

Statistics Canada. 2006e. *Community Profiles – Industry*. Retrieved January 13, 2011 from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page_Definitions.cfm?Lang=E&Geo1=CSD&Code1=6107017&Geo2=PR&Code2=61&Data=Count&SearchText=Inuvik&SearchType=Begins&SearchPR=01&B1=All&Custom=&LineID=23000

Statistics Canada. 2006f. *Community Profiles – Persons reporting hours of unpaid housework*. Retrieved January 13, 2011 from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page_Definitions.cfm?Lang=E&Geo1=CSD&Code1=6107017&Geo2=PR&Code2=61&Data=Count&SearchText=Inuvik&SearchType=Begins&SearchPR=01&B1=All&Custom=&LineID=24001

Statistics Canada. 2009a. *Income and expenditure accounts, Gross Domestic Product (GDP)*. Retrieved January 31, 2011 from http://www.statcan.gc.ca/nea-cen/gloss/iea-crd-eng.htm#gdp

Statistics Canada. 2009b. *Data Quality, Concepts and Methodology: Methodology*. Retrieved January 4, 2011 from http://www.statcan.gc.ca/pub/91-215-x/2009000/technote-notetech1-eng.htm

Statistics Canada. 2009c. *NAV CANADA Flight Service Stations and Airports without Air Traffic Control Towers: Total aircraft movements by class of operation*. Retrieved January 4, 2011 from http://www.statcan.gc.ca/pub/51-210-x/2009001/t001-eng.htm

Statistics Canada. 2010a. *Income Research Paper Series – Low Income Lines 2008-2009*. Retrieved December 14, 2010 from http://www.statcan.gc.ca/pub/75f0002m/75f0002m2010005-eng.pdf

Statistics Canada. 2010b. R*eal gross domestic product, expenditure-based, by province and territory*. Retrieved December 9, 2010 from http://www40.statcan.ca/l01/cst01/econ50-eng.htm

Statistics Canada. 2010c. *Consumer Price Index*. Retrieved December 14, 2010 from http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=2301&lang=en&db=imdb&adm=8&dis=2

Statistics Canada. 2010d. *Labour Force Information*. Retrieved December 20, 2010 from http://www.statcan.gc.ca/pub/71-001-x/2010012/technote-notetech1-eng.htm

Statistics Canada. 2010j. *Statistics Tables: NAV CANADA Flight Service Stations*. Retrieved from http://www.statcan.gc.ca/pub/51-209-x/2010001/tablesectlist-listetableauxsect-eng.htm

Stedman, S.J. 2000. Horned Grebe (*Podiceps auritus*). In (Eds.) A. Poole and F. Gill *The Birds of North America, No. 505*. Philadelphia, PA.: The Birds of North America, Inc.

Stefansson, V. 1919. Stefansson-Anderson Arctic Expedition. *Anthropological Papers of the American Museum of Natural History XIV*. New York, NY.

Stephenson, T. R., Van Ballenberghe, V., Peek, J. M., and MacCracken, J. G. 2006. Spatio-temporal constraints on moose habitat and carrying capacity in coastal Alaska: vegetation succession and climate. *Rangeland Ecology and Management 59*, 359-372

Stotts, V.D. 1988. *Observation of Miscellaneous Wildlife During 1980-82 Waterfowl Breeding Ground Surveys in Northwest Territories*. Draft paper prepared for submission to the Canadian Field Naturalist. Copy on file with Canadian Wildlife Service. Yellowknife, NWT.

Sugden, L.G. 1977. Horned Grebe Breeding Habitat in Saskatchewan Parklands. *Canadian Field-Naturalist 91*(4):372-376.

Swayze, K. 1994. The Tuktoyaktuk Peninsula Interior: Pre-Contact Inuvialuit Landuse. In (Ed.) J.L. Pilon Bridges Across Time: The NOGAP Archaeology Project (127-150). *Canadian Archaeological Association Occasional Paper 2*, Volume 2.

Talbot, S.S., Yurtsev, D.F., Murray, D.F., Argus, G.W., Bay, C., and Elvebakk, A. 1999. Atlas of rare endemic plants of the Arctic. *Conservation of Arctic Flora and Fauna (CAFF) Technical Report No. 3*. Anchorage, Alaska: U.S. Fish and Wildlife Service. 82 pp.

Tarnocai, C., Kettles, I.M., and Lacelle, B. 2003. Peatlands of the Mackenzie River Valley Database and Map. *Geological Survey of Canada, Open File 4413*.

Terrain Analysis & Mapping Services Ltd. 1975, October. *Bedrock Sources of Highway Materials Inuvik to Tuktoyaktuk Highway*. Prepared for Government of the Northwest Territories, Department of Public Works, Western Region.

