Hamlet of Tuktoyaktuk, Town of Inuvik
Government of Northwest Territories

ISSUED FOR USE

RESPONSE TO THE MARCH 8, 2012 INFORMATION REQUESTS (ROUND 2) FROM THE ENVIRONMENTAL IMPACT REVIEW BOARD FOR CONSTRUCTION OF THE INUVIK TO TUKTOYAKTUK HIGHWAY, NWT

EIRB FILE NO. 02/10-05

March 30, 2012

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ACRONYMS

CEAA	Canadian Environmental Assessment Act
CSA	Canadian Standards Association
DFO	Department of Fisheries and Oceans
DOT	Department of Transportation (GNWT)
EIRB	Environmental Impact Review Board
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENR	Environment and Natural Resources
GNWT	Government of the Northwest Territories
GTC	Gwich'in Tribal Council
HTC	Hunters and Trappers Committee
IFA	Inuvialuit Final Agreement, as Amended April 2005
IR	Information Request
ILA	Inuvialuit Land Administration
ISR	Inuvialuit Settlement Region
LSA	Local Study Area
NWT	Northwest Territories
OS	Operational Statements
PDR	Project Description Report
RSA	Regional Study Area
TAC	Transportation Association of Canada
VEC	Valued Ecological Component
VSC	Value Socio-economic Component
ZOI	Zone of Influence

1.0 Introduction

The Developers of the proposed Inuvik to Tuktoyaktuk Highway are pleased to provide the following responses to the Environmental Impact Review Board's second round of Information Requests (IRs) dated March 8, 2012. The Developers' responses are included after each information request and are organized into the following sections:

Section 2.0 (IR 90-96) – Environmental Impact Review Board

Section 3.0 (IR 97-102) – Aboriginal Affairs and Northern Development Canada

Section 4.0 (IR 103-113) – Fisheries and Oceans Canada

Section 5.0 (IR 114-117) – Environment Canada

Section 6.0 (IR 118) – Infrastructure Canada

Section 7.0 (IR 127-129) – Health Canada

Section 8.0 (IR 130-141) – Natural Resources Canada

Section 9.0 (IR 142) – Transport Canada

Section 10.0 (IR 143-145) – Tuktoyaktuk-Inuvik Working Group

Please note that new tables or figures, created for the most recent information requests, have been numbered according to their respective IR Number. Any tables or figures from the EIS or previous response documents have retained their original number.

2.0 Environmental Impact Review Board

IR Number: 90

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Permafrost and Ground Ice**

Preamble

The road design calls for construction of an embankment that, initially at least, will protect the permafrost beneath the road from thaw and consequent subsidence. However, the side slopes of the embankment will not be of sufficient thickness to prevent thaw of permafrost. Thawing beneath side slopes has recently been demonstrated from Alaska by Darrow (2001). The amount of subsidence to be expected beneath the side slopes will depend on the ice content of the permafrost. Subsidence beneath the side slopes will be expected to lead to shoulder rotation and other processes that will affect the integrity of the highway. The amount of subsidence will affect the extent of maintenance required and the volume of aggregate that must be extracted for this purpose.

Request

The Geological Survey of Canada has released several Open Files during the last 10 years in which databases of near-surface permafrost and ground ice conditions in the project area were presented.

1. Using data such as presented by the Geological Survey of Canada or other agencies, please indicate to the Board the extent of subsidence expected in the side slopes of the highway embankment over the life of the project.
2. Please also estimate the volume of aggregate that will be required to remediate the side slopes and maintain the integrity of the highway. Please provide estimates of total aggregate requirements over the life of the project for each of the four terrain units described on pp. 102-105 of the BS.

Reference

Darrow, M.M. 2011. Thermal modeling of roadway embankments over permafrost. Cold Regions Science and Technology, 65: 474-487.

Developer Response: 90.1

The minimum embankment thicknesses identified in the PDR and EIS vary depending on the sensitivity of the permafrost terrain to thaw-settlement. The PDR identified four generalized terrain types for preparing a preliminary design and quantity estimate as well as a budgetary or planning level cost estimate. The thicker embankment criteria will be applied when the objective is to ensure that the original active layer soils and the underlying permafrost will be preserved in a permafrost condition (high risk of thaw-subsidence).

These embankment thicknesses are considered satisfactory for preliminary design from which a budgetary or planning level cost estimate has been produced and for preparation of the Project Description Report and Environmental Impact Statement. It is not possible to reasonably predict the extent of thaw at the toe of the embankment under varying conditions with confidence. During the detailed design stage, the embankment will be modelled as a two-dimensional structure placed on a fully frozen permafrost foundation (winter construction). Geothermal analyses will predict the maximum ground temperature within the core of the embankment. At that time, the effect of the embankment sideslopes on localized permafrost thaw will be predicted and mitigative measures adopted to minimize long-term performance risks.

Embankment sideslopes encourage snowdrift formation, which changes the ground surface heat balance. The methodology used for two-dimensional thermal analyses during the detailed design stage is described in *Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions – Chapter 5, Engineering Considerations (*Transportation Association of Canada (TAC) 2010). Specific reference to the geothermal modelling that would be used is described in a TAC-referenced paper entitled *Permafrost Response Following Reconstruction of the Yellowknife Highway* (Hoeve et al. 2004).

Design measures for thick embankments at risk of deformation by thaw-subsidence below the sideslopes include flattening the sideslopes, construction of toe berms and increased crest width to allow a sacrificial shoulder. These options, together with an active monitoring and remediation program, have been successfully used on past projects including the Dempster Highway within the NWT.

Reference:

Hoeve, T. E., Seto, J. T. C., and Hayley, D. W. 2004. Permafrost Response Following Reconstruction of the Yellowknife Highway. Proceedings of the Twelfth International Conference on Cold Regions Engineering, ASCE Press, Reston, Va.

Developer Response: 90.2

Gravel highways require regular annual maintenance (grading, replacing surfacing material, etc.) and preservation efforts that include a level of reconstruction (maintaining the core embankment) about every 20-years to rectify distorted cross-section elements. Based on historic maintenance and reconstruction information from the Dempster Highway, it is anticipated that volumes of materials required for the Inuvik to Tuktoyaktuk Highway could be similar to the volumes shown in Table 1; however, because the design of the Highway will include the lessons learned on the Dempster and other highways on permafrost, we anticipate that these quantities would be smaller and not be fully required. As such, the gravel quantities at 50-year life with 20-year rehabilitation are shown in Table 1. Benching and grade repair gravel quantities are also shown.

TABLE 1: 50-YEAR HIGHWAY AGGREGATE REQUIREMENTS[1]

Length	Borrow Excavation Common (50 years)	Crushed Gravel (50 years)	Comments
Terrain Unit I (40%) 0.40 x 137,000 m	1,144,000 m^3	120,000 m^3	At year 20, and year 40 rehab, and ongoing benching and grade repairs
Terrain Unit II (35%) 0.35 x 137,000 m	1,010,000 m^3	99,800 m^3	At year 20, and year 40 rehab, and ongoing benching and grade repairs
Terrain Unit III (20%) 0.20 x 137,000 m	847,000 m^3	56,200 m^3	At year 20, and year 40 rehab, and ongoing benching and grade repairs
Terrain Unit IV (5%) 0.05 x 137,000 m	286,000 m^3	15,640 m^3	At year 20, and year 40 rehab, and ongoing benching and grade repairs
TOTAL	3,287,000 m^3	291,640 m^3	

1. Includes rehabilitation every 20-years, ongoing grade repairs and benching.

IR Number: 91

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Ice Wedges and Hill Slopes**

Preamble

The Developer has indicated in its response to IR 61 (pp. 176) that "significant subgrade collapse" occurred on the Dempster Highway "near Rat Pass, which led to a serious vehicle accident causing a human fatality." This collapse was due to thaw of massive ice beneath the roadbed. The remedial work conducted by GNWT included a ground penetrating radar survey of the Highway to locate similar structures.

The proposed route of the Inuvik-Tuktoyaktuk Highway crosses many slopes and is aligned in upland terrain along a considerable distance. Ice wedges on hill slopes and in upland terrain are characteristically difficult to delineate from their surface expression, due to slope movement. They are, however, abundant in the project area, especially north of the tree line (Mackay 1995). They represent large bodies of massive ice near the ground surface and may present a significant geohazard to the project.

Request

The Developer has described ice-wedge polygons from lowland terrain in the EIS (p. 111).

1. Please indicate the methods, techniques, and plans for preconstruction surveys to be conducted to delineate ice wedges on hill slopes and in upland terrain along the highway alignment.
2. Please indicate the plans for monitoring the integrity of these structures beneath the road, and the integrity of the road embankment in their vicinity, during the operating life of the project.

Reference

Mackay, J.R. 1995. Ice wedges on hill slopes and landform evolution in the late Quaternary, western Arctic coast, Canada. Canadian Journal of Earth Sciences, 32: 1093-1105.

Developer Response: 91.1

A number of studies have and will continue to be conducted to assist in delineating ice wedges on hill slopes in upland terrain along the Highway alignment. In the fall of 2011 the Department of Transportation retained KAVIK-STANTEC to conduct a more detailed terrain evaluation along the entire proposed alignment, including Alternative 1 and Alternative 3 minor realignments in the Husky Lakes area. As part of this study, surface material, surface expression, drainage slopes and geomorphic processes were mapped using a combination of recently acquired stereo digital imagery and KAVIK-STANTEC'S High Definition Mapping and APPlliations (HD-MAPP) system.

HD-MAPP incorporated PurVIEW™ and ArcGIS applications, making it possible to view medium to 1:30,000 scale aerial photographs in a digital environment at scales as large as 1:1,000. The ability to view stereo-imagery at such detailed scales allows for better identification, delineation and

classification of surficial geology, potential ice-rich terrain features such as polygonal peat plateaus, ice wedges and terrain-related constraints (e.g. steep slopes, thaw slumps and seepage areas). This recent report has been provided to the EIRB and is available on the public registry.

Concurrently with the terrain evaluation, GNWT DOT retained Jack M Byrne Consulting Ltd. of Killam Alberta under contract with FSC-STANTEC (formerly FSC Architects & Engineers) to complete high resolution LiDAR mapping of the proposed alignment, including Alternatives 1 and 3. The LiDAR imagery was subsequently transformed by McElhanney Engineering in Vancouver. Among other uses, the results of the LiDAR mapping and the existing terrain mapping will be used to assist in delineating areas with ice wedges.

Subsequently, during the detailed design phase, one-dimensional and two-dimensional thermal design analysis will be carried out as appropriate for the proposed alignment and for selected Highway cross sections to be constructed in areas of particularly sensitive terrain. In addition, further field investigations (subsurface geotechnical investigations including ground temperature) to delineate transitions zones between more and less sensitive terrain types will be carried out to support the detailed design work. In particular locations, specialized geotechnical techniques such as ground penetrating radar may be used to assist in mapping ground ice occurrence.

Reference:

KAVIK-STANTEC. 2012. Inuvik to Tuktoyaktuk Highway-Baseline Data Acquisition Program Terrain Evaluation. Report prepared by KAVIK-STANTEC Inc. for the Government of the Northwest Territories Department of Transportation.

Developer Response: 91.2

In responding to this information request, it should be noted that the use of geotextile under the road embankment will assist in retaining the integrity of the road embankment during the project life.

The plan for monitoring the performance of the Highway remains to be developed but may include:

- biannual collection and measurement of ground temperature at key locations;
- measuring settlements and comparing the measured results against settlement indicators,
- conducting visual observations on an ongoing basis (seasonal/annual inspections) by operational staff; and
- advanced technology, such as ground penetrating radar, may be used to assess and monitor subsurface conditions.

The GNWT DOT is currently considering the implementation of a monitoring program for the Tuktoyaktuk to Source 177 Access Road. The monitoring program includes the techniques listed above. The purpose of the monitoring program is to obtain data on how the performance of the road relates to its design, and the associated terrain and climate conditions. Information obtained from this program will be used to develop best practices to optimize the design and construction of the Inuvik to Tuktoyaktuk Highway.

IR Number: 92

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Aggregate Requirements**

Preamble

The aggregate requirements for road construction have been estimated in the EIS. The aggregate requirements for on-going maintenance of the road over the life of the project after construction, if complete, should be specified. This aggregate will be needed in summer, when access to quarries by winter road is not possible. The aggregate will be stockpiled near the road.

Request

1. Please provide the estimated volume of aggregate required for maintenance operations on an annual basis for the first fifty years of the life of the road. Indicate the gravel sources from which this aggregate is to be supplied.
2. Please provide the locations where aggregate is to be stockpiled for summer use in maintenance operations along the road.
3. Please indicate the maximum volume of aggregate to be positioned in each stockpile.
4. Please provide the plans for control of runoff from the stockpiles, especially runoff due to melting of ground ice in the aggregate.
5. Please indicate the plans for control of dust emissions from these stockpiles.
6. Please indicate the plans for prevention of excavation of dens by wildlife in the stockpiles.

Developer Response: 92.1

For Highway maintenance operations, an annual application of gravel surfacing and spot gravelling will be required. The objective of gravel surfacing is to maintain a safe driving surface by annually replacing lost gravel to avoid major and expensive rehabilitation and to preserve the surface in a cost-effective manner. Spot gravelling is conducted to ensure that the travelled surface is maintained to the intended cross-section. The estimated volume of aggregate required for annual maintenance operations over the first 50-years of the project are tabulated in Table 2.

TABLE 2: ESTIMATED AGGREGATE VOLUME REQUIREMENTS FOR HIGHWAY MAINTENANCE[1]

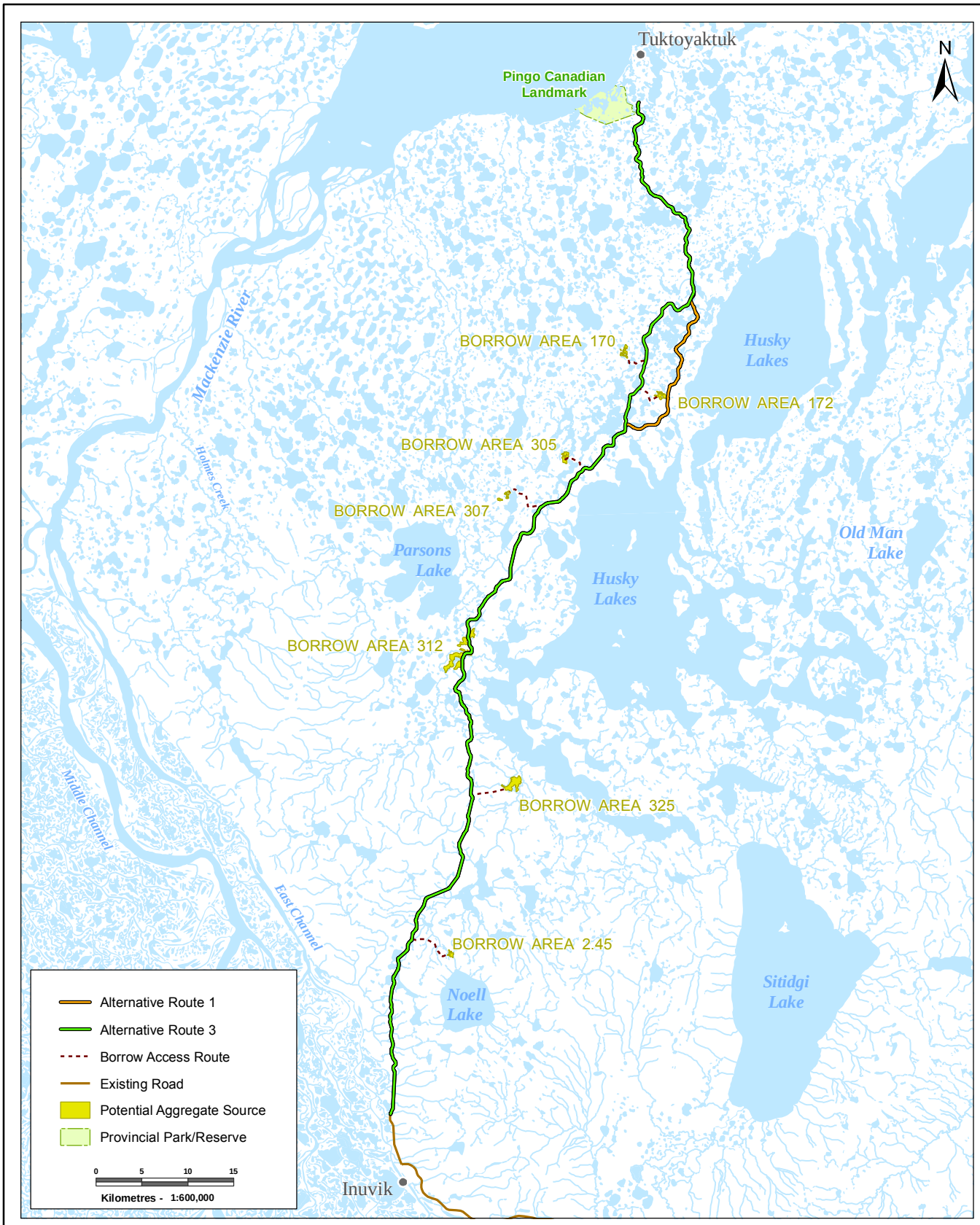
Item of Work	Borrow Excavation Common (50 years)	Crushed Gravel (50 years)	Gravel Sources
Gravel Re-surfacing	--	Annual application @ 100 m^3/km to total 13,700 m^3/annum, and 685,000 m^3/50-years	a) Pit 312, KM 58 (Near Parsons Lake) b) Inuvik Airport Quarry c) Pit 173 near KM 82, and Pit 170 near KM 101 may be added if geotechnical results were acceptable
Spot Gravelling	10 m^3/km/annum, total 1,370 m^3/annum, and 68,500 m^3/50 years	Annual average application @ 35 m^3/km to total 4,795 m^3/annum, and 239,750 m^3 for 50 years.	d) Pit 312, KM 58 (Near Parsons Lake) e) Inuvik Airport Quarry f) Pit 173 near KM 82, and Pit 170 near KM 101 may be added if geotechnical results were acceptable

1. Includes annual gravel resurfacing and spot gravelling as required

Developer Response: 92.2

As discussed in the EIS, aggregate material to be used for Highway construction and maintenance will generally be stockpiled in the borrow sources. Photo 1, taken at the Source 177 borrow source, illustrates the typical approach to aggregate stockpiling that will be employed at borrow sites that will have year round road access to the Highway. For other borrow sites that will only have winter road access, it may be necessary to establish a temporary annual stockpile at a suitable location immediately adjacent to the Highway. Figure 1-1 taken from the recently completed terrain analysis report prepared by KAVIK-STANTEC (2012), shows the locations of the priority borrow sites currently under consideration for the Highway construction program.

Photo 1: Typical example of aggregate stockpile at the Source 177 borrow site used for construction of the Tuktoyaktuk to Source 177 access road



Inuvik – Tuktoyaktuk Highway, Baseline Data Acquisition Program

Proposed Highway Alignments, Borrow Sources and Access Roads

Base Data provided by Government of the Northwest Territories; Surficial Data: Stantec

PREPARED BY: KAVIK-STANTEC

PREPARED FOR: Northwest Territories Transportation

FIGURE NO. 1-1

Last Modified: March 1 2012 By: tlenchuk

Developer Response: 92.3

With respect, it is not possible to provide a quantitative maximum volume of aggregate that will be positioned in each stockpile at this time. In the case of the Source 177 operation, the experience was that suitable aggregate that had been excavated but not used during the winter construction period was stockpiled within the disturbed area of the borrow site for initial use in the following winter construction period.

At future borrow sites, as described in the EIS, the current plan is to initiate excavation and proceed with the development of adequate stockpiles of suitable aggregate at those borrow sites that will be used for the particular year of Highway construction as soon as possible following annual freeze-up. Once the winter Highway construction program proceeds, the intent is to initially use the stockpiled material for embankment construction. Borrow excavation is expected to continue throughout the annual winter construction period and the stockpiles will be replenished as needed to meet the volume requirements of the particular winter construction program.

During the long-term operations period it is anticipated that the aggregate needed for annual maintenance purposes will be matched to the anticipated needs, which will be determined by the GNWT Department of Transportation in conjunction with the Highway maintenance contractors.

Developer Response: 92.4

As discussed in Section 2.6.8.6 of the EIS, Pit development plans, also known as pit management plans, will be developed for each of the borrow sites to be used for construction of the Highway. These plans will conform to the approving authority's regulations and permitting requirements. For borrow sources on Inuvialuit-owned land, the pit development plan will conform to the ILA's Granular Management Plan and requirements for a Quarry Permit. For borrow sources on Crown lands, the pit development plan will conform to INAC's (2010d) Northern Land Use Guidelines Access: Pits and Quarries. In both cases, the Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions (Transportation Association of Canada 2010) will be used as a reference for preparation of the pit development plans.

Erosion control and plans to control runoff from the borrow sites, including any stockpiles that may be developed, will be addressed in these plans. Site drainage controls, including localized ditching/swales within the borrow sites and silt fencing will be employed as necessary to ensure that sedimentation contained in meltwater from ground ice in the aggregate, or site runoff in general, are appropriately managed and are not released into the surrounding watershed.

In addition, given the nature of the borrow sites, which typically consist of deposits of relatively porous aggregate material (sand, gravel, rocks/boulders), it would be expected that much of the seasonal meltwater generated by melting ground ice in the aggregate stockpiles would likely percolate directly into the shallow active layer that naturally develops each summer in the area. An example of this is illustrated in Photo 2 taken at the Source 177 borrow site in the summer of 2011.

Photo 2: Typical example of meltwater generated from melting ground ice in the stockpile at Source 177 percolating directly into the ground below.

Developer Response: 92.5

As indicated in the EIS, the development of borrow sites and most activities associated with each of the active borrow sites will typically occur during the winter period when dust is not expected to be a significant concern. During the short annual snow-free period, as illustrated in Photo 2, it is expected that the seasonal melting of ground ice in the aggregate stockpiles and across the borrow site generally, combined with the greater amounts of precipitation that typically occurs in the region during the summer months will help to minimize dust generation from the stockpiles.

However, if dust control for certain stockpiles is needed, in particular for temporary stockpiles to be located directly adjacent to the Highway, water spray will be used for dust control, as necessary, in accordance with the GNWT Guideline for Dust Suppression (GNWT 1998).

Developer Response: 92.6

As discussed in Developer Responses 92.2 and 92.3 above, most stockpiles to be developed, either at a specific borrow site, or at sites to be located adjacent to the Highway, for summer Highway construction or maintenance purposes, will experience relatively high levels of activity involving the use of loaders and trucks. Under such conditions it is considered unlikely that wildlife (such as foxes, arctic ground squirrels, etc.) would try to establish dens in these stockpiles.

For stockpiles developed at active borrow sites for use in the following winter, the Highway construction contractor(s) or their environmental consultants will be tasked to carry out inspections of the stockpiles and the active borrow areas in the late summer to determine if a wildlife den has been established in any of the stockpiles or borrow sites. If a den is found, the contractor will be required to inform GNWT DOT, who in turn will then contact GNWT ENR to determine the most appropriate course of action to be taken.

IR Number: 93

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Snow Banks on Embankment Side Slopes**

Preamble

Snow accumulation will be expected on the side slopes of the road embankment due to ploughing and snow drifting on the lee side of the road. Near Inuvik and in the Mackenzie delta area, snow accumulation of over 1-m depth may lead to permafrost degradation (Smith 1975; Burn et al., 2009). As a result, snow accumulation on the side slopes of the embankment may alter ground temperatures and lead to enhanced requirements for maintenance, including enhanced demands for aggregate.

Request

1. Please indicate the thickness of drifts expected on the sides of the road embankment and adjacent to the embankment for both high (2 m) and low (1A m) configurations of the embankment. The thicknesses should be provided for typical sites along the route (a) south of the tree line; (b) in lowland terrain north of tree line; and (c) in upland terrain north of tree line. The thicknesses should be provided for road alignments parallel to prevailing winter winds and at right angles to prevailing winter winds.
2. Please describe any activities that are planned in order to (i) monitor and (ii) mitigate, if necessary, snow accumulation on the side slopes of the road embankment.

References

Burn, C.R., Mackay, J.R., and Kokelj, S.V. 2009. The thermal regime of permafrost and sensitivity to disturbance near Inuvik, N.W.T. Permafrost and Periglacial Processes, 20(2): 221-227. doi: 10.1002/ppp.649

Smith, M.W. 1975. Microclimatic influences on ground temperatures and permafrost distribution, Mackenzie Delta, Northwest Territories. Canadian Journal of Earth Sciences 12: 1421-1438.

Developer Response: 93.1

Snowdrifting is expected to be influenced by the orientation of the Highway embankment with respect to the predominant wind direction. Climatic data presented in Section 3.1.2.4 of the EIS establishes the predominant wind conditions that affect snowdrifting along the Highway. For the Tuktoyaktuk and Inuvik areas, west through northeast and east winds are expected to be most prevalent in terms of snowstorm conditions. The greatest snow accumulations along the Highway can be expected to occur where the alignment is positioned at approximately 90 degrees to the prevailing wind.

A key component to consider for snowdrifting is the ground cover of the surrounding area. Approximately 10 km north of Inuvik and northward the area is above the treeline and the ground is open tundra with generally low ground cover. The areas that have lower ground cover generally have the potential to generate greater drifting snow than the forested area near Inuvik.

The surrounding terrain features and the relative location of the Highway are expected to affect the amount of drifting snow that will build up along the sideslopes of the Highway embankment. Placing the embankment on the crest of a landform could generate the greatest snow accumulations on the sideslope, but will serve to reduce snow accumulation on the driving surface. It is also anticipated that more elevated locations will have more positive drainage conditions during snow melt and would preferentially shed snowmelt/water away from the road embankment during periods of melting. The thickness of snowdrifts along the Highway will depend on a number of factors including the Highway's sideslope and embankment heights. Steeper sideslopes with higher embankments are expected to generate deeper snow accumulations along the sideslope. Prior to the completion of analysis of the cross-section in detailed design, it is not possible to provide a quantitative answer to this line of questioning.

Minimizing snow accumulation on the sideslope will be one of the considerations in confirming the Highway cross section in the detailed design stage. Once constructed, the maintenance staff are expected to use wing-plows to lower the snow accumulations along the sideslopes of the Highway as far as possible (approximately 2 m) to reduce drifting and snow maintenance activities associated with the Highway.

For additional information on this subject, please see Developer Response 138.1.

Developer Response: 93.2

The Highway will be designed to be generally self-clearing and, as discussed in Developer Response 93.1, minimizing snow accumulation on the sideslope will be one of the considerations in confirming the Highway cross section in the detailed design stage.

When the Highway is in operation, GNWT DOT (and its maintenance contractors) are expected to monitor the weather and in anticipation of predicted snowstorms' will prepare the snow clearing crews to respond efficiently to such events as is presently done for the annual ice road and other public highways in the NWT. Depending on the volume of snow clearing required, V-plows and/or other truck mounted plows (such as those shown in Photo 3) will initially be sent out to remove the snow off the Highway surface quickly. Subsequently, graders equipped with wing plows will be deployed as necessary to plow down the sideslopes as far as possible (approximately 2 m) to reduce drifting and prevent other problems due to snow accumulation on the sideslope.

Photo 3: Typical examples of V plow and other plows used to clear the current Inuvik to Tuktoyaktuk ice road

IR Number: 94

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Active Layer Thickness**

Preamble

Active-layer deepening is the principal cause of subsidence in permafrost terrain (Mackay 1970). The design of the road embankment, as described in the EIS, attempts to minimize the possibility of disturbance to the active layer under the road. However, this will not be possible on the sides of the embankment, especially near the toe of the side slopes, because the disturbance due to the constructed surface is not offset by the thickness of the embankment. Degradation of permafrost at the sides of the road may require remediation, involving application of granular fill.

Request

1. Please indicate the depth of the active layer anticipated beneath the road embankment along cross-sections as presented in Fig. 2.6.5-1 of the EIS.
2. Please provide such representative cross sections for the four terrain units along the proposed alignment.
3. Please include increases in active layer thickness due to snow accumulation expected on the sides of the embankment. In particular, please estimate the active layer thickness expected near the bottom of the side slopes of the embankment.
4. Estimate the shoulder rotation expected from any changes in active layer thickness, and estimate the aggregate required to maintain embankment integrity over the life of the project.

Reference

Mackay JR. 1970. Disturbances to the tundra and forest tundra of the western Arctic. Canadian Geotechnical Journal 7: 420-432.

Developer Response: 94.1/2

The long-term position of the permafrost table below the core of the embankment and below the sideslopes has not been predicted (modelled) to date; however, it will be predicted (modelled) during the detailed design stage. Nevertheless, the minimum fill thicknesses adopted for preliminary design are anticipated to maintain the active layer in a permafrost condition under the core of the embankment (crest-to-crest). The minimum fill thicknesses adopted for preliminary design are based on experience and are considered to be of sufficient accuracy for preliminary design and budgetary cost estimating purposes.

The next (detailed) stage of design will include two-dimensional geothermal analyses to predict the risk of thaw under both the core and the sideslopes for both short term and long term estimated climatic conditions. That design process is described in response to IR 90.1. Mitigation measures can be adopted where the design is at risk of initiating unacceptable thaw settlement. Those measures are described in *Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions – Chapter 5, Engineering Considerations* (Transportation Association of Canada 2010).

The geothermal design requires geotechnical data specific to the route that is not currently available including, characterization of the active layer and permafrost foundation soils, seasonal ground temperature data and properties of the soil borrow materials that will be used for the embankment sections to be analyzed. Program planning to collect sufficient information for analyses of the design embankment on a range of typical terrain units is underway. Activities recently completed and that are underway are described in response to IR 131.

Developer Response: 94.3/4

The typical cross section and minimum embankment heights provided including side slopes were utilized in the PDR and EIS for preliminary design purposes. Cross sections with detailed side slopes will be determined during the detailed design stage incorporating route specific geotechnical data described in IR 90.3.

Incorporating the appropriate cross section at the detailed design stage, based on the geothermal analyses and the route specific geotechnical data will provide a mitigative measure reducing the risk of shoulder rotation. Some cracking and spreading of the embankment may be expected but full slope failure is considered to be a low probability event.

IR Number: 95

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Climate Change**

Preamble

The EIS presents climate change scenarios for the region developed more than a decade ago, and since then climate change science has advanced considerably. In 2010, a guideline for adaptation of infrastructure design to the consequences of anticipated climate change was sponsored by AANDC and published by the Canadian Standards Association (CSA 2010). Representatives from the Town of Inuvik and EBA Engineering contributed extensively to development of this guideline. It appears that the EIS does not follow the advice presented in the guideline. In particular, the EIS does not consider climate change anticipated beyond 2039, even though the life of the project is "permanent and long term."

A comprehensive assessment of climate change and its impacts on the project is required to fully assess the aggregate requirement that the project will impose in the ISR, both for construction, and during operations. Climate change is expected to vary over the project area, due to the proximity of the northern end of the highway corridor to the Beaufort Sea. Climate change scenarios are available from Environment Canada, as indicated in CSA (2010).

Request

1. Please provide climate change scenarios for the project area for the first 50 years of the operational phase of the project, up to 2065. Separate scenarios should be provided for the northern and southern ends of the project area. Please incorporate expected climate variability in the scenarios, so that for this fifty-year period, the Board may assess the range of conditions that may reasonably be anticipated.

Reference

Canadian Standards Association. 2010. Technical Guide, Infrastructure in permafrost: A guideline for climate change adaptation. PLUS 4011-10. Canadian Standards Association, Mississauga, ON.

Developer Response: 95.1

Following the procedures stated in CSA (2010), climate change scenario data were downloaded from the Canadian Climate Change Scenarios Network and are based on the Global Climate Model Ensemble's "Localizer" projections. Climate change scenarios for Inuvik are documented in Attachment 1 and climate change scenarios for Tuktoyaktuk are documented in Attachment 2.

Localizer reports were generated for Inuvik and Tuktoyaktuk Island, using the closest Environment Canada long-term climate observation station to the southern and northern ends of the proposed Inuvik to Tuktoyaktuk Highway. The reports apply the ensemble mean model projected change to the baseline observed values of temperature and precipitation. The observation period of 1971-2000 was used as the baseline for each report. The future projected temperature and precipitation

amounts presented are the observed station values plus the model ensemble projected change. The number of models used for the ensemble change varies with experiment:

- A2-High Emission Scenario = average of 20 models;
- A1B-Medium Emission Scenario = average of 24 models; and
- B1-Low Emission Scenario = average of 21 models.

The values presented are not statistically downscaled to the station location, but based on the ensemble grid-cell mean the station falls within.

The Localizer uses the climatology of the observation station for the period of 1971-2000 as the baseline climate in all cases. The model projected changes between 1971-2000 and the future time periods (i.e., 2011 to 2040; 2041 to 2070; and 2071 to 2100, called 2020s; 2050s; and 2080s respectively) are then added to the observed baseline. This results in a projected future scenario that is bias-corrected to the location. Monthly, seasonal and annual projected values of temperature and precipitation are calculated from the ensemble of models.

The climate change scenario data will be used during the Highway's detailed design phase.

References:

Canadian Climate Change Scenarios Network. March 9, 2011. Localizer: Inuvik, NT. Retrieved March 13, 2012 from http://yukon.cccsn.ca/?page=viz-localizer

Canadian Climate Change Scenarios Network. March 9, 2011. Localizer: Tuktoyaktuk Island, NT. Retrieved March 13, 2012 from http://yukon.cccsn.ca/?page=viz-localizer

IR Number: 96

Source: **EIRB**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Climate Change and Permafrost**

Preamble

The magnitude of climate change expected over the next 50 years may require reassessment of the risk basis upon which the present design is predicated. In order to make such a determination, the effect of climate change on annual thaw depth anticipated beneath the road must be assessed. Changes in annual thaw depth anticipated in natural terrain over the next century were recently summarized for Richards Island by Burn and Zhang (2010). If the current design of the road may require adjustment due to climate change effects in the future, then a greater demand on the aggregate resources of the region will be imposed than anticipated by the EIS.

Request

1. Using climate change scenarios for the next 50 years, and incorporating climate variability, please indicate the expected change in active layer thickness that may be anticipated beneath the centerline of the road alignment and beneath the side slopes.
2. Please indicate such changes in active-layer thickness for the project both north and south of the tree line.
3. Please present the changes for particularly warm and particularly cold years that may be anticipated during this period.
4. Please indicate the additional aggregate requirements along the length of the highway that may be required to manage the impact of anticipated particularly warm years.

Reference

Burn, C.R., and Zhang, Y. 2010. Sensitivity of active-layer development to winter conditions north of treeline, Mackenzie delta area, western Arctic coast. Paper 194. Proceedings, 6th Canadian Permafrost Conference, 12-16 September 2010, Calgary, Aft Canadian Geotechnical Society. pp.1458-1465

Developer Response: 96.1

The level of design undertaken for the PDR and the EIS is sufficient to confirm the general alignment and location of the Highway and preliminary quantity estimates to support budgetary or planning level cost estimates. Terrain, climate, and precipitation, as well as immediate and long-term impacts of climate change have been considered and design adaptations have been incorporated based on practical examples, lessons learned and other information in the available references (i.e., TAC 2010).

As noted in other responses, during the detailed design stage, the embankment will be modelled as a two-dimensional structure (including geothermal analyses), placed on a fully frozen permafrost foundation. The effect of the embankment (including sideslope) on the active layer under future climatic scenarios will be observed at that time. The geothermal design requires geotechnical data specific to the route that is not currently available including, characterization of the active layer and

permafrost foundation soils, seasonal ground temperature data and properties of the soil borrow materials that will be used for the embankment sections to be analyzed. Program planning to collect sufficient information for analyses of the design embankment on a range of typical terrain units is underway. Activities recently completed and that are underway are described in Developer Response 131.

Developer Response: 96.2

As discussed in Section 3.1.1.4 of the EIS, Burn and Kokelj (2009, p. 94) state that "near-surface ground temperatures are similar in the uplands north and south of the treeline in summer, but diverge in winter due to deeper snow cover in the forest". That is, ground temperatures are lower in the tundra than in areas south of the treeline. Figure 9 from Burn And Kokelj (2009) demonstrate the changes in temperature between tundra and forest conditions at (a) ground surface and (b) 1 m depth.

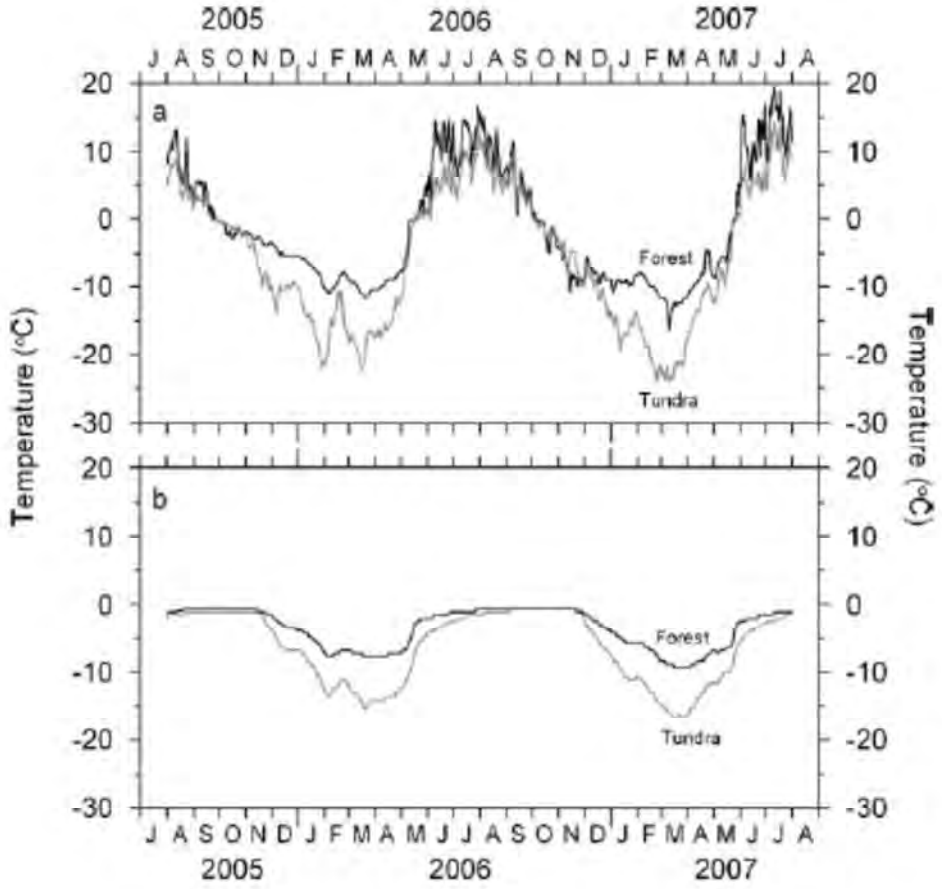


Figure 9 Ground temperatures from sites in open-canopy forest near Inuvik and low-shrub tundra on central Richards Island (see Figure 7c) for 2 years from 1 August 2005. Daily mean temperatures from data collected every 4 hours are presented for measurements at: (a) ground surface; (b) 1-m depth.

According to Burn and Kokelj (2009, p. 99), "the thickness of the active layer varies within the region, largely due to soil characteristics, particularly organic matter content and site wetness. There is also a general reduction in active-layer thickness with latitude."

The mean thaw depth at 12 sites from 1983 to 2008 on a tundra active-layer course from Illisarvik, Richards Island are shown in the following figure from Burn and Kokelj (2009) and reproduced in Burn and Zhang (2010). The figure shows that the thaw depth has varied over time, but appears to be thickening. It is assumed that the active layer will be thicker in the area south of the treeline, due to warmer ground temperatures.

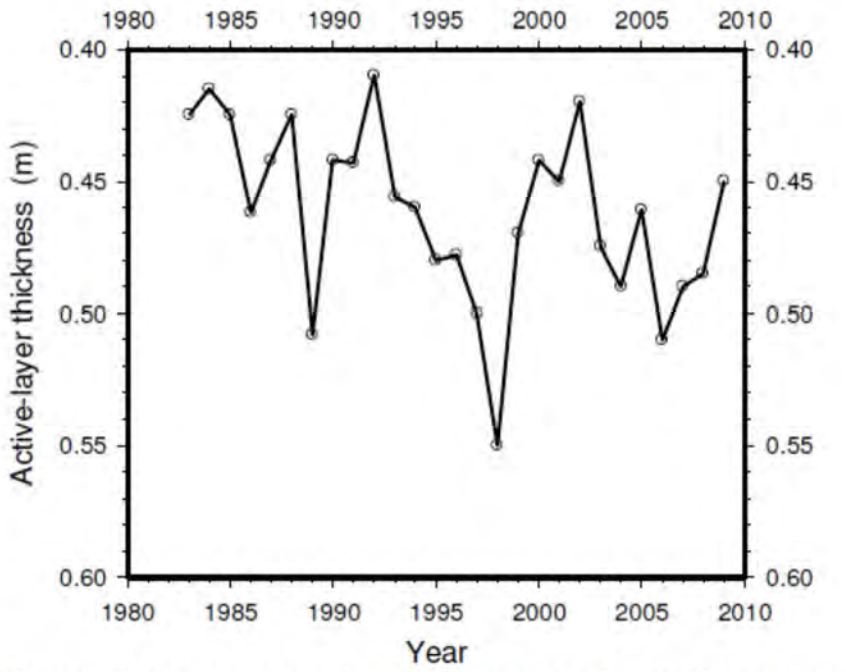


Figure 7: Mean active-layer thickness at 12 sites along the tundra course at Illisarvik (1983-2009).

Developer Response: 96.3

During a warm year, the active layer would be expected to deepen (thickens); during a cold year, the active layer would be expected to be more shallow (less thick) (see Figure 12 from Burn and Kokelj (2009)). However, it should be noted that from a Highway development and maintenance perspective, the incidence of individual warm or cold years will generally be of lower concern than a situation involving successive years of warming or cooling, when greater changes to the active layer could potentially occur.

However, as stated in Developer Response 96.1, detailed design of the Highway will incorporate factors relating to climate change.