Terres, J.K. 1982. *The Audubon Society Encyclopedia of North American birds*. New York: Alfred A. Knopf. 1109 pp.

The Canadian Petroleum Association and the Independent Petroleum Association of Canada (CPA and IPAC). 1989, November. *Oil Spill Preparedness in the Upstream Petroleum Industry*. Calgary, AB

The Hamlet of Tuktoyaktuk. 2006. *Submission of the Hamlet Council to the Joint Panel Examining the Mackenzie Gas Project*. Retrieved from http://www.ngps.nt.ca/Upload/Interveners/Tuktoyaktuk%20-%20Hamlet%20of/060825_Ham_of_Tuk_wrsub_Sept15_CH.pdf

Thiel, R.P., and Valen, T. 1995. Developing a state timber wolf recovery plan with public input: the Wisconsin experience. In (Ed) L.N. Carbyn, S.H. Fritts, and D.R. Seip *Ecology and management of wolves in a changing world*. *Canadian Circumpolar Institute, Occas. Publ. No. 35*, (pp.169-175). Edmonton. AB: Canadian Circumpolar Institute.

Thomas, D.C. 1969. Population Estimates and Distribution of Barren-Ground Caribou in Mackenzie District, N.W.T., Saskatchewan and Alberta – March to May 1967. *Canadian Wildlife Service report series No. 9*. Ottawa, Ontario.

Thompson, I.D. 1994. Marten Populations in Uncut and Logged Boreal Forests in Ontario. *Journal of Wildlife Management 58*, 272-280.

Thompson, J.R., Mueller, P.W., Fluckiger, W., and Rutter, A.J. 1984. The effect of dust on photosynthesis and its significance for roadside plants. *Environmental Pollution, Ser. A* (34), 171-190.

Thompson, G.W., Schuller, P.D., and Lewis, D.W. 1998. Dental Caries Knowledge in a Group of Northwest Territories Children. *Int J Circumpolar Health 57*, Suppl. 1, 169-73 Retrieved December 30, 2010 from http://www.ncbi.nlm.nih.gov/pubmed/10093268

Thurber, J.M., Peterson, R.O., Drummer, T.D., Thomasma, S.A. 1994. Gray wolf response to refuge boundaries and roads in Alaska. *Wildl. Soc. Bull. 22* (1), 61-68.

Town of Inuvik. 2006. *Town of Inuvik Submission: Mackenzie Gas Project*. Submitted to the Joint Review Panel Hearings. February 16, 2006. Retrieved December 1, 2010 from http://www.maca.gov.nt.ca/pipelineresource/documents/Inuvik%20Submission.pdf

Town of Inuvik. 2008. *Schedule 'C' Zoning Map*. Retrieved January 11, 2011 from http://inuvik.ca/wp-content/uploads/Zoning-2008-Town-Centre-Full-Size-with-plan-numbers.pdf

Town of Inuvik. 2009. *Community Profile*. Retrieved January 15, 2010 from http://www.inuvik.ca/tourism/community.html

Town of Inuvik. 2010a. *RCMP*. Retrieved December 20, 2010 from http://inuvik.ca/?s=police

Town of Inuvik. 2010b. *Solid Waste Collection Services*. Retrieved December 7, 2010 from http://inuvik.ca/town-hall/plans-policies/solid-waste-collection-services/

Town of Inuvik. 2010c. *Inuvik History*. Retrieved December 1, 2010 from http://inuvik.ca/living-in-inuvik/community-profile/inuvik-history/

Town of Inuvik. 2010d. *Inuvik Fire Department*. Retrieved December 20, 2010 from http://inuvik.ca/town-hall/inuvik-fire-department/

Town of Inuvik. 2010e. *Recreational Facilities*. Retrieved January 3, 2011 from http://inuvik.ca/living-in-inuvik/

Town of Inuvik. 2010f. *Town of Inuvik*. Retrieved February 1, 2011 from http://inuvik.ca

Tracy, D.M. 1977. *Reaction of wildlife to human activity along Mount McKinley National Park Road*. (M.S. Thesis.) University of Alaska-Fairbanks. 260 pp.

Transportation Association of Canada. 1998. *Manual of Uniform Traffic Control Devices for Canada* (MUTCDC).

Transportation Association of Canada. 2010, June. *Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions*.

Transport Canada. 2010. *TP141 Aircraft Movement Statistics*. Retrieved January 4, 2011 from http://www.tc.gc.ca/eng/policy/report-aca-tp141e-tp141-286.htm

Trenhaile, A.S. 2007. *Geomorphology, A Canadian Perspective* (pp. 247-249). Oxford University Press.