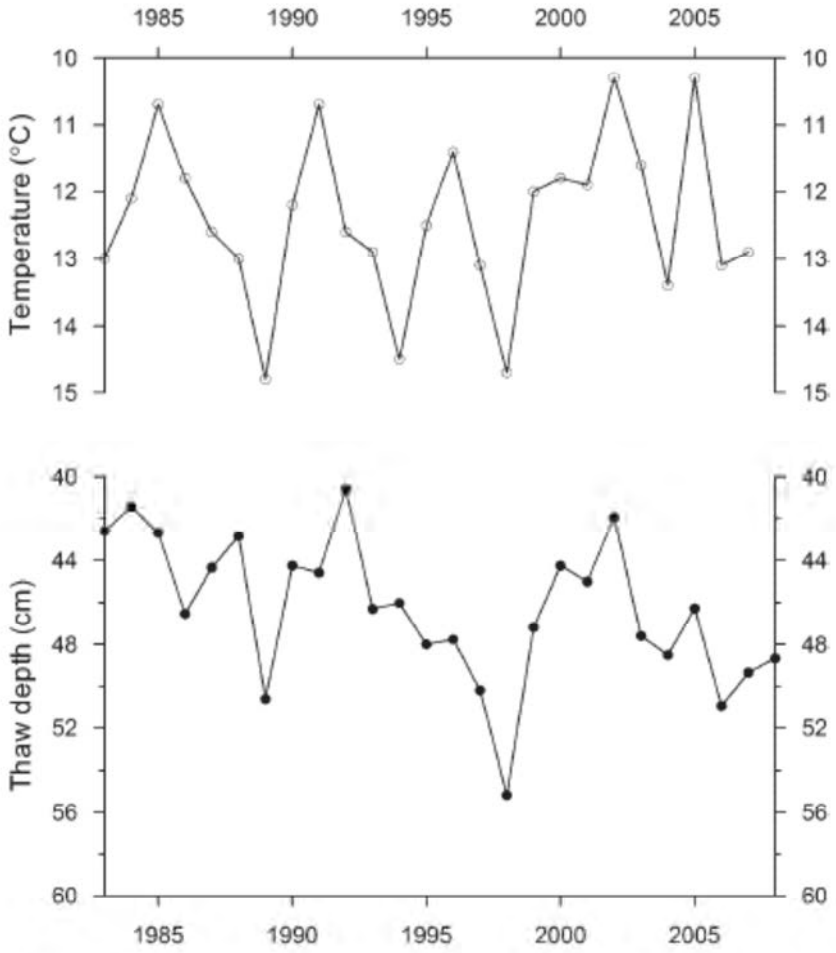


Figure 12 Mean thaw depth at 12 sites on a tundra active-layer course, Illisarvik, Richards Island, 1983–2008, and mean June-August air temperature at Inuvik, 1983–2007. Data for 1983–94 were kindly provided by J. R. Mackay. The correlation of these series is statistically significant ($r = 0.52$, $p = 0.007$, $n = 25$), representing the inter-annual fluctuation. Both variables are plotted in descending order to portray the nature of thaw penetration.

Developer Response: 96.4

Table 1 in Developer Response 90.2 identifies the 50-year aggregate requirements along the length of the Highway.

3.0 Aboriginal Affairs and Northern Development Canada

IR Number: 97

Source: **Aboriginal Affairs and Northern Development Canada (AANDC)**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Water Quality - Borrow Pits; Project Description Report**
PDR pg.52; EIS Pg 83

Preamble

Constructing the road during the winter appears to provide advantages from the perspective of maintaining permafrost conditions in the construction zone. However, one disadvantage identified in the DAR is that excavating frozen material from the borrow pits may require use of drill and blast methods.

Using explosives introduces a risk that nitrogen compounds in blasting residue may be released to the local aquatic environment in any run off from the borrow pits. Increased concentrations of nitrogen compounds may lead to issues with 'nitrification in the aquatic receiving environment.

Request

1. Please evaluate and quantify the potential for elevated concentrations of nitrogen based compounds in run-off water from borrow pits. Please identify monitoring and mitigation strategies that could be implemented in response to increased concentration of nitrogen compounds in run-off water from borrow pits.

Developer Response: 97.1

The Developer acknowledges that residual amounts of nitrogen-based compounds such as ammonia may be generated as a result of intermittent blasting activities undertaken at active borrow sites during the winter period. However, as discussed in Developer Response 92.4 above, pit development plans will be developed for each of the borrow sites to be used for construction of the Highway. These plans will conform to the approving authority's regulations and permitting requirements.

Erosion control and plans to control runoff from the borrow sites, including any stockpiles that may be developed, will be addressed in these plans. Site drainage controls, including localized ditching/swales within the borrow sites and silt fencing will be employed as necessary to ensure that sedimentation contained in meltwaters from ground ice in the aggregate, or site runoff in general, are appropriately managed and are not released into the surrounding watershed.

In addition, given the nature of the borrow sites, which typically consist of deposits of relatively porous aggregate material (sand, gravel, rocks/boulders), it would be expected that much of the seasonal meltwater and runoff associated with the borrow sites would likely percolate directly into the shallow active layer that naturally develops each summer in the area.

It is anticipated that any nutrients associated with runoff water that percolates into the active layer and moves off site, will be rapidly taken up by the roots of the surrounding tundra vegetation cover that extend into the active layer. Furthermore, as indicated in the EIS, the Developer is committed to ensuring that borrow sources will not be developed within 50 m of any watercourse and 1 km of the Husky Lakes.

IR Number: 98

Source: **Aboriginal Affairs and Northern Development Canada (AANDC)**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Borrow Material Ice Content - Borrow Pits**
EIS Section 2.6.8.2 Pg 86

Preamble

The Proponent has indicated that the construction sequence for this project will be to quarry and haul borrow material for embankment construction during the same season. "*Lessons learned from the construction and maintenance of the road from Tuktoyaktuk to Source 177 are applicable to the proposed Inuvik to Tuktoyaktuk highway since the roads are to be built in the same environment using similar construction and mitigation techniques*." Observations of slumping on the recently constructed Source 177 road may indicate that granular materials were not properly drained prior to their use in construction.

Request

1. Can the Proponent provide information indicating whether it has considered alternative methods and/or timelines related to quarrying borrow material and its placement in a manner that allows for drainage to occur prior to embankment construction.
   Or, can the Proponent indicate what borrow volumes would be needed to stockpile sufficient additional material to repair embankment sections that will be at risk of slumping.

Developer Response: 98.1

In responding to this particular information request, the Developer would initially note that the statement that "observations of slumping...may indicate that granular materials were not properly drained" is not correct.

In the Tuktoyaktuk and Inuvik region, road embankment construction projects have occurred in both winter and summer and have employed both thawed (drained) and frozen (undrained) granular materials. Northern road construction experience, such as that gained from the construction of several roads in the Tuktoyaktuk area (including the Tuktoyaktuk to Source 177 Access Road) during the winter period using frozen material placed directly on the frozen tundra has demonstrated that this type of winter construction is typically superior and that there is actually less slumping and subsidence with this type of winter construction.

All roads built on permafrost in this region go through periods of subsidence and slumping and need maintenance and attention. For example, the existing road from the Town of Inuvik to the Airport continually subsides and slumps and needs to be repaired every few years. The subsidence and slumping observed on the Source 177 Access Road is simply a natural process that occurs on all roads in the region.

When embankment construction takes place in the winter the "core" of the roadbed remains frozen and this leads to less slumping and subsidence. When road embankments are constructed in the summer there is more slumping and more subsidence as the initial "lifts" of granular materials

closest to the permafrost move and settle; this is observed in the section of the road to the existing Tuktoyaktuk sewage lagoon.

Normally, treatment for such slumping would consist of ongoing grade repairs, benching, spot gravelling, and gravel resurfacing in accordance with the existing practices and the Highway Maintenance Manual provisions. After 20-years, placement of reconstruction materials will re-new the cross-section and structural components.

As indicated in response to IRs 90.1 and 92, it is expected that normal road maintenance will require stockpiles of gravel to maintain and rehabilitate the road, similar to all roads in the region. The 50-year estimated borrow volumes required for all work, including operations, maintenance, and rehabilitation are 3,355,500 cubic metres of borrow excavation common materials, and 1,216,390 cubic metres of crushed aggregate. Of these volumes, maintenance quantities over a 50-year period will total 68,500 cubic metres of pit-run and 924,750 cubic metres of crushed gravel.

IR Number: 99

Source: **Aboriginal Affairs and Northern Development Canada (AANDC)**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Road Embankment Heights - Permafrost Retention**
EIS Section 2.6.4

Preamble

The height of the embankment is a critical component of maintaining permafrost conditions below the road surface. Different embankment heights are specified depending upon the type of terrain being crossed.

The proposed embankment thicknesses range from 1.4 in for relatively thy (ice-poor) areas up to 1.8 in for peatlands and areas of ice-rich permafrost. The source of the proposed depths were not provided.

The EIS further states that, "*The routing for each Highway alignment option has been largely developed based on terrain observations in an effort to select reasonable topography and avoid ice rich and other sensitive soils that are likely to result in geotechnical challenges. Such challenges can be mitigated through modification of horizontal alignment to avoid ice rich terrain and considering an overall embankment fill design (rather than balancing cut and fill) with minimum embankment height defined based on the nature of the terrain type*."

Request

1. Please provide the source of the selected embankment thicknesses and the rational used in determining that the mitigation measure is adequate.
2. Can the Proponent provide a detailed evaluation of mitigation measures (beyond increasing embankment thickness or re-routing the alignment) to prevent permafrost thaw in areas where ice-rich terrain cannot be avoided.

Developer Response: 99.1

The Transportation Association of Canada 2010 publication entitled *Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions*, provides a process, lessons learned and practical examples relative to embankment design for road infrastructure. The information presented in this guide, combined with experience on similar roadways with similar regional, climate and terrain characteristics (i.e., Red Dog Mine Road in Alaska, Dempster Highway, Alaska Highway, Skakwak Highway in Yukon and Tuktoyaktuk to Source 177 Access Road) was used to determine embankment requirements by terrain type suitable for the preliminary design.

Developer Response: 99.2

To prevent permafrost thaw in areas where ice-rich terrain cannot be avoided, the Highway design includes key mitigation features. Mitigation options that will be considered and employed will include:

- Installation of geotextile – the geotextile will assist in maintaining the integrity of the Highway embankment by minimizing the loss of material from the embankment into the underlying terrain.
- Selection of the appropriate embankment height and side slope ratio for the specific terrain type.
- Efficient drainage design - ensuring flow of water, in the spring/summer with defined stream and surface run-off to avoid or minimize standing water (ponding).
- Appropriate selection (i.e., type and size) and installation of drainage structures, including proper end treatments for culverts such as erosion control and drainage aprons.

IR Number: 100

Source: **Aboriginal Affairs and Northern Development Canada (AANDC)**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Permafrost Integrity - Permafrost Retention**
EIS Section 2.2.5

Preamble

An analysis of ice-rich terrain features was conducted for two of the proposed Inuvik to Tuktoyaktuk highway routes during the summer of 2010 by INAC. Aerial photographs and field assessments by helicopter, as well as on the ground examination to verify some areas of ice-rich terrain were completed. Pg 57 of the EIS refers to this work where INAC commented that. "...approximately 10% (or 14 km of 137 km) of the Primary 2009 Route was determined to be located on confirmed or suspected ice-rich terrain and approximately 8% (or 4 km of 45 km) of the Alternative 2 (Upland Route) was located on similar terrain."

The report also indicated that the detection of significant areas of ice-rich terrain that were not identified in the Project Description (of March 3, 2010) indicates that the Proponent needs to conduct more work to delineate ice-rich terrain and terrain hazards along the proposed route.

Request

1. Can the proponent confirm and/or provide a complete evaluation of ice rich terrain occurrences along the proposed Inuvik to Tuk Highway 2009 primary alignment.

Developer Response: 100.1

A report prepared by KAVIK-STANTEC entitled *Inuvik to Tuktoyaktuk Highway – Baseline Data Acquisition Program: Terrain Evaluation* (Terrain Report) was submitted to the EIRB March 2012, accompanied by a mapbook entitled *Surficial Geology and Terrain Constraints – Inuvik to Tuktoyaktuk Highway*. The Terrain Report and mapbook present the results of detailed mapping of surficial geology, geologic processes, drainage features and permafrost features within a 1 km corridor centered on Alignments 1 and 3.

The Terrain Report discusses each of the terrain units present within the study area and comments on the expected ground ice content, based on results of previous published studies in the area. The mapbook, presented at 1:10,000 scale, identifies these terrain units as well as specific locations where historic and active geoprocesses can be attributed to the presence of ground ice.

IR Number: 101

Source: **Aboriginal Affairs and Northern Development Canada (AANDC)**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Water Quality - Dust Control**
PDR

Preamble

The PDR indicates that water will be used for dust control during highway operations. It is not clear whether dust control chemicals, such as calcium chloride, are also being contemplated for use on the road.

Request

1. Please confirm whether dust control chemicals may be used for dust control. If so, please identify mitigative measures that are available to minimize potential impacts to the aquatic receiving environment, particularly with respect to sensitive areas such as the Husky Lakes.

Developer Response: 101.1

As indicated in the EIS, the developer is committed to controlling dust generated in relation to the construction and operation of the Highway through the application of non-toxic dust suppression techniques (water trucks) that comply with the GNWT's *Guideline for Dust Suppression* (GNWT 1998).

IR Number: 102

Source: **Aboriginal Affairs and Northern Development Canada (AANDC)**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Use of Environmental Monitors**
Developer response to IR number 11 issued by the EIRB -

Preamble

In responding to the information request relating to Environmental Monitors (EMs), the Developer has made several statements that require clarification. Statements of concern relate to the EM roles in determining compliance with AANDC authorizations as well as NWT Water Board authorizations, and actions presumed to be taken by the EM's in the course of their duties.

It should be noted that AANDC recognizes that EMs are an integral component to project development and delivery in the ISR on both Crown and Inuvialuit Private Lands, as well as within the context of water licences issued by the NWTWB. The ILA Environmental Monitor program that exists today is worthy of being held up as a model to the NWT. It is a program where local knowledge and participation is integrated with environmental protection and regulation programs carried out by Inspectors. On Crown land in the ISR, both programs work in collaboration with each other to ensure environmental impacts of projects such as this remain few.

Request

1. Please clarify your understanding of the legislative authorities the ILA Environmental Monitors hold in relation to the authorizations issued by AANDC under the Territorial Land Use Regulations and the NWT Quarry Regulations on Crown Land, and the NWT Waters Act in the ISR.
2. Please clarify your understanding of the relationships ILA Monitors and the ILA have with AANDC Inspectors as well as the legislative mandate AANDC inspectors hold in relation to enforcement and compliance of terms and conditions set out for projects such as this.
3. Please clarify your understanding of the differences between Environmental Monitors "monitoring" project activities and, "ensuring compliance with authorizations' terms and conditions".
4. Please clarify your understanding of the reporting relationships the EM's follow in identifying areas of concern to them while monitoring activities on Crown Land, as well as their authority to "take appropriate action" in the context of dealing with critical situations or non-compliance occurrences.

Developer Response: 102.1

It is the Developer's general understanding that the primary mandate of the ILA Environmental Monitors is to monitor Developer/Contractor compliance with the terms and conditions of authorizations and permits issued by the Inuvialuit Land Administration for activities on Inuvialuit Lands, consistent with the Inuvialuit Final Agreement.

However, as stated by AANDC in the preamble to this information request, AANDC recognizes that EMs are an integral component to project development and delivery in the ISR on both Crown and Inuvialuit Private Lands, as well as within the context of water licences issued by the NWTWB. The ILA Environmental Monitor program that exists today is worthy of being held up as a model to the NWT. It is a program where local knowledge and participation is integrated with environmental protection and regulation programs carried out by Inspectors. On Crown land in the ISR, both programs work in collaboration with each other to ensure environmental impacts of projects such as this remain few.

Developer Response: 102.2

Please see Developer Response 102.1 above.

Developer Response: 102.3

As stated in Developer Response 102.1 above, it is the Developer's general understanding that the primary mandate of the ILA Environmental Monitors is to monitor Developer/Contractor activities and compliance with the terms and conditions of authorizations and permits issued by the Inuvialuit Land Administration for activities on Inuvialuit Lands.

It is also the Developers general understanding that AANDC inspectors will play a key role in ensuring compliance with the terms and conditions of AANDC authorizations and permits as well as any water licences issues by the Northwest Territories Water Board.

Developer Response: 102.4

It is the Developer's general understanding that the primary reporting relationship that the ILA Environmental Monitors will follow while monitoring activities on ILA or Crown Lands will be through the Inuvialuit Lands Administration. However, as indicated by AANDC in the preamble to this series of questions, it is apparent that on Crown land in the ISR, both programs (ILA and AANDC) work in collaboration with each other to ensure environmental impacts of projects such as this remain few.

However, it should be noted that the Developer and its Contractors will be pleased to take direction as appropriate from any inspector(s) assigned to monitor project activities, including matters related to critical situations or non-compliance occurrences.

4.0 Fisheries and Oceans Canada

IR Number: 103

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Lessons learned - Water Crossings**
- Response to the January 16th, 2012 Information requests, p.2

Preamble

In the response to the EIRB Information Request (IR) #1, the Developer mentions that mitigation strategies were implemented for the Tuktoyaktuk to Granular Source 177 access road that were successful in keeping silt and embankment materials from migrating into the watercourses and having impacts on fish and fish habitat. These measures included the placement of erosion matting, riprap and silt fencing around the culverts. DFO agrees that properly installed mitigation measures, such as those listed by the Developer, can help reduce or eliminate the likelihood of materials entering the aquatic environment and potentially affecting fish and fish habitat.

Despite the implementation of mitigation strategies for the Source 177 access road, DFO still observed failures at various crossing locations that resulted in blockage to fish passage as well as road fill and embankment materials entering the aquatic environment causing impacts to fish and fish habitat.

Request

1. Based on the Developer's experience from the construction of the Source 177 access road, please provide design considerations, modifications to the construction techniques and mitigation measures that will be used to avoid similar issues from occurring at crossings for the new highway.

Developer Response: 103.1

Analysis of the culvert installation at crossing #6 on the Source 177 access road by GNWT DOT and FSC-STANTEC showed that the culvert length was too long for this site; that is the inlet end of the pipe extended too far beyond the embankment slope without granular cover. In addition, there was a collared joint at the interface of the least amount of embankment cover and the exposed length. The inlet end was then buoyed upwards by the water, thus blocking fish passage.

To mitigate this problem in the future, bridge and culvert designs will include the following:

1) Bridges and culverts will be designed in accordance with the current Canadian Highway Bridge Design Code addressing stream hydraulics, design flood, scour, fish passage, vertical clearance, structure design life, climatic conditions, geotechnical design, structural design, protective aprons, and slope stabilization.

2) The overall structure designed for each site will be based on the above noted analysis, plus a review of site conditions/constraints, logistics for material supply and construction, and regulatory guidelines and conditions.

IR Number: 104

Source: **Fisheries and Oceans Canada**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

Subject: **Water Crossings - Fish Habitat**
- Response to the January 16th, 2012 Information requests, p.75;
- IMG-Golder Fish Habitat Assessment January 2012, Table 1, p. 4-6

Preamble

Table 1 in the IMG-Golder January 2012 report provides an overview of the watercourse crossings that intersect the Highway's primary and alternative routes as well as summarizes results from the 2009 assessment (IMG-Golder 2009), Kiggiak EBA's 2010 assessment (Kiggiak EBA 2010 a) and data from the current 2011 fish habitat assessment completed by IMG-Golder. The Developer has also stated that "all streams that are to be crossed by the proposed Highway have now been assessed".

DFO has reviewed the various fisheries assessments as well as the information provided in the EIS for water crossings and is still unclear as to the names (identification) and number of crossings for the entire route.

Request

1. In order to assist parties in understanding and reviewing potential impacts at water crossings, please provide in a table format a summary of all the information gathered to date for all crossings, including:
    a. total number of crossings for the entire route and consistent names/ID;
    b. Crossing type/design with a discussion on how each crossing design will meet the objectives at each location including ensuring no impacts to fish passage or habitat, maintaining flow, etc...
    c. Stream type with description of up and downstream connections;
    d. Flow data including at freshet;
    e. Bank-full or wetted width; and
    f. Details on habitat condition and suitability

    As per the details of the Jan 31, 2012 meeting between the Developer and DFO, plans regarding the type of crossing structures may change as compared to those suggested in the EIS, for example, changing round culverts to open-bottom culverts. This could ultimately change the impact assessment, especially as it relates to fish.
2. Please clarify the timing of each crossing installations (winter versus summer construction), as this would also changes DFO's assessment of impacts on fish and fish habitat.

Developer Response: 104.1

The attached tables (Tables 3 and 4) provide information regarding two alternative routes (Alternatives 1 and 3), although Alternative 3 is presently the preferred option. These tables cross references stream crossing identification names among the several studies that have been carried out to date, which have not necessarily followed a consistent numbering protocol. The tables also provide georeferenced location (UTM) information, assessments of stream type and fish bearing status, a preliminary identification of the stream crossing structure to be constructed, and the wetted width of the stream.

The tables identify several crossing locations where fish habitat is indicated as being "unknown." This designation is based on a lack of definitive information regarding fish presence, since fish surveys were not conducted at these locations. However, these sites were assessed as having little capability to support fish due to the absence of, or minimal availability of, spawning sites, lack of overwintering, restricted flow volumes and depths, and ephemeral/seasonal flow conditions.

Despite the very poor fish production potential of these channels, it is recognized that they possibly provide limited nutrient export to downstream, fish bearing waters. As such, culvert installation in these streams will follow appropriate design and installation criteria to prevent the disruption of flows and minimize the degradation of water quality.

It should also be noted that the stream crossing structures identified in Tables 3 and 4 represent preliminary planning results. It has been determined that short span bridges will be constructed over many of the streams assessed as having a moderate to good potential to support fish. Actual stream crossing structure designs will be determined on a site specific basis during the final design stage of this project and will be based on stream dimensions, flow characteristics, terrain, and fish/fish habitat considerations.

Individual stream crossing structures will be oversized (two to three times the size used in non-permafrost areas) to prevent flow restrictions and to compensate for design uncertainties, such as settlement and ice or snow blockages (TAC 2010)[1]. Each structure installed in a fish bearing stream will also follow DFO guidelines (Dane 1978; DFO 2010)[2]. Culverts and bridges will be constructed in the winter to minimize soil disturbance and sediment mobilization. Culverts will be set into the substrate to an approximate depth of one-third of the culvert barrel diameter to avoid creating a flow obstruction to fish passage. It is anticipated that culvert bottoms will eventually become filled with natural bed material, providing the possibility of limited fish rearing and refuge. Bridge abutments will be positioned outside of the mean high water mark to avoid stream constriction.

Previous studies have not examined upstream and downstream connectivity at each location since these will not generally have a bearing on the choice and design of the stream crossing structures. There would be a substantial effort in assessing the entire length of each stream to identify fish migration barriers, especially since detailed observations cannot be conducted from the air due to

[1] TAC (Transportation Association of Canada). 2010. Guidelines for development and management of transportation infrastructure in permafrost regions.

[2] Dane, B.G. 1978. Culvert guidelines: Recommendations for the design and installation of culverts in British Columbia to avoid conflict with anadromous fish. Fisheries and Marine Service, Dept. of Fisheries and the Environment, Tech. Rpt. No. 811.

DFO. 2010. Culvert installations (fact sheet). http://www.nfl.dfo-mpo.gc.ca/e0005527.

the small size of most stream channels and the dense cover afforded by streamside (mainly willow) vegetation. As such, crossing structures will be designed to permit unimpeded fish migration.

During the detailed design stage, flow data using regional flow gauge information will be used to model stream flows to permit suitable culvert and bridge sizing.

The details of habitat condition and suitability for fish spawning/rearing are provided in the EIS and in the January 2012 Golder report.

Developer Response: 104.2

Developer Response 106.1 provides the rationale for summer vs. winter installation and timings. The structures installation will comply with the windows dictated by DFO for fish bearing and non-fish bearing streams.

TABLE 3: WATERCOURSE CROSSING ID NUMBERS, LOCATIONS, AND SUMMARY INFORMATIONA FOR ALTERNATIVE 1 (2009 MINOR REALIGNMENT)

Golder Watercourse Crossing Number	Kiggiak-EBA Watercourse Crossing Number	KM Marker b	UTM East Zone 8 NAD 83	UTM North Zone 8 NAD 83	Assessment Completed	Stream Type	Fish Habitat c	Crossing Type d	Wetted Width (m)
Southern Section (from end of Old Navy Road – KM 0)									
	1	1.3	550651.906	7591440.899	Kiggiak-EBA in 2010/ IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
	2	1.7	550676.184	7591876.476	Kiggiak-EBA in 2010	Ephemera	UK	Culvert	4.5
	3	2.3	550701.098	7592438.556	Kiggiak-EBA in 2010	Perennial	F	Culvert	1.9
	4	3.2	550737.758	7593313.897	Kiggiak-EBA in 2010	Perennial	F	Culvert	2.3
	5	3.9	550773.520	7594072.451	Kiggiak-EBA in 2010	Perennial	F	Culvert	1.1
	6	5.9 (?)	550843.132	7595986.508	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	0.3
	7	6.9 (7.0)	550461.106	7596943.679	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	4.0
	8	(7.8)	550600.000	7597000.000	Kiggiak-EBA in 2010	Perennial	F	Culvert	3.7
	9	8.2 (8.4)	550528.110	7598257.717	Kiggiak-EBA in 2010/ IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
	10	8.9 (9.1)	550432.381	7598916.091	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	2.1
	11	9.3 (9.4)	550485.901	7599284.722	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	6.1
	12	10.9 (11.1)	550300.455	7600886.706	Kiggiak-EBA in 2010	Perennial	F	Culvert	14.0
	13	13.0 (13.3)	550415.804	7603031.166	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	NA
	13a	16.7 (17.0)	551298.553	7606550.279	Kiggiak-EBA in 2010	Perennial	F	Bridge (15m)	3.0
	14	18.6 (19.1)	552193.999	7608091.180	Kiggiak-EBA in 2010	Ephemeral	F	Culvert	1.2
	15	21.6 (22.0)	553225.000	7610775.000	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	14.3
	16	22.5 (23.0)	553243.573	7611734.645	Kiggiak-EBA in 2010	Ephemeral	F	Culvert	4.1
	17	22.9 (23.4)	553384.867	7612049.583	Kiggiak-EBA in 2010	Ephemeral-	UK	Culvert	9.5
	18	25.1 (26.1)	554803.545	7613971.447	Kiggiak-EBA in 2010	Perennial	F	Bridge (20m)	4.8
25.8	19	25.8	555438.454	7614239.192	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
26.5	20	26.5	556043.372	7614500.579	IMG-Golder in 2011	Intermittent	UK	Culvert	1.8
28.9	21a	28.9	557679.409	7616108.457	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
31.1	22a	31.1	558041.881	7618195.273	IMG-Golder in 2011	Perennial	F	Culvert	10.5
39.4 (Trail Valley Creek)	23a	39.4	559226.897	7626137.370	IMG-Golder in 2011	Perennial	F	Bridge (20m)	2.0
41.4	24a	41.4	559011.889	7628013.584	IMG-Golder in 2011	Perennial	F	Culvert	15.0
42.5	25	42.5	559107.389	7629151.034	IMG-Golder in 2011	Perennial	F	Culvert	2.3
43.9	26	43.9	558700.421	7630515.327	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
45.5	27a	45.5	559102.643	7632056.447	IMG-Golder in 2011	Intermittent	UK	Culvert	2.0
46.8	27b	46.8	558945.761	7633282.726	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
52.4	28a	52.4	558393.923	7638036.696	IMG-Golder in 2011	Perennial	F	Culvert	9.8
52.8	29	52.8	558280.812	7638458.961	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
54.1	29a	54.1	558210.692	7639744.181	IMG-Golder in 2011	Perennial	F	Bridge (20m)	17
54.9 (Hans Creek)	30a	54.9	558736.305	7640377.967	IMG-Golder in 2011	Perennial	F	Bridge (25m)	7.2
66.1 (Zed Creek)	31	66.1	563402.892	7648602.442	IMG-Golder in 2011	Perennial	F	Bridge (25m)	6.7
76.0	33a	76.0	567384.611	7656681.816	IMG-Golder in 2011	Intermittent	F	Culvert	15.0
76.3	33b	76.3	567667.025	7656751.512	IMG-Golder in 2011	Intermittent	F	Culvert	5.4
78.7	34a	78.7	569614.712	7657867.327	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
82.7	34b	82.7	572161.178	7660491.938	IMG-Golder in 2011	Intermittent	F	Culvert	1.4
85.6	34e	85.6	573750.780	7662855.894	IMG-Golder in 2011	Intermittent	F	Culvert	1.6
88.2	35a	88.2	575422.172	7664333.159	IMG-Golder in 2011	Perennial	F	Bridge (10m)	7.3
Alternative 1 – Watercourse Crossings									
A3-88.9 e	A 13	88.9	575975	7664634	IMG-Golder in 2011	Intermittent	UK	Culvert	NA
	36a	92.5 (94.1)	578796	7665217	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	NA
	37	93.4 (95.0)	579578.567	7665694.644	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	1.0
	37a	94.5 (96.3)	580529.271	7666601.261	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	3.3
A1-100	A 5	100	581333	7671439	IMG-Golder in 2011	Perennial	F	Culvert	NA
A1-101.9	A 4	101.9	579458	7671953	IMG-Golder in 2011	Perennial	F	Culvert	NA
A1-105.5 (A3-99.4)	A 3	105.5	577863	7674377	IMG-Golder in 2011	Perennial	F	Culvert	4.3
A1-108 (A3-101.9)	A 2	108	579011	7676323	IMG-Golder in 2011	Intermittent	F	Culvert	0.9
A1-112.3 (A3-106.2)	A 1	112.3	582840	7677885	IMG-Golder in 2011	Perennial	F	Culvert	4.4
Rejoins Primary Route – Northern Section									
	39b	113.3 (115.1)	582872.646	7683007.102	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	2.8
	39c	113.9 (115.8)	582798.580	7683621.645	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	NA
Tuk 1		118.4	582491	7687628	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 2		120.2	581290	7688591	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 3		120.3	581158	7688888	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 4		122.5	579313	7690396	IMG-Golder in 2009	Perennial	F	Culvert	NA
Tuk 5		126.4	577660	7693145	IMG-Golder in 2009	Perennial	F	Culvert	NA
Tuk 6		127.5	577475	7694082	IMG-Golder in 2009	Perennial	F	Culvert	NA
Tuk 7		128.0	577385	7694422	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 7b		129.7	577025	7696021	IMG-Golder in 2009	Intermittent	CH	Culvert	NA
Tuk 8		133.9	577431	7699375	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA

a – Various site IDs and names have been used in the studies that have been carried out to date. This table cross references these designations.
b – Kilometre Marker as measured from the northern end of Old Navy Road, Inuvik.
c - F = known or assumed fish habitat CH = contributing to fish habitat downstream UK = unknown
d – bridge locations identified by EBA 2010b (Table 2.5-2)
e – this sample site is located along the Primary Route and Alternative Route 1, not Alternative 3.

TABLE 4: WATERCOURSE CROSSING ID NUMBERS, LOCATIONS, AND SUMMARY INFORMATIONA FOR ALTERNATIVE 3 (2010 MINOR REALIGNMENT)

Golder Watercourse Crossing Number	Kiggiak-EBA Watercourse Crossing Number	KM Marker a	UTM East Zone 8 NAD 83	UTM North Zone 8 NAD 83	Assessment Completed	Stream Type	Fish Habitat b	Crossing Type c	Wetted Width (m)
Southern Section (from end of Old Navy Road – KM 0)									
1.3	1	1.3	550651.906	7591440.899	Kiggiak-EBA in 2010/ IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
	2	1.7	550676.184	7591876.476	Kiggiak-EBA in 2010	Ephemera	UK	Culvert	4.5
	3	2.3	550701.098	7592438.556	Kiggiak-EBA in 2010	Perennial	F	Culvert	1.9
	4	3.2	550737.758	7593313.897	Kiggiak-EBA in 2010	Perennial	F	Culvert	2.3
	5	3.9	550773.520	7594072.451	Kiggiak-EBA in 2010	Perennial	F	Culvert	1.1
	6	5.9 (?)	550843.132	7595986.508	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	0.3
	7	6.9 (7.0)	550461.106	7596943.679	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	4.0
	8	(7.8)			Kiggiak-EBA in 2010	Perennial	F	Culvert	3.7
8.2	9	8.2 (8.4)	550528.110	7598257.717	Kiggiak-EBA in 2010/ IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
	10	8.9 (9.1)	550432.381	7598916.091	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	2.1
	11	9.3 (9.4)	550485.901	7599284.722	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	6.1
	12	10.9 (11.1)	550300.455	7600886.706	Kiggiak-EBA in 2010	Perennial	F	Culvert	14.0
	13	13.0 (13.3)	550415.804	7603031.166	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	NA
	13a	16.7 (17.0)	551298.553	7606550.279	Kiggiak-EBA in 2010	Perennial	F	Bridge (15m)	3.0
	14	18.6 (19.1)	552193.999	7608091.180	Kiggiak-EBA in 2010	Ephemeral	F	Culvert	1.2
	15	21.6 (22.0)	553225.000	7610775.000	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	14.3
	16	22.5 (23.0)	553243.573	7611734.645	Kiggiak-EBA in 2010	Ephemeral	F	Culvert	4.1
	17	22.9 (23.4)	553384.867	7612049.583	Kiggiak-EBA in 2010	Ephemeral-	UK	Culvert	9.5
	18	25.1 (26.1)	554803.545	7613971.447	Kiggiak-EBA in 2010	Perennial	F	Bridge (20m)	4.8
25.8	19	25.8	555438.454	7614239.192	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
26.5	20	26.5	556043.372	7614500.579	IMG-Golder in 2011	Intermittent	UK	Culvert	1.8
28.9	21a	28.9	557679.409	7616108.457	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
31.1	22a	31.1	558041.881	7618195.273	IMG-Golder in 2011	Perennial	F	Culvert	10.5
39.4 (Trail Valley Creek)	23a	39.4	559226.897	7626137.370	IMG-Golder in 2011	Perennial	F	Bridge (20m)	2.0
41.4	24a	41.4	559011.889	7628013.584	IMG-Golder in 2011	Perennial	F	Culvert	15.0
42.5	25	42.5	559107.389	7629151.034	IMG-Golder in 2011	Perennial	F	Culvert	2.3
43.9	26	43.9	558700.421	7630515.327	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
45.5	27a	45.5	559102.643	7632056.447	IMG-Golder in 2011	Intermittent	UK	Culvert	2.0
46.8	27b	46.8	558945.761	7633282.726	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
52.4	28a	52.4	558393.923	7638036.696	IMG-Golder in 2011	Perennial	F	Culvert	9.8
52.8	29	52.8	558280.812	7638458.961	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
54.1	29a	54.1	558210.692	7639744.181	IMG-Golder in 2011	Perennial	F	Bridge (20m)	17
54.9 (Hans Creek)	30a	54.9	558736.305	7640377.967	IMG-Golder in 2011	Perennial	F	Bridge (25m)	7.2
66.1 (Zed Creek)	31	66.1	563402.892	7648602.442	IMG-Golder in 2011	Perennial	F	Bridge (25m)	6.7
76.0	33a	76.0	567384.611	7656681.816	IMG-Golder in 2011	Intermittent	F	Culvert	15.0
76.3	33b	76.3	567667.025	7656751.512	IMG-Golder in 2011	Intermittent	F	Culvert	5.4
78.7	34a	78.7	569614.712	7657867.327	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
82.7	34b	82.7	572161.178	7660491.938	IMG-Golder in 2011	Intermittent	F	Culvert	1.4
85.6	34e	85.6	573750.780	7662855.894	IMG-Golder in 2011	Intermittent	F	Culvert	1.6
88.2	35a	88.2	575422.172	7664333.159	IMG-Golder in 2011	Perennial	F	Bridge (10m)	7.3
Alternative 3 – Watercourse Crossings									
A3-88.6	A 14	88.6	575417	7664716	IMG-Golder in 2011	Intermittent	UK	Culvert	NA
A3-91.9	A 12	91.9	576315	7667618	IMG-Golder in 2011	Perennial	F	Culvert	2.2
A3-92.4	A 11	92.4	576435	7668140	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
A3-92.8	A 10	92.8	576532	7668536	IMG-Golder in 2011	Intermittent	UK	Culvert	NA
A3-94.7	A 9	94.7	577748	7669874	IMG-Golder in 2011	Perennial	F	Culvert	4.8
A3-96.4a	A 6	96.4a	577977	7671432	IMG-Golder in 2011	Intermittent	F	Culvert	2.3
A3-96.4b	A 8	96.4b	577954	7671470	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
A3-96.6	A 7	96.6	577770	7671724	IMG-Golder in 2011	Ephemeral	UK	Culvert	NA
A3-99.4 (A1-105.5)	A 3	99.4	577863	7674377	IMG-Golder in 2011	Perennial	F	Culvert	4.3
A3-101.9 (A1-108)	A 2	101.9	579011	7676323	IMG-Golder in 2011	Intermittent	F	Culvert	0.9
A3-106.2 (A1-112.3)	A 1	106.2	582840	7677885	IMG-Golder in 2011	Perennial	F	Culvert	4.4
Rejoins Primary Route – Northern Section									
	39b	113.3 (115.1)	582872.646	7683007.102	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	2.8
	39c	113.9 (115.8)	582798.580	7683621.645	Kiggiak-EBA in 2010	Ephemeral	UK	Culvert	NA
Tuk 1		118.4	582491	7687628	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 2		120.2	581290	7688591	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 3		120.3	581158	7688888	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 4		122.5	579313	7690396	IMG-Golder in 2009	Perennial	F	Culvert	NA
Tuk 5		126.4	577660	7693145	IMG-Golder in 2009	Perennial	F	Culvert	NA
Tuk 6		127.5	577475	7694082	IMG-Golder in 2009	Perennial	F	Culvert	NA
Tuk 7		128.0	577385	7694422	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA
Tuk 7b		129.7	577025	7696021	IMG-Golder in 2009	Intermittent	CH	Culvert	NA
Tuk 8		133.9	577431	7699375	IMG-Golder in 2009	Ephemeral	UK	Culvert	NA

a – Kilometre Marker as measured from the northern end of Old Navy Road, Inuvik. If discrepancies in KM markings between Golder and Kiggiak-EBA, Kiggiak-EBA markings are shown in ().

b - F = known or assumed fish habitat CH = contributing to fish habitat downstream UK = unknown

c – bridge locations identified by EBA 2010b (Table 2.5-2)

IR Number: 105

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Water Crossings - Fish Passage**
- Response to the January 16th, 2012 Information requests, p.50.2

Preamble

The Developer mentions various sampling programs to evaluate the effectiveness of mitigation measures, specifically measurements of turbidity, pH, dissolved oxygen, temperature and conductivity upstream and downstream of crossings over fish bearing streams.

DFO notes that the Developer has not specifically addressed how fish passage will be monitored.

Request

1. Please provide details on how fish passage will be monitored.

Developer Response: 105.1

The majority of the stream crossings will involve the installation of culverts, which will follow appropriate guidelines to prevent the obstruction of fish passage. Past studies have either not attempted to capture fish (Golder 2012), or have involved sampling at relatively few locations (Kiggiak-EBA 2010) due to very low water, limited or difficult access, and safety concerns. Fish were only captured at two of the sites electrofished (Kiggiak-EBA 2010) despite assessments of good rearing conditions at these locations.

Due to the lack of a good baseline of information and because it is probable that fish capture would be ineffective using conventional methods, it is therefore suggested that direct fish passage monitoring is not necessary. It is reasonable to assume that fish passage will not be inhibited if culverts are appropriately designed and sized, based on site-specific conditions, installed according to accepted standards and methods, and monitored regularly to ensure that they are operating as designed. An assessment of the culverts annually is therefore recommended as a surrogate for fish passage monitoring.

IR Number: 106

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Water Crossings - Timing Window**
- Response to the January 161h, 2012 Information requests, p.140;
- EIS, Section 1.5.1.4, p.18

Preamble

On page 140 of the January 16th responses to the EIRB, the Developer has committed to "*Constructing in non-fish bearing streams during winter" and that "culverts in fish bearing streams will not permitted between April 1 and July 15 for watercourses that provide habitat for spring/summer spawners*."

On page 18 in the EIS, the Developer has listed various DFO operational statements that are applicable to the project.

Request

1. As discussed during the Jan 31, 2012 meeting between DFO and DoT, construction in frozen conditions causes fewer impacts in the aquatic environment than summer construction in almost all situations, including fish-bearing streams. Please provide a rationale for why the Developer only mentions construction in non-fish bearing streams in the winter. DFO also recommends that the proponent review DFO's operational statement for timing windows in the NWT (http://www.dfo-mpo.qc.ca/regions/centralthabitatios-eo/provinces-territories-territoires/nUpcif/os-eo21 e.pdf)
2. If the Developer is considering constructing crossings during the open-water season, please describe the measures that will be implemented to ensure that flows and fish passage are maintained during works in water and that the appropriate sediment and erosion control measures are implemented.

Developer Response: 106.1

The EIS (p. 495) indicates that it may be advisable or necessary to install culverts in fish bearing streams in summer due to the normal requirement that culverts should be buried into the stream bottom to prevent downstream erosion and culvert perching. Upon further examination of this issue, it has been determined that although it is difficult under frozen conditions to prepare channels for culvert installation, it is feasible to do so. Winter construction will involve considerably more work using heavy equipment and a greater degree of channel disturbance.

However, its advantage is that the absence of flow precludes concerns over fish passage and sediment releases while work is progressing. As such, it is now recommended that all culverts, in fish bearing and non-fish bearing streams, should be installed during the winter in streams that have no winter flow. Culvert installation during winter will follow procedures that include the application of bed and bank stabilization prior to snow melt to reduce erosion and downstream sedimentation at the onset of freshet flows.

Developer Response: 106.2

As indicated above, it is recommended that culverts should be installed in winter when the streams are frozen to the bottom, indicating no flow. It is probable that almost all small streams within the Highway corridor will be frozen during winter. However, if streams are not completely frozen and water flow is apparent, it may be preferable to install culverts in the summer due to the extensive use of heavy equipment that will be necessary to prepare those channels, with the consequence of erosion and downstream sedimentation. These decisions will be made on a case-by-case basis, depending on the quality of existing fish habitat, the amount of flow, and the weighing of relative risks between winter and summer construction.

Where it is deemed preferable to install culverts in summer, construction will adhere to appropriate guidelines, such as those identified in Dane (1978)**3** and in the DFO Land Development Guidelines for the Protection of Aquatic Habitats, 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. Summer construction will not take place between April 1 and July 15, in accordance with the DFO timing window for spring spawning fish (respecting grayling and northern pike, which are the only large-bodied fish species likely to use Project area streams for spawning).

Short span bridges will be constructed bank to bank to eliminate instream activities, thus preserving natural stream flows and fish passage. Temporary erosion and sediment control measures will be utilized to protect the streams during construction, and site-specific preventive measures will be employed for each crossing as appropriate.

[3] Dane, B.G. 1978. Culvert guidelines: Recommendations for the design and installation of culverts in British Columbia to avoid conflicts with anadromous fish. Dept. of Fisheries and Environment, Pacific Region.

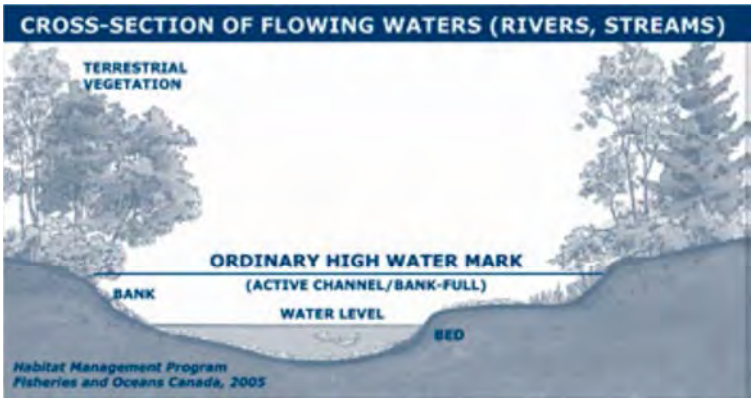
IR Number: 107

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Water Crossings - Bridges**
- EIS, Section 2.6.6, p.72-74

Preamble

The Developer is proposing to use the DFO clear-span bridge operational statement (OS) for the construction of bridges for the project. On page 74 of the EIS, the Developer states that The bridges will be designed to span stream widths, but for some crossings may encroach on the floodplain (to minimize length) with approach fill construction".