Treseder, L., and Graf, R. 1985. *Moose in the Northwest Territories - a discussion paper*. Manuscript Report No. 13. Yellowknife, NWT: Government of the Northwest Territories, Department of Renewable Resources, NWT Wildlife Service. 50 pp.

Trombulak, S.C., and Frissell, C.A. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology 14* (1), 18-30.

Tyler, G. 1989. Uptake, retention and toxicity of heavy metals in lichens, a brief review. Effects of Heavy Metals in Forest Ecosystems. *Water, Air and Soil Pollution 47* (3-4), 321-333. Kluwer Academic Publishers.

Underhill, J.E., and Angold, P.G. 2000. Effects of roads on wildlife in an intensively modified landscape. *Environ. Rev. 8*, 21–39.

United States Department of Agriculture (USDA). 2006. *USDA Forest Service Invasive Species Program Website*. Retrieved February, 2011from http://www.fs.fed.us/invasivespecies/prevention.shtml

United States Department of the Interior and United States Geological Survey. 2001. *Field Manual of Wildlife Diseases. General Field Procedures and Diseases of Birds.*

United States Department of Transportation, Federal Highway Administration (US DOT FHWA). ND. *Highway Traffic Noise.* Retrieved January 27, 2011 from http://www.fhwa.dot.gov/environment/htnoise.htm

United States Department of Transportation, Federal Highway Administration (US DOT FHWA). 2004. *Synthesis of Noise Effects on wildlife Populations*. US Department of Transportation Publication No. FHWA-HEP-06-016.

United States Department of Transportation, Federal Highway Administration (US DOT FHWA). 2010. *Highway Traffic and Construction Noise - Problem and Response: 23 CFR 772 Procedures for Abatement of Highway Traffic Noise and Construction Noise.* Retrieved January 25, 2011 from http://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/probresp.cfm#t3

United States Environmental Protection Agency (US EPA). 1995, January. *AP 42, Fifth Edition: Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.*

United States Environmental Protection Agency (US EPA). 2006. Chapter 13: Miscellaneous Sources. *AP 42, Fifth Edition: Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.*

Usher, P. 1971. *Fur Trade Posts of the Northwest Territories 1870-1970*. Ottawa, ON: Northern Science Research Group, Department of Indian Affairs and Northern Development (DIAND).

Valkenburg, P., and Davis, J.L. 1985. A comparison of the reaction to aircraft of caribou from two herds in Alaska. *Alaska Science Conference Proceedings 34*, 14.

Van Zyll de Jong, C.G. 1975. The Distribution and Abundance of the Wolverine (*Gulo gulo*) in Canada. *Can Field-Nat. 89*, 431-437.

Voipio, H.-M., E. Björk, M. Hakumäki, and T. Nevalainen. 1998. Sound: from noise to communication. *Scandinavian Society for Laboratory Animal Science (Scand-LAS) Symposium. Hafjell, Norway: April 15th -19th 1998*, (Abstract).

Walker, D.A., and Everett, K.R. 1987. Road dust and its environmental impact on Alaskan taiga and tundra. *Arctic and Alpine Research 19*(4), 479-489.

Walker, D.A., and Everett, K.R. 1991. Loess Ecosystems of Northern Alaska: Regional Gradient and Toposequence at Prudhoe Bay. *Ecological Monographs 61*(4), 437-464

Weaver, J.L. 2001. *The Transboundary Flathead: A Critical Landscape for Carnivores in the Rocky Mountains.* Working Paper No. 18. Wildlife Conservation Society. 62 pp.

Weaver, J.L., Paquet, P.C., and Ruggiero, L.F. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. *Cons. Biol. 10* (4), 964-76.

Western Governors' Association. 2006. *Western Regional Air Partnership's (WRAP) Fugitive Dust Handbook*. Prepared by Countess Environmental, WGA Contract No. 30204–111, September, 2006. Westlake Village, California, USA

Wetzel, R.G. 1975. *Limnology*. W.B. Saunders Comp., Toronto.

Wielgus, R.B., Vernier, P.R., and Schivatcheva, T. 2002. Grizzly bear use of open, closed, and restricted forestry roads. *Can. J. For. Res. 32*, 1597-1606.

Wiggins, D.A., Holt, D.W., and Leasure, S.M. 2006. Short-eared Owl (*Asio flammeus*). In (Ed.) A. Poole *The Birds of North America*. Ithaca: Cornell Laboratory of Ornithology. Retrieved from http://bna.birds.cornell.edu/BNA/account/Short-eared_Owl/

Williams, N.A., Calverley, B.K., and Mahrt, J.L. 1977, July. Blood Parasites of Mallard and Pintail Ducks from Central Alberta and the Mackenzie Delta, Northwest Territories. *Journal of Wildlife Diseases. Vol. 13*, July 1977.