One of the conditions in the DFO clear-span bridge OS is that the bridge must be located entirely above the high-water mark. As well the OS specifies that the bridge structure should not be located on meander bends, braided streams, alluvial fans, active flood plains or any other area that is inherently unstable and may result in the alteration of natural stream functions or erosion and scouring of the bridge structure. The figure below, taken from the OS, shows the location of a typical high water mark.



Request

1. Please confirm if all bridge structure will meet the requirements of the OS. For the bridges that do not meet the OS, DFO will require more detailed information on each of the crossing design as well as any portion of the structure within the high water mark of the channel.

Developer Response: 107.1

As indicated in the preamble to this Information Request, the Developer is pleased to confirm that the bridges required to cross the larger streams will be designed to span the stream widths (ranging from 10 m to 25 m in width), consistent with the specifications of the DFO clear-span bridge operational statement (OS).

As also indicated, for some of the larger stream crossings, the approaches to the bridge crossing may need to encroach on the historic floodplain (to minimize bridge span length) with approach fill construction. However, based on the Developers current understanding of the streams that need to be crossed with a single span bridge, it is anticipated that the necessary bridge crossings can be achieved consistent with the DFO clear-span bridge operational statement.

However, the Developer is aware and appreciates that if one or more of the OS specifications cannot be met for a particular bridge, DFO will require more detailed information on the specific bridge crossing design. Should this situation arise, the Developer is committed to providing the necessary, more detailed crossing design(s) to DFO as soon as it/they become available in the detailed design phase of project implementation.

IR Number: 108

Source: **Fisheries and Oceans Canada**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

Subject: **Borrow Sites - Location, Mitigation and Use of Explosives**

- Response to the January 16th, 2012 Information requests, p.18-19 and Figure 2.6.8-2;

- EIS, Section 2.6.8, Table 2.6.8-1, p. 79-81

Preamble

In response to the EIRB IR#4.2, the Developer included a map (Figure 2.6.8-2) showing approximate locations of potential borrow sources as well as in the EIS on pages 79-81 provided a description of these sites. It appears from those two documents that several of the borrow sites may be located in or near lakes and streams. On page 18 of the EIS, the Developer mentions that "*Borrow sources will not be developed within 50 in of any watercourse and 1 km of the Husky Lakes. Where blasting is required, DFO guidelines for the use of explosives will be followed"* (Wright and Hopky 1998).

Please note that based on NWT-specific monitoring results, DFO recommends the use of a lower threshold values than indicated in our guidelines to mitigate impacts associated with the use of explosives in or near water. Other mitigation should also be employed including using a series of smaller blasts, timing, and fish exclusion measures if necessary. Two useful references are:

Offshore Oil and Gas Environmental Effects Monitoring: Approaches and Technologies. Edited by Armsworthy, Shelley, Peter J. Cranford, Kenneth Lee. Cott, P., B. Hanna. 2005.

Monitoring Explosive-Based Winter Seismic Exploration in Water Bodies NWT 2000- 2002. Cott, P., B. Hanna, J. Dahl. Canadian Manuscript Report for Fisheries and Aquatic Sciences 2648. 2003. Discussion on Seismic Exploration in the Northwest Territories 2000-2003.

Request

1. Please indicate if any of the borrow sources will be located in or near water. Even though the Developer will have a set back from watercourses and Husky Lakes, it is not clear if these setbacks also include waterbodies.
2. Please provide any associated monitoring and mitigation measures for any borrow sites in or near water. This includes measures for the use of explosives as well as sediment and erosion control measures.

Developer Response: 108.1

As indicated in the preamble to this Information Request, in response to the first round of EIRB Information Requests (Developer Response 4.2), the Developer had included a map (Figure 2.6.8-2 of the EIS) showing approximate locations of potential borrow sources and descriptions of these sites were provided on pages 79-81 of the EIS. As noted by DFO, several of these proposed borrow sites may be located in or near lakes and streams.

More recently, KAVIK-STANTEC was retained by GNWT DOT to complete an updated terrain evaluation which included seven (7) of the more prospective borrow sites that are currently being investigated. These seven sites are illustrated in Figure 1.1 of the KAVIK-STANTEC terrain evaluation report (KAVIK-STANTEC 2012), which is presented in the Developer's response to IR 92.2 in this document.

Some of these deposits are located near either lakes or streams. However, as indicated in the EIS, the Developer is committed to not developing any borrow source within at least 50 m of any watercourse and at least 1 km from the Husky Lakes. Stated another way, if the proposed borrow source extends closer than 50 m of a watercourse or lake, or indeed extends into the watercourse or lake, that potential borrow material will not be developed.

Developer Response: 108.2

As discussed in Section 4.2.5.1 of the EIS, the borrow pits required for construction of the Highway 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 Northern Land Use Guidelines: Pits and Quarries) and according to pit development plans (PDPs).

The PDPs will include the available mitigation measures described in the suite of applicable guidelines to address potential environmental concerns. Key mitigation measures include developing borrow sources primarily during the winter period, maintaining sufficient distance of undisturbed land between borrow source locations and any waterbody, and the application of appropriate erosion and sediment control management practices for the borrow source activities.

As also indicated in the EIS, where blasting is required, DFO guidelines for the use of explosives will be followed (Wright and Hopky 1998). In addition, any blasting that may be required at any of the active borrow sites will be undertaken during the winter period, when fish are not expected to be present in any nearby streams.

IR Number: 109

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Monitoring – Turbidity**
- Response to the January 16Ih, 2012 Information requests, p.19-20

Preamble

The Developer has committed to developing an Environmental Management Plan (EMP) that will include measures to avoid or minimize effects to aquatic resources. The plan will also include annual culvert inspections as well as turbidity measurements up and downstream from crossings to monitor the effectiveness of the culvert design as well as the sediment and erosion control plan.

The turbidity measurements will be done in the spring following ice-out and taken within 50 meters upstream of each crossing as well as 50 and 100 meters downstream from the crossings. The turbidity thresholds are based on the BC Ministry of Environment Ambient Water Quality Guidelines, which state:

- During clear flow periods: background levels should not be exceeded by more than 8 NTU.
- During turbid flow periods: background levels should not be exceeded by more than 5 NTU at any time when background turbidity is between 8 and 50 NTU. When background exceeds 50 NTU, turbidity should not be increased by more than 10% of the measured background level at any one time.

DFO agrees that turbidity criteria can be useful for monitoring potential impacts of the project on the aquatic environment and to trigger action if required. DFO recommends that the Developer review the following document to assist in drafting the plan:

The Validity of Including Turbidity Criteria For Aquatic Resource Protection in Land Development Guideline (Pacific and Yukon Region. 2008. l.K. Birtwell, M. Farrell, and A. Jonsson. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2852

Request

DFO feels that monitoring should be done at all crossings until the Developer can demonstrate that crossings are stable. The plan should be implemented during construction, post-construction and if needed after major precipitation events.

1. Will all crossings be sampled for turbidity? If not, for the crossings not monitored, please provide a rationale for why they do not require sampling.
2. Will turbidity sampling also take place during construction in order to monitor the effectiveness of the sediment and erosion control measures? If so please provide more details on the sampling plan.
3. How will the Developer determine the effectiveness of the crossings designs and mitigation measures at other times of the year, including during extreme precipitation events?
4. Please clarify the differences between clear flow periods versus turbid flow periods. When on site, how will the Developer determine which turbidity thresholds to use?

5. What will be done if turbidity exceeds criteria? How will turbidity monitoring translate into corrective action if required?
6. How will the cause of the increases in turbidity be determined (e.g. poor culvert design, ineffective sediment and control measures, scouring, etc.)?

Developer Response: 109.1

All crossings will be sampled for turbidity during construction and mitigative measures will be applied if turbidity criteria are exceeded. Following construction, turbidity monitoring will be carried out during spring freshet following each culvert installation, in streams known or expected to support fish spawning or rearing.

Due to the large number of stream crossings, it is impractical to consider monitoring at every culvert crossing. However, all culvert crossings will be regularly inspected for signs of erosion or damage, which would likely result in increased turbidity downstream. In addition, exceedances of turbidity levels at a significant number (>10%) of the monitored streams would trigger the requirement to carry out monitoring at all stream crossings.

Developer Response: 109.2

Turbidity sampling will occur at all crossing sites during construction. Sampling will follow the general guidance provided in Birtwell et al. (2008) as follows:

Sampling will occur at three locations: upstream (true baseline control) of the crossing structure, at the point of, and immediately downstream of, the structure.

Environmental monitors will visually identify potential inputs of sediment and determine suitable sampling locations accordingly.

Developer Response: 109.3

As indicated above, turbidity monitoring will occur at the time of highest runoff, which typically occurs during spring freshet. It is at this time, when channels experience the greatest flows and velocities and when terrestrial sheet runoff is highest. Comparisons at stream crossing locations of upstream versus downstream turbidity levels during this time will therefore provide a good indication of the stability of each of the monitored sites. As indicated above, culvert crossings will also be regularly monitored to determine functionality. These inspections will also reveal erosion problems that can then be rectified as necessary.

Developer Response: 109.4

Adopting the definitions in Birtwell et al. 2008, clear flow periods equate with dry periods (<25 mm rainfall in the previous 24 hours); turbid flow occurs under wet conditions (>25 mm rainfall in the previous 24 hours).

Developer Response: 109.5

The mitigation measures to be implemented due to exceedances of turbidity criteria will vary according to the development stage, apparent cause, and severity of the problem. Decisions regarding corrective actions will be made by the environmental monitor. For example, during construction, observations of faulty construction methods may result in the stoppage of work and modifications to the construction method. Sediment inputs from drainage ditches will involve implementation of sediment controls such as ditch breaks, silt fences, or ditch rerouting, in conjunction with an investigation to determine the source of the sediment. Streambank erosion will require temporary stabilization with mats or longer term armouring.

Developer Response: 109.6

The causes of turbidity, particularly in severe cases, are usually observable when occurring from a point source, such as an eroding streambank or from ditch inputs. Since turbidity meter measurements provide instant readouts of turbidity levels, it is possible to quickly identify the source(s) of erosion and sediment releases. Training will be provided for environmental monitors to identify sources and causes of erosion and sedimentation, but these individuals will also have access to professional engineers and biologists who can assist in identifying and rectifying potential or actual erosion sources.

IR Number: 110

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Monitoring - Impacts to Fish and Fish habitat**
- Response to the January 16th, 2012 Information requests, p.19-20
- IMG-Golder Fish Habitat Assessment January 2012, Table 1, p. 4-6

Preamble

The Developer states in response EIRB IR#5.1 as well as other places within the document that inspections of culverts and monitoring will be carried out "*particularly in fish bearing streams*".

In the Table 1 of the IMG-Golder January 2012 report, stream crossings have been classified as either "*known or assumed fish habitat*", "*contributing to fish habitat downstream*" or as "*unknown*".

Request

1. As with the turbidity monitoring, all streams including those considered to be "unknown" fish habitat should be monitored unless the Developer can provide adequate evidence to show that streams are not fish frequented year-round. Please confirm that the Developer will inspect culverts at all stream locations that are or likely to be fish habitat or fish migration corridors.

Developer Response: 110.1

All stream crossing culverts will be regularly inspected as part of normal highway monitoring efforts. Culvert failure, plugged culverts, and bank and Highway embankment erosion can all result in damage to the Highway, causing potentially costly repairs and inconvenience to travellers. As a result, regular inspections will take place regardless of the fish-bearing status of a stream.

IR Number: 111

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Increase access to fisheries resources - Action Plan**
- Response to the January 161h, 2012 Information requests, p.84-85 and p.109-111

Preamble

Increased access to lakes and streams along the proposed highway corridor could impact the fisheries resources over the life of the project. The Developer has suggested that an Action plan be developed in cooperation with the ILA, the HTCs, the FJMC, and DFO during the period of Project construction to achieve resource protection and sustainability. The Action Plan would integrate public, government, and NGO input, and develop strategies for limiting access to sensitive water bodies, and a public education program that will increase awareness of the consequences of human harvesting activities on fish and fish habitat.

Upon recommendation from DFO, the FJMC formed the Tuktoyaktuk-Inuvik Working Group (TIWG) specifically to deal with arising issues with regards to fisheries resources along the proposed Tuk-Inuvik Highway route. Members from the Inuvik and Tuktoyaktuk Hunters and Trappers Committee compose of the group, and the DFO fisheries biologist participates as an advisor/observer. DFO recommends that the proponent and other potential partners (e.g. ILA) work with the TIWG to create this action plan.

Request

1. What are the expected timeframes for the development, consultation and implementation of the Action Plan? A plan should be in place prior to the opening of the road.
2. How will the Action Plan be coordinated with other existing or future Land Use and Community Conservation Plans?

Developer Response: 111.1

The Developer expects its primary construction phase mitigation plan, the Fish and Fish Habitat Action Plan, to be developed six months prior to the commencement of construction. Depending on the timing of the environmental assessment and regulatory processes, this could be in late October 2012. However, the construction will take 3-4 years before the highway is open to the public. The Action Plan would likely be in place six months prior to the opening of the road. It must be clear that the Developer has no legal mandate for fisheries management. The scope of the Action Plan will be limited to the Project.

Developer Response: 111.2

The primary responsibility for Land Use and Community Conservation Plans rests with Inuvialuit organizations. The Developer believes it would be appropriate for these organizations as well as the co-management bodies [including the Fisheries Joint Management Committee and the DFO] to apply existing fisheries-related legislation and fisheries management strategies for any future revisions to the current Community Conservation Plans.

It is uncertain whether the current Land Use and Community Conservation Plans would materially affect the development of the Action Plan, but it is important to recognize the limited geographic scope of the Action Plan as it relates to the Project, when compared to the inherent fisheries resource planning and management responsibilities included in the legal mandates of the Department of Fisheries and Ocean and the Fisheries Joint Management Committee. The Developer fully expects that the legally responsible agencies and organizations will carry out their mandates for the ISR and the Project will be a consideration within the larger geographic scope and issues. [see also Developer Response 144].

IR Number: 112

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Increase access to fisheries resources - Fish Species**
- EIS, Section 3.1.7, p.150;
- Fish Habitat Assessment (January 2012)

Preamble

Section 3.1.7 of the EIS as well as Appendix II of the IMG-Golder January 2012 describe the life history information and habitat preferences of valued fish species that are likely to be encountered along the proposed Highway. While these documents discuss the timing and required habitat of fish at different life stages, several biological characteristics associated with species-specific susceptibilities to fishing pressures are not described such as lifespan, growth rate, body size, fecundity, timing of maturity and several other life history traits. These characteristics can be used to predict species vulnerability to overharvesting.

Figure 3.2.8-16 of the EIS identifies the larger fish-bearing lakes along the highway route. The fisheries assessments along the corridor completed in 2010 and 2011 further identify fish-bearing waterbodies. It is important to note that specific streams may be affected with regards to increased angling, as well as smaller lakes may be accessed for subsistence fishing closer to the communities.

Request

1. Based on the biological characteristics of fish present near the proposed highway, please describe how certain species may be more susceptible to overharvesting pressures.
2. Please discuss how smaller lakes and streams will also be included in the Action Plan.

Developer Response: 112.1

Increased access following completion of the Highway has been identified as a possible indirect effect on fish populations due to the potential for increased exploitation. The species that might be affected in streams and lakes are discussed below.

Streams: The majority of streams crossed by the proposed Highway are ephemeral or intermittent. Based on habitat assessments and limited electrofishing, it is apparent that few of these streams support significant runs of fish at any time. The two species that are most likely to be found in small numbers in these streams near road crossings are Arctic grayling and northern pike.

Arctic grayling migrate to their spawning grounds soon after ice-out in the spring. Spent adults move back to larger waterbodies shortly after spawning. As a result, there is only a short time window during which these fish might be susceptible to angling. However, since only very few streams would contain numbers of grayling that would justify angling effort, it is highly unlikely that the Project area grayling population would be significantly affected due to increased access.

Northern pike spawn in slow flowing, marshy stream and lake habitats in the spring, in areas of submerged and emergent vegetation. Adult pike in most of the small streams crossed by the Highway likely descend to larger waterbodies after spawning due to decreased flows and depths following freshet.

Zed and Hans creeks provide suitable open-water habitat conditions for grayling, migrating pike, coregonid species and burbot, and are the only streams where consequential angling might be expected near the proposed Highway. None of these fish are likely to be resident in these streams beyond their spawning periods, which is spring for grayling and burbot, and fall for coregonids (e.g. lake whitefish, broad whitefish, least cisco, inconnu). As such, the introduction of angling in limited locations within these streams will likely not affect fish population abundance. However, the use of nets within these streams could impact fish populations in the Husky Lakes due to the probable importance of Zed and Hans creeks as migratory channels and as spawning and rearing areas.

Lakes: Although there are several lakes within the proximity of the Highway, most are small, shallow and would contain only sparse populations of large bodied fish, making them unattractive for angling. Although not investigated, some medium sized lakes (e.g. at km 88-93) may contain fish populations, particularly coregonids and burbot, which could be exploited. Coregonids spawn in the spring, and in cases of anadromous or adfluvial fish, begin their upstream migrations in mid to late summer when they could be susceptible to fishing pressure.

Four larger freshwater lakes exist near the proposed road crossing: Noell, Jimmy, Parsons and Big (Ilkaasuat) lakes. These waterbodies support a variety of fish species, including lake trout (Noell, Parsons and Big lakes), coregonids, burbot, Arctic grayling, and northern pike. Although the proposed Highway ranges from one to five kilometres from these lakes, it is possible that increased access will occur using All Terrain Vehicles (ATV) and possibly, the use of boats transported in winter and left for summer use. The distance, difficult terrain, and requirement for specialized vehicles will likely limit the impact that recreational fishing has on fish species in these lakes. However, net fishing could result in substantial resource impacts.

Husky Lakes: The population of Tuktoyaktuk already has good access to the Husky Lakes, particularly during the winter period, where recreational and subsistence fishing is common. Due to the marine/estuarine nature of the Husky Lakes, it is not expected that the Highway will significantly affect the fish populations in these waters. Effects, if any, on fish populations could possibly result from the exploitation of large numbers of fish migrating from or to the Husky Lakes in streams such as Zed and Hans.

Developer Response: 112.2

It is unlikely that most smaller lakes and streams will be subject to increased fishing pressure, as such waterbodies support very limited or no fish populations due to poor connectivity at times of low water, winter ice conditions, low quality habitat, and low dissolved oxygen and food levels. However, the Action Plan should address the value of the more important streams, such as Zed, Hans, and Trail Valley creeks, and the medium to large lakes along the corridor. Options for preventing overexploitation include restricting gear types, regulating fishing seasons and implementing public information sessions and signage.

IR Number: 113

Source: **Fisheries and Oceans Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Cumulative Effects**
- Response to the January 16th, 2012 Information requests, p.115

Preamble

The potential future projects and activities discussed in the cumulative effects assessment in the EIS include the Mackenzie Gas project, the Tuktoyaktuk Harbour Project and possible future developments in the Husky Lakes area.

Request

1. Please provide a rationale for why the Mackenzie Valley Highway was not included as part of the cumulative effects assessment. The new Mackenzie Valley Highway would join the Inuvik to Tuktoyaktuk Highway with existing portions of road at Wrigley. As a potential future development the new Mackenzie Valley Highway could have cumulative impacts in the local and regional study area of the project.
2. What are the potential cumulative effects of the new Mackenzie Valley Highway with respect to fish habitat, fish migration, and impacts to populations from increased access.

Developer Response: 113.1

As discussed in Section 5.0 (Cumulative Effects Assessment) of the EIS, the spatial boundaries considered for the cumulative effects assessment included the portion of the Mackenzie Delta and the Tuktoyaktuk Peninsula in the general vicinity of the proposed Highway, extending between Inuvik and Tuktoyaktuk, including alternate alignments considered. (as shown in Figure 4.3.8-1 of the EIS). The easterly boundary extended 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, located within the Inuvialuit Settlement Region, 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 within this extensive area. At the time of EIS preparation, it was considered that the proposed new highway, if anything, represented an extension of the existing Dempster Highway, which terminates at Inuvik.

The proposed Mackenzie Valley Highway from Wrigley to Inuvik was not included as part of the cumulative effects assessment because, if and when developed, it would connect to the existing Dempster Highway at some point south of Inuvik and north of Tsiigehtchic. It was also generally understood that potential cumulative effects associated with the possible future development of the Mackenzie Valley Highway (Wrigley to Inuvik) would be undertaken as part of the anticipated environmental review process for that project.

Developer Response: 113.2

As previously indicated, potential cumulative effects related to the proposed Mackenzie Valley Highway (Wrigley to Inuvik) were not assessed in relation to the proposed Inuvik to Tuktoyaktuk Highway. However, it is the Developer's opinion that there are no clear linkages between fish habitats and fish migration patterns experienced in the vicinity of the Inuvik to Tuktoyaktuk Highway , with fish habitats and fish migration patterns related to the proposed Mackenzie Valley Highway.

Regarding potential cumulative impacts to fish populations from increased access due to a future new road connection (Mackenzie Valley Highway) from the south to Inuvik, no significant impacts to existing fish populations in the vicinity of the Inuvik to Tuktoyaktuk Highway would be expected to occur, because few fishermen would be expected to travel that far from their traditional fishing areas for the purpose of fish harvesting.

However, it will be important for the Department of Fisheries and Oceans, the Fisheries Joint Management Committee, and the HTCs to monitor and regulate fish harvesting activities in relation to the proposed Inuvik to Tuktoyaktuk Highway and the future Mackenzie Valley Highway, if and when the Mackenzie Valley Highway from Wrigley to Inuvik is eventually constructed.

5.0 Environment Canada

IR Number: 114

Source: **Environment Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Cumulative effects assessment for species at risk**

Preamble

Section 10.1.5 of the Terms of Reference (TOR) for the EIS stipulates that all direct, indirect and cumulative effects should be considered for species at risk listed on Schedule 1 of SARA and those designated at risk by COSEWIC. Section 11 of the TOR directs the Developer to identify and assess the cumulative environmental and socio-economic effects of the project in combination with other past, present or reasonably foreseeable projects and/or activities within the Study Area(s). Specifically, the Developer is required to identify the sources of potential cumulative effects and to specify other projects or activities that have been or will be carried out that could produce effects on each selected VEC or VSC within the boundaries defined, and whose effects would act in combination with the residual effects of the project.

The Developer has identified an area extending from the westerly shores of the Husky Lakes to the eastern side of the Mackenzie River as the spatial boundary for their cumulative effects assessment (Response to EIRB IR 49). Potential future projects/activities that are considered in the cumulative effects assessment include the Mackenzie Gas Project, the Parsons Lake gas field, associated infrastructure and gathering pipeline, the Tuktoyaktuk Harbour Project and Husky Lakes Development.

As highlighted by the EIRB in their Information Request #48 to the Developer, the cumulative effects assessment is very qualitative in nature, and currently does not provide a quantitative assessment of the potential cumulative direct and indirect impacts of these potential future projects/activities. This includes the assessment for cumulative effects on species at risk.

Under paragraph 16(1)(a) of CEAA, every environmental assessment must consider "*the environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out*" (Environment Canada and Parks Canada, 2010, pg. 39).

Since the definition of "environmental effect" includes any change a project may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, it is important that cumulative environmental effects on listed wildlife species are considered in the environmental assessment process (Environment Canada and Parks Canada, 2010, pg. 39).

SARA establishes no explicit obligations to address cumulative environmental effects on listed wildlife species. However, many listed wildlife species are at risk precisely because of cumulative environmental effects that have occurred in the past, such as gradual loss of habitat (Environment Canada and Parks Canada, 2010, pg. 39).

Thus, it is implicitly important in the cumulative environmental effects analysis that environmental assessments always consider the potential for cumulative environmental effects on listed wildlife species, the residences of their individuals and their critical habitat, in the context of the combined past threats the species have faced, as well as any additional present or future threats that can reasonably be expected to occur (Environment Canada and Parks Canada, 2010, pg. 39).

The following species at risk were identified as potentially occurring within the Regional Study Area:

Terrestrial Species at Risk	COSEWIC Designation	Schedule of SARA	Government Organization with Lead Management Responsibility[1]
Horned Grebe (Western population)	Special Concern	Pending	EC
Eskimo Curlew[2]	Endangered	Schedule 1	EC
Rusty Blackbird	Special Concern	Schedule 1	GNWT
Peregrine Falcon (*anatum-tundrius* complex[3])	Special Concern	Schedule 1 - Threatened (*anatum*)	GNWT
Short-eared Owl	Special Concern	Schedule 3	GNWT
Woodland Caribou (Boreal population)	Threatened	Schedule 1	GNWT
Grizzly Bear	Special Concern	Pending	GNWT
Polar Bear	Special Concern	Schedule 1	GNWT
Wolverine (Western population)	Special Concern	Pending	GNWT

1 Environment Canada (EC) has a national role to play in the conservation and recovery of Species at Risk in Canada, as well as responsibility for management of birds described in the Migratory Birds Convention Act (MBCA). Day-to-day management of terrestrial species not covered in the MBCA is the responsibility of the Territorial Government. Populations that exist in National Parks are also managed under the authority of the Parks Canada Agency.

2 Eskimo Curlew could potentially occur within the project area. However, there have been no reliable sightings of Eskimo Curlew since 1998 and the National Recovery Team for this species has determined that recovery is not feasible at this time. It is EC's view that, in light of its current status, there is no need for further action with respect to Eskimo Curlew. An appropriate mitigation and monitoring plan will be developed with the Proponent if it is established that this species does occur in the area.

3 The *anatum* subspecies of Peregrine Falcon is listed on Schedule 1 of SARA as threatened. The *anatum* and *tundruis* subspecies of Peregrine Falcon were reassessed by COSEWIC in 2007 and combined into one subpopulation complex. This subpopulation complex was listed by COSEWIC as Special Concern.

The Developer's cumulative effects assessment is currently inadequate to satisfy the requirements of CEAA subsections 16(1)(a), particularly with respect to species at risk.

A precautionary approach to predicting cumulative effects suggests that it would be conservative to assume that the Mackenzie Gas Project will proceed and that the associated Parsons Lake Gas Field and associated infrastructure and gathering lines will be built. Given that the MGP has already undergone an in-depth review, information is available on the area and location of the direct footprint of the Parsons Lake facilities and gathering pipelines as well as the projected zone of influence due to sensory disturbance from these features. It should therefore be possible to provide a quantitative estimate of the cumulative area of habitat for each species at risk within the spatial boundaries selected for the cumulative effects assessment that will be directly or indirectly affected by infrastructure proposed for the MGP, in combination with the proposed HWY and other existing development.

The Developer has also identified a number of programs to collect further baseline data during the summer and fall of 2012 (summarized in response to EIRB IR#15) that may help to improve the prediction, mitigation and monitoring of cumulative effects to species at risk. It is currently unclear how this information will be integrated into the environmental assessment given the proposed review timeline, or how it will be integrated into refining the design of the project or in refining mitigative measures, and whether regulators will have the opportunity to review and comment on the information collected prior to the board issuing its decision on the project.

Reference

Environment Canada and Parks Canada, 2010, "Addressing Species at Risk Considerations under the Canadian Environmental Assessment Act for Species Under the Responsibility of the Minister Responsible for Environment Canada and Parks Canada". Available at: www.ec.gc.ca/nature/default.asp?lang=En&n=132ADBFC-1&parent=0C1743A2-4D49-4183-AC5F-1DE909D2FEB1

Request

For the Developer to provide:

1. A quantitative summary of the direct footprints and indirect effects on habitat quality due to sensory disturbance (e.g. dust, noise, light) of existing and foreseeable projects within the spatial boundaries selected for the cumulative effects assessment. The projected footprints should be broken down by habitat type and expressed as a total proportion of each habitat type available in the cumulative effects assessment study area.
2. An assessment of the potential impact of cumulative direct habitat loss and indirect changes in habitat quality due to sensory disturbance for each species at risk likely to occur in the cumulative effects study area, using knowledge of current distribution and habitat associations of each species at risk to inform the impact assessment.
3. Where current data is insufficient to provide an adequate assessment of the potential impact on each species at risk, provide an outline of how future baseline data collection programs will address these deficiencies, how the information obtained will be shared with the EIRB, regulators and other interested parties, and how it will be used to refine mitigation and monitoring plans.

Developer Response: 114.1

This response is in preparation and will be submitted to the EIRB in April 2012.

Developer Response: 114.2

This response is in preparation and will be submitted to the EIRB in April 2012.

Developer Response: 114.3

This response is in preparation and will be submitted to the EIRB in April 2012.

IR Number: 115

Source: **Environment Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Noise impact assessment for the operation phase of the highway**

Preamble

Section 10.1.7 of the Terms of Reference for the EIS direct the Developer to describe and evaluate potential impacts of visual or auditory disturbance, including habitat avoidance and effective habitat loss in relation to Project facilities or activities, and the duration and geographic extent of such impacts. The TOR specifically mentions the distance of noise related disturbance as an example of the duration and geographic extent of an impact.

The Developer states in Sections 3.1.4. and 4.2.3 of the EIS state that ambient noise levels measured at the Inuvik Area Facility as part of baseline studies for the Mackenzie Gas Project were between 20 dBA (winter) and 31 dBA L_{eq} (summer). It is expected that noise levels associated with passengers travelling at the speed limit will typically be within 72-74 dBA at 15 m from the vehicle and heavy-duty trucks will typically be within 84-86 dBA at 15 m from the truck. The Developer predicts that vehicles would not be expected to create excessive noise beyond the immediate vicinity of the Highway and that higher sound levels will be intermittent, short in duration, and transient in nature. However, there is no indication of the distance at which noise from vehicle traffic along the highway would be expected to attenuate to ambient levels, and therefore no quantitative estimate of the potential zone of influence for noise effects on wildlife has been provided.

Request

For the Developer to:

1. Calculate the expected zone of influence within which noise from operation of the highway will exceed baseline ambient noise levels (i.e. provide the distance from the highway at which vehicle noise will attenuate to ambient levels).
2. Calculate the proportion of the LSA and RSA that will be within the predicted zone of influence from traffic noise during the operation of the highway.

Developer Response: 115.1

The expected zone of influence within which noise from operation of the Highway will exceed baseline ambient noise levels has been estimated based on the results of available data from several other northern projects including the proposed Gahcho Kue Mine Project and the Meadowbank Mine Project.

Data from the Gahcho Kue Environmental Impact Statement (Appendix 7.II Noise Assessment) regarding the proposed winter access road for that project, which will have approximately 2,400 trucks using the access road during the period of late January to early April each year (approximately 10-12 weeks, or 29-34 vehicles per day), were used to identify the expected zone of influence.

According to Table 7.II.6-1, from the Gahcho Kue EIS, noise from the winter road traffic only at the edge of the 1.5 km Gahcho Kue project buffer were predicted to be 23.5 dBA, not including ambient sounds. The predicted cumulative noise levels, including average baseline noise, were 35 dBA at the 1.5 km boundary location (Table 7.II.6-2). It is important to note that the ambient noise levels near Gahcho Kue ranged from 35 to 52 dBA due to higher wind speeds.

Annual noise monitoring has been conducted at the Meadowbank Gold Project, including a monitoring location (R1) within 400 m of the all weather private access road (AWPAR). R1 is situated approximately 400 m east northeast of the all-weather private access road. The dominant, valid noise sources measured at this location were helicopter and aircraft flyovers, construction activity including vehicles, and wind. During the July 20-21, 2010 monitoring period, the $L_{eq,\ 1\ hr}$ values ranged from 24 dBA to 49 dBA at R1. The 24-hour ($L_{eq,\ 24\ hr}$) time-average at R1 was 42 dBA at a distance of 400 m from the all-weather road.

Based on noise assessment data from Gahcho Kue and noise monitoring evidence from Meadowbank, the distance from the roads that noise returned to baseline levels was between 400 m and 1,500 m. Therefore, the estimated zone of influence of noise generated by vehicles using the proposed Inuvik to Tuktoyaktuk Highway is likely to be within the range of 400 m to 1,500 m from the proposed Highway. It is important to note that the nature of the noise to be generated by vehicles using the Highway will be transitory (moving), short term and rapidly reversible, thus creating temporary noise that will dissipate shortly after the vehicle passes by.

References:

De Beers Canada Inc. December 2010. Gahcho Kue Environmental Impact Statement. Section 7. Appendix 7.II Noise Assessment.

Golder Associates Ltd. March 2011. 2010 Noise Monitoring – Meadowbank Division, Nunavut. Submitted to Agnico-Eagle Mines Limited. Project Number: 10-1428-0035/3000. Retrieved March 13, 2010 from ftp://ftp.nirb.ca/03-MONITORING/03MN107-MEADOWBANK%20GOLD%20MINE/03-ANNUAL%20REPORTS/02-PROPONENT/2010/01-REPORT/Report%20to%20NIRB/110923-03MN107-Appendix%20L-Noise-IT4E.pdf

Developer Response: 115.2

Based on a predicted zone of influence of between 400 m to 1,500 m, the proportion of the LSA and RSA potentially affected by temporary and rapidly reversible noise are identified as follows.

The proportion of the LSA (includes a 500 m buffer on either side of the proposed Highway alignment) that will be within the predicted zone of influence from intermittent traffic noise during the operation of the Highway is 100%.

The proportion of the RSA (includes a 15 km buffer on either side of the proposed Highway) that will be within the predicted zone of influence of intermittent traffic noise during the operation of the Highway is between 3.3% and 10%.

IR Number: 116

Source: **Environment Canada**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

Subject: **Potential bird mortality due to vehicle collisions during the operational life of the highway**

Preamble

Section 10.1.7 of the Terms of Reference for the EIS directs the Developer to describe and evaluate potential impacts of wildlife mortality due to harvesting and vehicle collisions, including the duration and geographic extent of such impacts.

In section 4.2.7.6 of the EIS, the Developer acknowledges the potential for increased mortality through vehicular collisions but does not provide a quantitative assessment of this potential mortality. Some quantitative information was later provided in response to EIRB IR#26; however, the Developer only presents data on bird mortality from monitoring data obtained along Meadowbank gold mine's all-weather public access road (AWPAR) from 2007 to 2010. Monitoring of wildlife mortality along mine and winter roads associated with the Ekati, Diavik and Snap Lake mines has been taking place for a much longer period and could provide further information on potential bird mortality along the proposed highway during the operational period.

Request

For the developer to provide:

1. Data on bird mortality due to collisions with vehicles from monitoring programs at other mines operating above the tree-line in the NWT and Nunavut.
2. Based on available data, estimate potential annual bird mortality due to operation of the proposed highway, accounting for expected traffic volume and the length of the highway.
3. Where possible, estimate combined mortality from vehicle collisions and annual harvest rates.

Developer Response: 116.1

Data on bird mortality due to collisions with vehicles from monitoring programs conducted at Ekati, Diavik and Snap Lake mines are provided as follows:

- Ekati mine site – 23 birds (11 willow ptarmigan, 1 rock ptarmigan, 8 ptarmigan (unidentified species), 1 green-winged teal, 1 unidentified bird, and 1 rough-legged hawk) have been reported killed by vehicle collisions during the period of 1997 to 2009.
- Diavik mine site – 7 birds (1 unidentified duck and approximately 6 rock ptarmigan) have been reported killed by vehicle collisions during the period of 2000 to 2009.
- Snap Lake mine site – no birds have been reported killed by vehicle collisions during the period of 1999 to 2009.

The Tibbitt to Contwoyto Winter Road (primary road from Yellowknife to each of the mines) is in operation generally from late January to early April only. From 1996 to 2009, 1 wolverine, 5 caribou and 1 red fox have been reported killed by vehicle collisions. No bird mortalities were reported during this period.

Reference:

De Beers Canada Inc. December 2010. Gahcho Kue Environmental Impact Statement. Section 11.12.

Developer Response: 116.2

It is important to note that data from mine sites, including Ekati, Diavik, and Snap Lake are less relevant to the Inuvik to Tuktoyaktuk Highway as there is limited traffic at the mine site and reduced speeds. No data were available from the mine sites identifying how many vehicles were operational per day, average speed, or the length of the roads used.

The Tibbitt to Contwoyto Winter Road does not provide an adequate comparison due to the reduced speeds (less than 35 km/h) and required spacing between vehicles along the road. It is important to note, however, that thousands of vehicles travel along the road during the few weeks each year that the road is operational (Table 5).

TABLE 5: ANNUAL NUMBER OF VEHICLES TRAVELING ON THE TIBBITT TO CONTWOYTO WINTER ROAD

Year	Operating Period	Number of Truckloads (northbound)	Number of Backhauls (southbound)
2001	Feb 1 – Apr 13	7981	201
2002	Jan 26 – Apr 16	7735	433
2003	Feb 1 – Apr 2	5243	883
2004	Jan 28 – Mar 31	5091	165
2005	Jan 26 – Apr 5	7607	243
2006	Feb 5 – * Mar 26	6841	469
2007	Jan 27 – Apr 9	10,922	818
2008	Jan 29 – Mar 31	7484	890
2009	Feb 1 – Mar 22	4847	530
2010	Feb 4 - March 21	3508	429
2011	Jan 28 - March 31	6832	530

Source: Tibbitt to Contwoyto Winter Road Joint Venture 2012

According to Kociolek and Clevenger (2011), Preston and Preston (2006), and Banks (1979), the contributing factors for bird-vehicle collisions include:

- Annual and regional differences in bird abundance
- Dispersal and migration periods(seasonality or activity periods)
- Gap-crossing tendency among species
- Learned or adapted behaviour
- Resource availability or attractants
- Roadside habitat type and structure

- Traffic speed and volume
- Road features/types
- Crossover height (i.e., the height that bird species fly across the road)
- Height of vehicles that cross the road
- Traffic volume
- Traffic speed
- Number of lanes
- Weather
- Time of day at which traffic is heavy

Another factor to consider is driver awareness (e.g., slowing down or avoiding birds).

It is difficult to predict with certainty how many bird-vehicle collisions will occur each year due to the operation of the proposed Highway. No data are available for NWT Highways (including the Dempster Highway) regarding bird-vehicle collisions. It is clear from reading available research on the matter that estimating mortalities due to bird-vehicle collisions is difficult due to search efficiency, scavenger bias or cause of death determination (Kociolek and Clevenger 2011) and the lack of data on successful crossovers. This has led to a wide range of estimates.

According to Preston and Preston (2006), "of the few studies that do report on bird-vehicle collisions, the numbers reported are usually only of dead birds, and not of those that successfully cross. Those dead birds are then commonly presented as the number per unit of distance driven and mortality estimates are extrapolated to much broader geographic areas."

Banks (1979) reviewed several studies from Great Britain, the United States and Australia that identified the rates of avian road deaths. The number of bird mortalities reported per mile per year ranged from 2.7 birds/ mile per year (Washington, U.S.) to 144 birds/mile/year (Northamptonshire, England). Other studies were reported in Erickson, Johnson and Young (2005) that record the number of bird mortalities as 21 birds per kilometre per year (Illinois, U.S.) up to 139 birds per kilometre per year (Ontario, Canada). Banks (1979), when estimating the annual mortality of birds on roads in the United State used a value of 15.1 mortalities per mile per year (or 9.4 mortalities per kilometre per year). The various factors that may have affected the number of bird mortalities per mile are not known; however, it is important to note that the density of roads, volume of traffic, and population are considerably greater in these areas.

Since the proposed Inuvik to Tuktoyaktuk Highway is located in a relatively remote area of Canada, with no other roads in the area between Inuvik and Tuktoyaktuk, and with an estimated 150-200 vehicles using the Highway each day at a posted speed limit of 80 km/hr, it is assumed that the bird-vehicle collision rate will be less than those stated in the other studies conducted in more populated areas with higher traffic volumes.

As stated in the Developer Response 26 (first round of the EIRB's information requests), road-related wildlife mortality was recorded during the weekly wildlife monitoring program conducted during construction of Meadowbank Gold Project's 110 km all weather private access road (AWPAR) beginning in 2007. The AWPAR is maintained and operated as a private access road for the Meadowbank Project with controlled access for non-mine use by ATV for the purpose of carrying out traditional activities. The maximum posted speed limit on the AWPAR is 50 km/hr (Agnico-Eagle Mines Limited – Meadowbank Division 2010). In 2007, bird mortalities were limited to three passerines (cause of death uncertain). The road has been fully operational since 2008.

Weekly wildlife surveys were conducted along the AWPAR from 2008-2010 with a total of 20 bird mortalities attributed to vehicle impacts (Gebauer and Associates 2011). This is an average of 6.67 bird mortalities per year or 0.06 bird mortalities per kilometre per year.

It is likely that the number of bird mortalities per year related to the Inuvik to Tuktoyaktuk Highway will be similar to those recorded in relation to the Meadowbank AWPAR. . It is also anticipated that most of the relatively few bird mortalities that would be expected to occur in a typical year would involve the small passerines that frequent the area, rather than waterfowl species that are preferred by local harvesters. The information from Ekati, Diavik and Snap Lake, although not directly relevant, support the order of magnitude presented in the estimate for potential bird-vehicle collisions.

References:

Agnico-Eagle Mines Limited – Meadowbank Division. May 2010. Meadowbank Gold Project Transportation Management Plan: All Weather Private Access Road. Version 2. Retrieved March 8, 2012 from ftp://ftp.nirb.ca/03-MONITORING/03MN107-MEADOWBANK%20GOLD%20MINE/01-PROJECT%20CERTIFICATE/12.8.2%20AMENDMENTS/CONDITION%2032/7-FOLLOW%20UP/100513-03MN107-Meadowbank%20Transportation%20Management%20Plan%20AWPAR%20Version%202-IT4E.pdf

Banks, R.C. 1979. Human Related Mortality of Birds in the United States. United States Department of the Interior, Fish and Wildlife Service. Special Scientific Report – Wildlife No. 215. Washington, DC. Retrieved March 8, 2012 from http://www.sf-planning.org/ftp/files/publications_reports/bird_safe_bldgs/Banks1979.pdf

Erickson, W.P., G.D. Johnson, and D.P Young Jr., 2005. A Summary and Comparison of Bird Mortality from Anthropogenic Causes with an Emphasis on Collisions. USDA Forest Service General Technical Report. PSW-GTR-191. Retrieved March 7, 2012 from http://studentaffairs.case.edu/farm/doc/birdmortality.pdf

Kociolek, A.V. and A.P. Clevenger. March 2011. Effects of Paved Roads on Birds: A literature Review and Recommendations for the Yellowstone to Yukon Ecoregion. Technical Report #8. Retrieved March 7, 2012 from http://www.y2y.net/data/1/rec_docs/979_Y2Y_Technical_Report_8_-_Effects_of_Paved_Roads_on_Birds.pdf

Preston, M.I. and J. Preston. June 2006. Estimating the Probability of Potential Vehicle Collision from Birds Crossing Roads in Interior British Columbia. Wildlife Afield. Volume 3:1 June 2006 (supplement). Retrieved March 7, 2012 from http://www.wildlifebc.org/UserFiles/File/3_1S_Preston_Preston.pdf

Tibbitt to Contwoyto Winter Road Joint Venture. 2012. Facts. Retrieved March 7, 2012 from http://www.jvtcwinterroad.ca/jvwr/Facts.asp

Developer Response: 116.3

Annual harvest rates for birds are derived from the Inuvialuit Harvest Study 1988-1997 (Joint Secretariat 2003). This study has not been updated since it was originally published; in the Inuvialuit Settlement Region, comprehensive harvest studies are no longer being conducted (G. More, Manager Environmental Assessment and Monitoring, GNWT ENR, pers. comm., October 26, 2010).