Wolfe, S. A., Griffith, B. and Wolfe, C.A.G. 2000. Response of reindeer and caribou to human activities. *Polar Research, 19* (1), 63-73.

Woo, M.K. 1993. Chapter 5 Surface Hydrological Processes (pp. 117-142). In (Ed.) H.M. French and O. Slaymaker *Canada's Cold Climates*. McGill Queen's University Press.

Woo, M.K., and Guan, X.J. 2006. Hydrological Connectivity and Seasonal Storage Change of Tundra Ponds in a Polar Oasis Environment, Canadian High Arctic. *Permafrost and Periglacial Processes 17*(4), 309-323.

Woo, M.K., Mollinga, M., and Smith, S.L. 2007. *Climate warming and active layer thaw in the boreal and tundra environments of the Mackenzie Valley*. NRC Research Press. Retrieved from http://cjes.nrc.ca

Working Group on General Status of NWT Species. 2011. *NWT Species 2011-2015 - General Status Ranks of Wild Species in the Northwest Territories, Department of Environment and Natural Resources, Government of the Northwest Territories*. Yellowknife, Northwest Territories. 172 pp.

Wright, D.G., and Hopky, G.E. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. *Canadian Technical Report of Fisheries and Aquatic Sciences 2107*: iv + 34p.

Wulder, M., Cranny, M., Dechka, J., and White, J. 2004, March. *An Illustrated Methodology for Land Cover Mapping of Forests with Landsat-7 ETM+ Data: Methods in Support of EOSD Land Cover, Version 3*. Victoria, BC, Canada: Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre. 35 pp.

Yukon Info. ND. *Inuvik Igloo Church*. Retrieved December 20, 2010 from http://www.yukoninfo.com/inuvik/info/igloochurch.htm

Statutes Cited

Canada Labour Code, R.S.C. 1985, c. L-2

Canada National Parks Act, S.C. 2000, c. 32

Canada Occupational Health and Safety Regulations, SOR/86-304 (*Canada Labour Code*, Part II)

Canadian Environmental Assessment Act, S.C. 1992, c. 37

Canadian Environmental Protection Act, 1999, SC 1999, c. 33

Child Day Care Act, R.S.N.W.T. 1988, c. C-5

Critical Wildlife Areas Regulations, R.R.N.W.T. 1990, c. W-3, (*Wildlife Act*)

Environmental Protection Act, R.S.N.W.T. 1988, c. E-7

Explosives Use Act, R.S.N.W.T. 1988, c.E-10

Fisheries Act, R.S., 1985, c. F-14

General Safety Regulations, R.R.N.W.T. 1990, c. S-1, R-028-93 (*Northwest Territories Safety Act*)

Gwich'in Land Claim Settlement Act, S.C. 1992, c. 53

Historical Resources Act, R.S.N.W.T. 1988, c.H-3

Historic Sites and Monuments Act, R.S., c. H-6, s. 1

Migratory Birds Convention Act, 1994, S.C. 1994, c. 22

Navigable Water Protection Act, R.S., 1985, c. N-22

Northwest Territories Act, R.S.1985, c. N-27

Northwest Territories Archaeological Sites Regulations, SOR/2001-219 (*Northwest Territories Act*)

Northwest Territories Waters Act, S.C. 1992, c. 39

Northwest Territories Waters Regulations, SOR/93-303, (*Northwest Territories Waters Act*)

Public Health Act, S.N.W.T. 2007, c.17

Public Highways Act, R.S.N.W.T. 1988, c. P-13

Safety Act, R.S.N.W.T .1988, c. S-1

Scientists Act, R.S.N.W.T. 1988, c. S-4

Species at Risk (NWT) Act, S.N.W.T. 2009, c.16

Species at Risk Act, S.C. 2002, c. 29

Spill Contingency Planning and Reporting Regulations, N.W.T. R-068-93 (*Environmental Protection Act*)

Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations, SOR/2008-197 (*Canadian Environmental Protection Act*)

Territorial Lands Act, R.S. 1985, c. T-7

Territorial Lands Regulations, C.R.C., c. 1525 (*Territorial Lands Act*)

Territorial Land Use Regulations, C.R.C., c. 1524 (*Territorial Lands Act*)

Territorial Quarrying Regulations, C.R.C., c. 1527 (*Territorial Lands Act*)

Waste Reduction and Recovery Act, S.N.W.T. 2003, c. 29

Western Arctic (Inuvialuit) Claims Settlement Act, S.C. 1984, c. 24

Western Arctic (Inuvialuit) Claims Settlement Act, S.C. 1984, c. 24, amended P.C. 2004-337

Wildlife Act, R.S.N.W.T. 1988, c.W-4

Workers Compensation Act, S.N.W.T. 2007, c. 21