Table 65 (Inuvik) and Table 131 (Tuktoyaktuk) of the Inuvialuit Harvest Study identifies the ten year mean estimated harvest for selected species. The results of these tables are reproduced in Table 6.

The relatively few birds anticipated to be killed by vehicle collisions (see Developer Response 116.2) will represent an insignificant fraction of the overall number of birds harvested by the people of the region. As indicated in the previous response, it is also anticipated that most of the relatively few bird mortalities that would be expected to occur in a typical year would involve the small passerines that frequent the area, rather than the waterfowl species that are typically preferred by local harvesters.

TABLE 6: TEN YEAR MEAN ESTIMATED HARVEST FOR SELECTED BIRD SPECIES, INUVIK AND TUKTOYAKTUK (1988-1997)

Species	Mean Estimated Harvest		Total Estimated Harvest
	Inuvik	Tuktoyaktuk	
Brant	2	443	445
Eider (unspec.)		8	8
Goose (Canada)	72	14	86
Goose (Greater White-fronted)	246	1,028	1,274
Goose (Snow)	314	2,196	2,510
Mallard	133	7	140
Oldsquaw	27	4	31
Pintail (Northern)	28	17	45
Ptarmigan (unspec.)	36	281	317
Scoter (unspec.)	106	15	121
Swan (unspec.)	30	39	69
Wigeon (American)	163	7	170
Canvasback	9	3	12
Crane (Sandhill)	0	1	1
Duck (unspec.)	9		9
Goldeneye (unspec.)	0	1	1
Goose (unspec.)	1	2	3
Loon (Common)	0	0	0
Loon (unspec.)		1	1
Merganser (unspec.)	0	1	1
Scaup (unspec.)	10	1	11
Shoveler	3	2	5
Teal (Green-winged)	1		1
TOTAL	**1,190**	**4,071**	**5,261**

Source: Joint Secretariat 2003

IR Number: 117

Source: **Environment Canada**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

Subject: **Potential habitat disturbance within the boreal woodland caribou range**

Preamble

The Developer has noted that the southern end of the proposed HWY may overlap with the northern limit of the range of boreal woodland caribou. Boreal woodland caribou are listed as Threatened on Schedule 1 of the federal Species at Risk Act.

Environment Canada posted a proposed "Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada" on the Species at Risk Public Registry on August 26, 2011. National recovery strategies for federal Species at Risk are planning documents that must identify a species' critical habitat, to the extent possible, and approaches to stop or reverse the decline of the species. The intent of the SARA is to protect critical habitat from being destroyed wherever it occurs.

The proposed recovery strategy for boreal caribou identifies two local population ranges in the Northwest Territories (NWT). The southern end of the proposed highway may overlap with the northern limit of the NWT North boreal woodland caribou range identified in the proposed national recovery strategy.

Maps of the NWT North boreal caribou local population, range attributes and a description of the biophysical attributes of critical habitat, are provided in Appendix F-1 of the proposed Recovery Strategy available at: httpliwww.sararegistry.gc.ca/document/default_e.cfm?docurnentID=2253

The proposed national recovery strategy considers the total disturbed area in a local population range as the area of the anthropogenic footprint plus a 500 m buffer around the perimeter of the footprint (for linear features this equates to the width of the feature plus a 500 m buffer on either side), plus areas where a fire has occurred in the past 40 years (no buffer applied). EC has made the range boundaries and disturbance data (shapefiles) for boreal caribou available online at:

http://www.data.go,ca/default.asp?lang=En&n=5176A6F0-&xs1=datacataloguerecord&metaxsi=datacataloguerecord&formid=F34DCB32-4845-4E88- B125-5ACO3CGE4A7F,°/020F34DCB32-4845-4E88-B125-5ACO3C6E4A7F

Shapefiles are provided for both the buffered anthropogenic disturbance and unbuffered fires within each boreal caribou local population range across Canada.

Request

For the developer to:

1. Provide a map showing whether the proposed highway alignments overlap with the NWT North boreal caribou range.
2. Calculate the area of new disturbance that the highway corridor will cause, including a 500 m buffer on either side of the direct footprint from the highway right of way, if a portion of any of the proposed routes lies within the NWT North boreal caribou range.

Developer Response: 117.1

This response is in preparation and will be submitted to the EIRB in April 2012.

Developer Response: 117.2

This response is in preparation and will be submitted to the EIRB in April 2012.

6.0 Infrastructure Canada

IR Number: 118

Source: **Infrastructure Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Engagement with the Gwich'in Tribal Council**

Preamble

The Inuvik to Tuktoyaktuk highway will commence approximately 5 kilometres from Inuvik and the highway start (kilometre 0) is located on the border of the Gwich'in Settlement Area. Although the highway will be located entirely within the Inuvialuit Settlement Region, the highway may have impacts on the Town of Inuvik and the road from Inuvik to the start of the highway, both of which are located within the Gwich'in Settlement Area.

The Developer's correspondence to date notes some involvement of the Gwich'in in community consultations and it is understood that additional efforts may be undertaken.

Request

1. Please summarize the Developer's engagement efforts with the Gwich'in to-date, describe any concerns that have been identified, and outline any future planned engagement efforts.

Developer Response: 118.1

The Inuvik to Tuktoyaktuk Highway (ITH) project has been formally discussed with the Gwich'in Tribal Council (GTC) on two occasions to date.

On January 11, 2012 at the GNWT/Gwich'in Leadership Meeting in Inuvik a number of questions and comments on the ITH were provided by the GTC leadership to GNWT DOT.

GNWT DOT also met with the GTC Board of Directors in Inuvik on February 22, 2012. The main purpose of this meeting was to provide an update on the ITH project. Questions asked by the GTC related to the role of CEAA in this project, possible impacts on Gwich'in lands and the procurement process being proposed for this project, among others.

GNWT DOT left the meeting with a commitment to investigate Gwich'in lands that could be impacted by future upgrades to Navy Road and to provide a further update in the future. GNWT DOT has reviewed land tenure adjacent to Navy Road and has identified four properties owned by the GTC and/or the Nihtat Gwich'in Council. At the present time it is expected that any improvements to Navy Road will be accommodated within the existing road right-of-way and will not impact/encroach directly on these properties.

7.0 Health Canada

IR Number: 127

Source: **Health Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Air Quality**

Preamble

Health Canada appreciates the Developer's response (Comment 2) providing additional details about the project's dust emissions (PM_{25}, PM_{10} and Total Suspended Particulates (TSP)) and the potential effects on health due to air quality. However, the draft EIS indicates that project emissions also include nitrogen oxides (NO_x), sulphur oxides (SO_x) and notes these contaminants may be associated with adverse health effects. However, the draft EIS or the Developer's response does not identify the potential health effects associated with the predicted levels of these contaminants.

Request

1. Please include information regarding the potential health implications from the NO_x and SO_x emissions.

Developer Response: 127.1

According to Health Canada (2006), the potential health implications resulting from elevated levels of nitrogen oxides (NO_x) and sulphur dioxide (SO_2, which belongs to the sulphur oxide gases (SO_x)) are as follows.

At elevated levels, NO_x can impair lung function, irritate the respiratory system and, at very high levels, make breathing difficult, especially for people who already suffer from asthma or bronchitis.

SO_2 can cause breathing problems in people with asthma, but at relatively high levels of exposure. There is some evidence that exposure to elevated SO_2 levels may increase hospital admissions and premature deaths.

As discussed in Section 4.2.2 of the EIS, minimal temporary and intermittent increases of NO_x and SO_2 are anticipated to be generated by vehicles driving down the Highway. The anticipated levels of NO_x and SO_2 in the air are expected to be within the NWT and National Ambient Air Quality Objectives.

Reference:

Health Canada. May 2006. Let's Talk About Health And Air Quality. Retrieved March 13, 2012 from http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/effe/talk-a_propos-eng.php#nitrogen

IR Number: 128

Source: **Health Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Air Quality**

Preamble

Comment 2 of the Developer's Response responds to Health Canada's request for a discussion of potential human health effects resulting from air quality changes including $PM_{2.5}$ and PM_{10} to support the statement in the EIS that "no residual effects in terms of substances are anticipated".

In the Developer's response, the NAAQOs and NWT Ambient Air Quality Standards are mentioned and there indicates that "*No residual effects to humans are anticipated ....Other emissions that may be generated during construction and operation of the Highway are anticipated to be minimal, with air quality parameters remaining within the accepted standards and guidelines, as discussed in the EIS*."

It is important to note that air quality criteria and standards for particulate matter should not be considered as thresholds below which human health effects do not occur[4].

Request

1. Health Canada suggests rephrasing the statement that "no residual effects to humans are anticipated" as there are no thresholds for particulate matter below which human health effects do not occur[5].

Developer Response: 128.1

As stated in the EIS (Section 4.2.2), the CCME acknowledges that there is no apparent lower threshold for the effects of particulate matter and ozone on human health and that there are additional benefits to reducing and maintaining ambient levels below the standards.

However, it is important to note that air quality criteria and standards, such as the NWT Guideline for Ambient Air Quality Standards in the Northwest Territories, specify criteria for maximum concentrations deemed to be acceptable in ambient air.

The Developer continues to assert that no residual effects to humans are anticipated primarily due to the very limited number of potential human receptors within 1,000 m of the Highway (two residential leases). Other factors that reduce the potential residual effects include:

- the limited distance that particulate matter may be transported (100 m to 400 m depending on particulate size);
- the intermittent, short-term and rapidly reversible nature of dust that will be generated, primarily by moving vehicles;

[4] World Health Organization (WHO). 2003. Health aspects of air pollution with particulate matter, ozone, and nitrogen dioxide. Report on a WHO Working Group. Bonn, Germany 13-15 January 2003. Copenhagen: World Health Organization. Retrieved December 1, 2011, from:
http://www.euro.who.int/data/assets/pdf file/0005/112199/E79097.pdf
[5] Ibid.

- the relatively short snow-free and dry season when dust is most likely to be generated; and
- the implementation of mitigation measures to suppress dust, primarily during the relatively short snow-free and dry season.

IR Number: 129

Source: **Health Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Noise**

Preamble

The Developer's response indicated that there are some (1 or 2) residential leases within 1 km of the proposed alignments and many (19 to 33) residential leases within 5 km of the proposed alignments.

Request

1. Depending on the potential for future human use of these residential leases, Health Canada suggests that a noise assessment may be appropriate for predicting the potential effects of noise on human health. If a noise assessment is completed, Health Canada suggests including the relevant information specified in the Noise Effects section of Useful Information for Environmental Assessment[6].

   If a noise assessment is not completed, Health Canada suggests providing a rationale for its exclusion referring to the nature of human use (likelihood of use, type of use, duration, etc.) of the residential leases.

Developer Response: 129.1

As discussed in the Developer Response 115, the estimated zone of influence within which noise from operation of the Highway will exceed baseline ambient noise levels is likely within 400 m to 1,500 m from the proposed Inuvik to Tuktoyaktuk Highway.

Due to the low volume of intermittent traffic anticipated and the limited number of human health receptors (two residential leases within 1 km from the proposed Highway), a noise assessment is not warranted.

The two residential leases located within 1 km of the proposed Highway are most likely to be temporarily occupied through the fall and winter months for hunting and other traditional activities, as there is limited or no access to this area during the snow-free periods.

As stated in Section 3.1.4.4 of the EIS, anthropogenic contributions are associated with annual winter traffic on the existing winter ice road, local off-road ATV and snowmachine traffic, helicopter and aircraft overflights, and associated hunting that occur seasonally in the area. According to Figure 4.3.8-1 of the EIS, the seasonally-used snowmobile trail that goes through the Husky Lakes passes by (within 1 km) a number of residential leases. No concerns regarding noise were discussed during the consultations for the Inuvik to Tuktoyaktuk Highway (Appendix B of the EIS).

[6] http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/environ_assess-eval/index-eng.php

8.0 Natural Resources Canada

IR Number: 130

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Terrain conditions and sensitivity along proposed route**
(TOR 6, 7, 9.1, 10.1, App. A; Reference: EIS 2.1, 2.2, 2.3, 2.4, 3.1)

Preamble

Information on baseline terrain conditions and sensitivity along the proposed route is required to determine design parameters for the highway, impact assessment and to ensure impacts of the project on the environment as well as the impact of the environment on the project are minimized. The Proponent has provided a surficial geology map (Figure 3.1.1-1), the proportion of the proposed route underlain by various terrain types and general terrain descriptions for segments of the route in tabular format (section 2.3, Table 2.3-1). A map of previous landslide occurrence has also been provided (Figure 3.1.1-4). However, the Proponent has not provided any large scale alignment sheets that provide information on terrain types and potential geohazards and instability in addition to those associated with landslides. This information (such as areas of massive ice, thermokarst etc.) is required to provide more site specific conditions along the route and to identify areas where potential impacts may occur and where mitigation may be required. It is not clear whether the Proponent has produced the larger scale alignment sheets.

Request

1. Please clarify whether large scale alignment sheets showing terrain type and sensitivity along the proposed route have been developed. Please provide these maps if available.

Developer Response: 130.1

A terrain report entitled *Inuvik to Tuktoyaktuk Highway – Baseline Data Acquisition Program: Terrain Evaluation*, accompanied by a mapbook entitled *Surficial Geology and Terrain Constraints* was submitted to the EIRB on March 16, 2012.

The terrain report and mapbook include detailed airphoto interpretation of the surficial geology, geologic processes, drainage and permafrost features along route Alternatives 1 and 3, as well as the identification of potentially problematic terrain along the pre-identified alignments and borrow sources. The map atlas accompanying this report is presented at a 1:10,000 scale.

IR Number: 131

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Baseline permafrost and geotechnical information**
(TOR 9.1, App. A; Reference: EIS Section 2.2, 2.3, 2.4, 2.7, 3.1)

Preamble

Baseline information on geotechnical and permafrost conditions is required for adequate design of the highway and for characterizing potential borrow sites. This information is also required for assessment of potential impacts and implementation of mitigation techniques. The Proponent indicates that the identification of geotechnical challenges is based on limited terrain assessments (section 2.2.5). They also indicate that field work was done in 2009 and indicate additional studies are required for detailed design of the highway (section 2.1.2. section 2.7.7). Reference is made to historical studies for which geotechnical investigations were conducted (section 2.1.2). Much historical information exists, including results of geotechnical investigations, designs, and environmental assessment material related to past highway and pipeline proposals. Much of this information (including reports for and by Public Works and INAC) has been compiled into a digital borehole database by Smith et al. (2005) and Chartrand et al. (2002), with more recent data relevant to the section of the route between Inuvik and Parsons Lake published in Wolfe et al. (2010). Information on ground ice conditions can be found in the database of Cote et al. (2003). It is NRCan's understanding that the Proponent's consultant received a CD containing historical reports from the federal lands program manager. It is not clear from the EIS how existing information has been utilized to characterize the baseline geotechnical conditions and for the impact analyses. Also, no details have been provided on the investigations conducted during the 2009 field work and the information obtained. Without information regarding what site specific (either historical or new studies) information has been utilized and where information is lacking, it is difficult to determine the completeness of the baseline environmental description (and therefore the validity of the impact assessments) and the extent of further work that may be required to support detailed design.

References

Chartrand, J., Lysyshyn, K., Couture, R., Robinson, S., and Burgess, M. 2002. Digital Geotechnical Borehole Databases and Viewers for Norman Wells and Tuktoyaktuk, Northwest Territory, Geological Survey of Canada Open File 3912. littp://geopub.nrcan,ge.ca/moreinfo_e.php?id=213818&_h=chartrand

Cote, M.M., Wright, J.F., Duchesne, C., and Dallimore, S.R. 2003. Surficial materials and ground ice information from seismic shotholes in the Mackenzie-Beaufort region, Yukon and Northwest Territories: digital compilation. Geological Survey of Canada Open File 4490.

Smith, S.L., Burgess, M.M., Chartrand, J., and Lawrence, D.E. 2005. Digital borehole geotechnical database for the Mackenzie Valley/Delta region, Geological Survey of Canada Open File 4924. littp://geopub.nrcan.ge.ca/moreinfoe.php?id=220383

Wolfe, S.A., Smith, S.L., Chartrand, J., Kokelj, S.V., Palmer, M., and Stevens, C. 2010. Geotechnical database and descriptions of permafrost monitoring sites established 2006-10 in the northern Mackenzie Corridor, Geological Survey of Canada Open File 6677.

http://geoscan.ess.nrcan.gc.ca/cgi binistartinder/O?path---geosean.fl&id=fastlink&pass---8cformat=FLSHORTORG&search-R-287167

Request

1. Please provide clarification on how historical and recent geotechnical studies have been utilized to describe baseline conditions and to support the impact assessments. In particular, provide details on the location of available information (including its adequacy) and areas where information is lacking and plans to fill these gaps.

Developer Response: 131.1

To assess baseline conditions, in 2009 the initial field reconnaissance team used reports prepared by Public Works Canada (PWC) for the proposed highway and preliminary engineering work undertaken on the route in 1975-1977, which became known as the "1977 PWC Surveyed Route" (PWC 1975, 1976, 1977, 1981). The reconnaissance team also relied on surficial geology maps of the subject area described by Rampton (1988, 1987, 1981). Additionally, the field team contacted R. Gowan of Indian and Northern Affairs (INAC) to access the granular material resource inventory database INAC has compiled (http://caldatageol.com/INAC/MV_Map2011.htm), and resourcing personal knowledge gained from the Mackenzie Gas Project between 2003 and 2007. These resources were appropriate for the intent and scope of the field reconnaissance program undertaken from September 15 to 17, 2009 along the corridor of the proposed Inuvik to Tuktoyaktuk Highway for the preparation of the PDR and subsequently for the EIS.

The project team has copies of all of the above references and other engineering reports and studies that have been prepared and undertaken in the vicinity of the proposed project over the last 40 years. Many of these records are also available at The Arctic Science and Technology Information System (ASTIS) database that contains records describing publications and research projects throughout northern Canada.

The borrow areas identified by PWC 1977 and PWC 1981 were the best available known potential sources of borrow material in the area within proximity of the alignment and sources that they had investigated as acceptable to them at the time for construction of a highway. Thirty years later, these sources have not been further investigated and therefore, based on the PWC assessments, were considered to still be acceptable, with the exception of a few potential borrow sources located in close proximity to the Husky Lakes, which will not be considered for use in construction of the Highway. Over these years, other regional investigations have been completed in the surrounding areas, with the intent of documenting these sources for use by governments, industry and local communities and land claims organizations, but these material sources remain largely unproven.

The recent terrain evaluation was completed by KAVIK-STANTEC in 2012 (KAVIK-STANTEC 2012), and geotechnical investigations are presently being undertaken (March-April 2012) at seven potential borrow sources being considered for use during construction. These investigations will help to delineate and characterize the type and quantity of aggregate material available at these locations. A ground temperature cable will be installed at borrow source 312, for the purpose of

collecting project specific ground temperature data. The work completed this winter, once synthesized, will be used to evaluate where any additional data gaps may exist and identify plans to collect additional information and/or address the data gaps in future programs.

The field reconnaissance in 2009 used the following references and personal communications:

Department of Public Works, Western Region, 1975. Mackenzie Highway, NWT. Mile 970.95 to 1060.6 Inuvik to Tuktoyaktuk alignment review. ASTIS Record 35304.

Department of Public Works, Western Region, 1976. Report on geotechnical investigation, mile 970 (Inuvik) to mile 1059 (Tuktoyaktuk), Mackenzie Highway. ASTIS Record 35303.

Department of Public Works, Western Region, 1977. Supplemental report: geotechnical investigations, mile 970 (Inuvik) to mile 1059 (Tuktoyaktuk), Mackenzie Highway. ASTIS Record 55207.

Department of Public Works, Western Region, 1981b. Materials availability and construction alternatives, Inuvik-Tuktoyaktuk Highway / submitted by: R.D. Cook.

Department of Public Works, Western Region, 1981a. Report: geotechnical investigations, mile 970 (km 0) to mile 1059 (km 143), Mackenzie Highway: combined data – 1976 to 1980. ASTIS Record 55108.

Rampton, V.N. 1981. Surficial Geology, Mackenzie Delta, District of Mackenzie. Geological Survey of Canada, Preliminary Map 32-1979 1:250,000 scale.

Rampton, V.N., 1987. Surficial Geology, Tuktoyaktuk Coastlands, Northwest Territories; Geological Survey of Canada, Map 1647A, scale 1:500,000.

Rampton, V.N. 1988. Quaternary Geology of the Tuktoyaktuk Coastlands, Northwest Territories, Geological Survey of Canada Memoir 423, 98 p.

Bob Gowan, 2009. Personal Communication. Mackenzie Valley Granular Resource Database. (http://caldatageol.com/INAC/MV_Map2011.htm).

IR Number: 132

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Ground thermal conditions in the project area**
(TOR 9.1, App. A; Reference: EIS section 2.4, 2.6, 3.1)

Preamble

Information on ground thermal conditions is required for adequate design of the highway, assessment of impacts associated with the highway and granular resource extraction and also for determining the effects of climate change on the project. Some general information has been provided in the EIS (section 3.1) on regional ground temperature conditions (extracted from Burn and Kokelj 2009). There is, however, no information provided on any site specific information that may have been utilized to describe baseline conditions and the assessment of impacts. NRCan notes that there has been recent information on ground thermal conditions published which is relevant to the study area including Smith et al. (2005, 2010a,b); Ednie et al., (2011); Wolfe et al. (2010) and Stevens et al. (2011). Information is also available in the vicinity of lakes and stream crossings which is particularly relevant for delineation of taliks and design of stream crossings (eg. Kokelj et al. 2009; Wolfe et. al. 2010; Stevens et al. 2011). Additional information on active layer conditions since the 1990s can also be found in Smith et al. (2009). It is not clear whether these and other sources of information have been utilized to describe the spatial variation in ground temperature and for characterizing ground thermal conditions of representative terrain types. It is also not clear whether the Proponent has collected any site specific information to characterize ground thermal conditions and support the impact assessment and project design. Clarification is therefore required regarding how existing and recently collected ground temperature information has been utilized to support the project design and impact assessment. NRCan did not see an assessment of where information is lacking and a description of further studies that are still required.

References

Ednie, M., Chartrand, J., and Smith, S.L. 2011. Report on 2010 Field Activities and Collection of Ground Thermal and Active Layer Data in the Mackenzie Corridor Completed Under N.W.T. Science Licence #14686, Geological Survey of Canada Open File 6932.

littp://geoscan.ess.nrcan.geea/egi-bin/starfinder/O?path=geoscan.fl&id=fastlink&pass=&format=FLSHORTORG&search= R=288924

Kokelj, S.V,, Lantz, T.C., Kanigan, J., Smith, S.L., and Coutts, R. 2009. Origin and polycyclic behaviour of tundra thaw slumps, Mackenzie Delta region, Northwest Territories, Canada. Permafrost and Periglacial Processes, 20(2): 173-184.

Smith, S.L., Romanovsky, V.R., Lewkowicz, A.G., Burn, C.R., Allard, M., Clow, G.D., Yoshikawa, K., and Throop, J. 2010. Thermal state of permafrost in North America - A contribution to the International Polar Year. Permafrost and Periglacial Processes, 21: 117-135.

Smith, S.L., Throop, J., Ednie, M., Chartrand, J., Riseborough, D., and Nixon, F.M. 2010. Report on 2009 field activities and ground thermal data collection in the Mackenzie corridor completed under NWT Science Licence 04582, Geological Survey of Canada Open File 6695. http://geosearLess.nrean.gc.ea/cgi¬bin/starfinder/O?path—geoscan.fl&id=fastlink&pass=&forrnat=FLSHORTORG&search R----287166

Smith, S.L., Riseborough, D,W., Nixon, F.M., Chartrand, J., Duchesne, C., and Ednie, M. 2009. Data for Geological Survey of Canada active layer monitoring sites in the Mackenzie valley, N.W.T., Geological Survey of Canada Open File 6287. http://geopub.nrcan.ge.ca/moreinfo_e.php?id-248197

Smith, S.L., Burgess, M.M., Riseborough, D., and Nixon, F.M. 2005. Recent trends from Canadian permafrost thermal monitoring network sites. Permafrost and Periglacial Processes 16: 19-30.

Stevens, C.W., Palmer, M., Wolfe, S.A., Kokelj, S.V., and Smith, S.L. 2011. Permafrost and Environmental Conditions at Stream Crossing Sites along the Northern Mackenzie Pipeline Corridor, Northwest Territories, Geological Survey of Canada Open File 6976. http://geoscan.ess.nrean.ge.ca/cgi binistarfinder/O?path=geoscan.fl&id=fastlink&pass=&format=FLSHORTORG&search-- It

Wolfe, S.A., Smith, S.L., Chartrand, J., Kokelj, S.V., Palmer, M., and Stevens, C. 2010. Geotechnical database and descriptions of permafrost monitoring sites established 2006¬10 in the northern Mackenzie Corridor, Geological Survey of Canada Open File 6677.http://geoscan.ess.nrcan.gc.ca/cgi bin/starfinder/O?path—geoscan. Mid= fas tli nk&pass=84.fortnat—FLSHORTORG&search-R=287167

Request

1. Please provide clarification on the existing site-specific ground thermal information either collected by others or the Proponent utilized in the description of baseline conditions and how this information has been utilized to support project design and impact assessment.
2. In addition, please provide an assessment of where information is lacking and a description of further studies to be conducted to address these gaps.

Developer Response: 132.1

Near-surface ground temperature data from the 1960s to 1970s and 2003 to 2007 from Burn and Kokelj (2009) were discussed in the EIS in Section 3.1.1.4 and shown on Figures 3.1.1-2 and 3.1.1-3.

Additional review of the existing literature and site-specific geothermal investigations are planned to be undertaken in advance of the detailed design stage. The resulting information and analyses will be used in the detailed design stage to refine the alignment as appropriate and to confirm the Highway cross sections for the different types of terrain to be traversed by the Highway.

In general, the minimum embankment heights used in the preliminary design are reflective of the anticipated ground temperature and terrain compositions anticipated for specific locations along the proposed Highway alignment t, with thicker embankments and revised side- slopes proposed for areas of greater concern related primarily to thaw stability.

As noted in Developer Response 137; "*The placement of a thick layer of frozen granular material directly on this frozen existing ground will have the effect of protecting the existing ground, under the roadbed, from exposure to temperatures above freezing, when the weather warms in the spring and summer.*

Thus, the line between permafrost and active zone will be moved into the road embankment due to the construction."

The effect of the greater depth of fill noted will be to provide greater insulation using frozen non frost susceptible material between the warmth of the upper portion of the active zone in the embankment, and the frozen native ground.

Developer Response: 132.2

It is anticipated that the geotechnical investigation along the Highway alignment that will be undertaken to support the detailed design stage will include installation of ground temperature cables at selected locations. Furthermore, it is anticipated that drill core information will be collected to assist in determining transitions in ground types at critical areas.

Two-dimensional thermal analysis of the embankment on the permafrost foundation will be used as a primary design tool for establishing appropriate cross sections in areas with differing ground conditions.

IR Number: 133

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Thermal analysis to support design and impact assessment**
(TOR 9.1, 10.1, 10.4, App A; Reference: EIS section 2.4, 2.6, 3.1, 4.0, 4.5)

Preamble

Thermal analyses are often conducted to determine the effects on the ground thermal regime, including changes in thaw depth (and associated ground movements) resulting from project activities such as road construction. These analyses can be utilized to support project design such as embankment height and also to determine effects of climate change on the project. The Proponent indicates that a risk-based approach has been utilized to support project design including incorporation of climate change effects (section 2.6, 4.5.1). This approach originally proposed by Environment Canada (1998) and summarized in TAC (2010) and CSA (2010) indicates that roads constructed in permafrost regions are moderately sensitive to climate change and moderate consequences are associated with failure. This classification suggests that a semi-quantitative analysis is required and NRCan suggests that thermal analysis for representative terrain types in the project area could be useful. It is not clear, however, whether any such analysis has been conducted. Although the EIS includes information on embankment heights that will be used for various terrain conditions (section 2.6.4), it is not clear how these values were determined or how climate change may have been incorporated. Disturbance to the ground surface during site preparation (disturbance to vegetation, grading, etc.) and construction can cause changes in the ground thermal regime resulting in increased thaw depth, thaw settlement and changes to drainage (e.g. Smith et al. 2008; Burgess and Smith 2003; Kokelj et al. 2009). These effects can be exacerbated by climate warming (eg. Smith and Riseborough 2010). Recent research has indicated that permafrost is warming in the region at rates of 0.5 to 1° per decade (Burn and Kokelj 2009; Smith et al., 2005, 2010) and project design needs to consider this as well as the impacts of the project on the ground thermal regime.

References

Burgess, M.M., and Smith, S.L. 2003. 17 years of thaw penetration and surface settlement observations in permafrost terrain along the Norman Wells pipeline, Northwest Territories, Canada. In Proceedings of 8th International Conference on Permafrost. Edited by M. Phillips, S.M. Springman, and L.U. Arenson. Zurich Switzerland. July 2003. A.A. Balkerna, pp. 107-112,

Burn, C.R., and Kokelj, S.V. 2009. The environment and permafrost of the Mackenzie Delta area. Permafrost and Periglacial Processes, 20(2): 83-105.

Canadian Standards Association 2010. Technical Guide - Infrastructure in permafrost: a guideline for climate change adaptation, Report Plus 4011-10.

Environment Canada 1998. Climate Change Impacts on Permafrost Engineering Design, Environment Canada Environmental Adaptation Research Group.

Kokelj, S.V., Lantz, T.C., Kanigan, J., Smith, S.L., and Coults, R. 2009. Origin and polycyclic behaviour of tundra thaw slumps, Mackenzie Delta region, Northwest Territories, Canada. Permafrost and Periglacial Processes, 20(2): 173-184,

Smith, S.L., Burgess, M.M., Riseborough, D. and Chartrand, J. 2008. Permafrost and terrain research and monitoring sites of the Norman Wells to Zama pipeline Thermal data collection and case histories, April 1985 to September 2001. GSC Open File 5331. http://geopub.nrcan.gc.ca/moreinfo e.php?id=224831

Smith, S.L., and Riseborough, D.W. 2010. Modelling the thermal response of permafrost terrain to right-of-way disturbance and climate warming. Cold Regions Science and Technology, 60: 92-103.

Smith, S.L., Burgess, M.M., Riseborough, D., and Nixon, F.M. 2005. Recent trends from Canadian permafrost thermal monitoring network sites. Permafrost and Periglacial Processes 16: 19-30.

Smith, S.L., Romanovsky, V.E., Lewkowicz, A.G., Burn, C.R., Allard, M., Clow, G.D., Yoshikawa, K., and Throop, J. 2010. Thermal state of permafrost in North America - A contribution to the International Polar Year. Permafrost and Periglacial Processes, 21: 117-135.

Transportation Association of Canada (TAC). 2010. Guidelines for development and management of transportation infrastructure in permafrost regions. May 2010. TAC. Ottawa, ON.

Request

1. Please provide information on the analysis conducted to determine the impacts of the project on the ground thermal regime and to support the project design including determination of embankment height. Please also provide information of how climate change has been incorporated into the analysis to support project design and the impact assessment.

Developer Response: 133.1

a) Please see Developer Response 94.1/2.

b) Please see Developer Response 96.1 and Section 4.5.1 of the EIS.

IR Number: 134

Source: **Natural Resources Canada**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

Subject: **Design values utilized for stream crossing design**
(TOR 6.2, 9,1, 10.4, App. A; Reference: EIS 2.6.6, 3.1, 4.5)

Preamble

Design of stream crossings requires information on expected water levels and flows, including those that may result from extreme events. The Terms of Reference requires that the description of baseline environmental conditions include climate related extreme events that may affect the project, stream flow and flood regimes (TOR App. A). This information is required to support project design and also to determine potential impacts of the environment on the project. In addition, this information is required to determine the impacts of the project on the environment and the potential for erosion. The EIS provides some information on climate variability and extreme precipitation events (section 3.1.2). The EIS (section 3.1.6) also provides some information on water flows. However, NRCan was unable to locate information regarding the variability in stream flow or how extreme events have been incorporated into stream crossing design. In addition, NRCan was unable to locate information regarding potential changes in stream flow under a changing climate or how this will be considered in project design.

Request

1. Please provide information on the design values (streamflow and rainfall) utilized for design of stream crossings. NRCan further requests information on how extreme weather or hydrologic events were incorporated into the design.

Developer Response: 134.1

Detailed design of the stream crossings has not yet been undertaken.

Identification of crossing location is based on field observations and topographic data utilized in the preliminary design of the horizontal and vertical alignment, (ground conditions, evidence of erosion, roadway grade, width of crossing). Establishment of stream crossing structure type (e.g., small diameter culvert, large diameter culvert, or bridge) is based on whether or not the stream was considered to be fish habitat.

In the 2009 field program, a number of streams were assumed to be fish habitat or having the potential to be fish habitat. Confirmation in regards to fish habitat was undertaken in 2010 and 2011 with more investigative aquatic and fish habitat studies at the crossings (Kiggiak-EBA 2010 and IMG-Golder 2012).

Structure span length was estimated using the field observations and topographic data noted above, the observed evidence of high water limits and floodplains, and the limited geotechnical information that is available for the area.

The next phases of field investigation and data collection at the individual stream crossing locations (larger streams) will be needed to support detailed design of the specific crossing structures. This includes (but is not limited to):

- Detailed topographic survey;
- Geotechnical investigation; and
- Hydrology and hydraulics studies (stream flow, water levels, precipitation and flood analyses).

References:

Kiggiak-EBA Consulting Ltd. 2010. Spring 2010 Aquatic Field Program Results for the Inuvik To Tuktoyaktuk Highway, Northwest Territories. Hamlet of Tuktoyaktuk, Town of Inuvik, Government of the Northwest Territories.

IMG-Golder Corporation. 2012. Fish Habitat Assessment at select Watercourse Crossings along the Inuvik to Tuktoyaktuk Highway. Department of Transportation, Government of the Northwest Territories.

IR Number: 135

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Surficial geology**
(TOR Sections 6, 9 and Appendix A; EIS Sections 2, 3.1.1)

Preamble

The Proponent identifies that the most recent surficial geology mapping in the study area, and the one upon which almost all further surficial geological terrain characterization is based on, is that produced by Rampton (1979, 1987). Further, the Proponent indicates that "*the potential for geotechnical challenges is based on the limited terrain assessment*" (p51; 2.2.5 Technical Factor), and that embankment thicknesses are prescribed according to Terrain and associated sediment type (p69; Table 2.6.4-1; elsewhere through document), the determination of which seems to principally reflect Rampton's (1987) surficial geology map.

NRCan notes that the scale of Rampton's (1987) surficial geology map is very small (depicting a large area; 1:500 000), and should only be considered a reconnaissance assessment of the terrain and its surficial geology. Typical GSC maps are at a much larger scale (1:250 000; 1:100 000; 1:50 000), while detailed terrain assessments for development proposals are typically conducted at even larger scales (e.g., 1:20 000 or even 1:5 000). Even comparing the information on Rampton (1979; a 1:250 000 scale map), to Rampton (1987; a 1:500 000 scale map), it can be recognized that there has been a great deal of generalization produced as part of the 1:500 000 compilation. Field terrain assessments reported in the EIS appear to have been focusing on issues of topography, and identification of ice-rich and other sensitive terrain, rather than testing of basic surficial geology classification. NRCan further indicates that the seismic shothole drillers' log data of Cote et al, (2003), Smith and Lesk-Winfield (2010a), and Smith (2011) could be used to evaluate the accuracy of Rampton's (1987) map units, and to further characterize the sedimentology and ice-bearing tendencies of different materials; no such indication of their utilization is indicated in the EIS.

References

Cote, M.M., Wright, J.F, Duchesne, C. and Dallimore, S.R. 2003, Surficial materials and ground ice information from seismic shotholes in the Mackenzie Beaufort region, Yukon and Northwest Territories: digital compilation. Geological Survey of Canada, Open File 4490. 1 CD-ROM.

Rampton, V.N. 1987. Surficial Geology, Tuktoyaktuk Coastlands, Northwest Territories. Geological Survey of Canada, Map 1647A, scale 1:500,000

Rampton, V.N. 1979. Surficial Geology Mackenzie Delta, District of Mackenzie, Northwest Territories. Geological Survey of Canada, Map 32-1979, scale 1:250,000.

Smith, I.R. 2011. The seismic shothole drillers' log database and GIS for Northwest Territories and northern Yukon: an archive of near-surface lithostratigraphic surficial and bedrock geology data. Geological Survey of Canada, Open File 6833, 1 DVD-ROM.

Smith, I.R. and Lesk-Winfield, K. 2010a. A revised lithostratigraphic database of baseline geoscience information derived from seismic shothole drillers' logs, Northwest Territories and northern Yukon. Geological Survey of Canada, Open File 6049, 1 DVD¬ROM.

Request

1. Please provide information to what degree ground surveys and additional mapping have been used to test the interpretations and representations of Rampton (1979, 1987), as so much of the terrain analysis and proposed embankment thickness is based off of these classifications.

Developer Response: 135.1

A report entitled *Inuvik to Tuktoyaktuk Highway – Baseline Data Acquisition Program: Terrain Evaluation* (Terrain Report) was submitted to the EIRB March 2012, accompanied by a mapbook entitled *Surficial Geology and Terrain Constraints – Inuvik to Tuktoyaktuk Highway*. The Terrain Report and mapbook present the results of detailed mapping of surficial geology, geologic processes, drainage features and permafrost features, within a 1 km corridor centered on Alignments 1 and 3 at a scale of 1:10,000. The mapping is based on the classifications of Rampton (1979, 1987), but is more detailed, reflecting the larger scale.

The mapping was undertaken by viewing 1:30,000 stereo digital colour photographs from 2004 and 2005 using STANTEC's High Definition Mapping and Applications System (HD-MAPP) which incorporates PurVIEW and ArcGIS applications. Using HD-MAPP, mapping was completed at a scale of 1:2,500 to 1:7,500 and finally represented at 1:10,000 for the purpose of the map book. Further review of LiDAR imagery (2010, now available) will confirm areas of active geoprocesses, steep slopes and areas of sensitive terrain requiring further consideration during the detailed design phase.

Initial field reconnaissance of the proposed alignment was undertaken in fall 2009, and limited field reconnaissance of proposed borrow sources was undertaken in fall 2010, although the program was limited by poor weather conditions. Targeted field investigations, including subsurface geotechnical investigations will be conducted at selected locations to support the detailed design phase in order to confirm terrain and subsurface conditions and to further delineate transition zones between more and less sensitive terrain types.

IR Number: 136

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Massive ice**
(TOR Sections 6, 9 and Appendix A; EIS Sections 2, 3.1.1, 4.2.1)

Preamble

The Proponent identifies that massive ice layers exist within the development area, and are common at depths, particularly within certain sediment types [3.0 Existing Environment; 3.1.1 Terrain, Geology, Soils and Permafrost; elsewhere in the EIS]. High and low-centered polygons as being particular ice-rich terrain which is preferentially avoided in the routing of the highway are also discussed [2.6.4 Design Embankment; and elsewhere through document].

NRCan notes that the connection between the presence of massive ice and the existence of surface ice-wedge polygon networks is not an absolute. While many areas of massive ice do support surface high and low-centered ice-wedge polygons, they also support less distinct polygonal networks, and indeed can exist independently of surface polygonal ground. Massive ice poses a permafrost hazard in the development area.

References

Chartrand, J., Lysyshyn, K., Couture, R., Robinson, S., and Burgess, M. 2002. Digital Geotechnical Borehole Databases and Viewers for Norman Wells and Tuktoyaktuk, Northwest Territory, Geological Survey of Canada Open File 3912. http://geopub.nrean.ge. ea /morei nfoe.php?i d=2138188c_h=chartrand

Cote, M.M., Wright, J.F., Duchesne, C, and Dallimore, S.R. 2003. Surficial materials and ground ice information from seismic shotholes in the Mackenzie — Beaufort region, Yukon and Northwest Territories: digital compilation. Geological Survey of Canada, Open File 4490, 1 CD-ROM.

Gowan, R.J. and Dallimore, S.R. 1990. Ground ice associated with granular deposits in the Tuktoyaktuk Coastlands area, N.W.T. Proceedings of the 511' Canadian Permafrost Conference, Collection Nordicana, no. 54, 1990: 283-290.

Mackay, J.R. and Dallimore, S.R. 1992. Massive ice of the Tuktoyaktuk area, western Arctic coast, Canada. Canadian Journal of Earth Sciences, 29: 1235-1249.

Smith, S.L., Burgess, M.M., Chartrand, J., and Lawrence, D.E. 2005, Digital borehole geotechnical database for the Mackenzie Valley/Delta region, Geological Survey of Canada Open File 4924. http://geopub.nrcan.ge.ca/moreinfo_e.plip?id=220383

Smith, I.R. and Lesk-Winfield, K. 2010b. Massive ground ice occurrences, and permafrost geology-related observations from seismic shothole drillers' log records, Northwest Territories and northern Yukon. Geological Survey of Canada, Open File 6472, 1 DVD-ROM

Request

1. Please provide information on the actual presence, developmental significance, and degree of hazard posed by massive ice within the proposed development area.
2. Please indicate which techniques are being used as part of the engineering site assessments to determine ice-content of materials (e.g., ground penetrating radar; resistivity mapping, drilling).
3. Please provide what information sources have been examined in order to identify the presence of massive ice deposits and the potential sedimentological associations with different surficial geology units and ice content.
4. Please clarify if the following existing research and data sets were used: Chartrand et al (2002); Gowan and Dallimore, 1990; Mackay and Dallimore 1992; Cote et al. 2003; Smith et al (2005); Smith and Lesk-Winfield, 2010b.

Developer Response: 136.1

The occurrence of massive ice has been documented in the region and it is recognized that tabular bodies of ground ice usually referred to as massive ice do exist in the region, and there is a high probability such features will underlie the Highway embankment in some locations.

Massive ice is of different genesis than ice wedge polygons, thus polygonal ground is not a surface indicator of the presence of massive ice. The presence of thaw-flow slides at the margin of thermokarst lakes is an indicator of massive ground ice. Massive ice at depth is not anticipated to be a hazard to embankment performance. Where thaw-flow slides are prevalent and massive ice is exposed, route location will be adjusted to avoid those locations.

Developer Response: 136.2

Massive ice may be encountered in geotechnical boreholes planned along the route. At locations where it is considered close enough to the ground surface to constitute a hazard, additional boreholes or geophysical surveys may delineate it. Further delineation may be required if the occurrence of massive ice seems to be widespread or might affect the proposed Highway. At these locations, Ground Penetrating Radar (GPR) will be used. A geophysical team with in-depth experience in delineating ground ice in permafrost will be used to supplement the drilling and sampling program.

Developer Response: 136.3

Available published surficial geology mapping (Rampton) has been used to characterize the soil, permafrost distribution and ground ice within the region. In addition, the Project Team's internal library, including extensive site-specific work at Inuvik, Parsons Lake and Tuktoyaktuk, have been consulted.

Developer Response: 136.4

EBA has been a major contributor to the granular material database assembled by INAC under the direction of R. Gowan, including an extensive supply-demand study for the Hamlet of Tuktoyaktuk. These data were available for planning purposes.

The following comments are provided regarding the quoted references:

Chartrand et al. (2002)

The report presents geotechnical databases for two communities in the Mackenzie valley, Norman Wells and Tuktoyaktuk. This dataset is mostly outside the Project area (only the data in the immediate vicinity of the community of Tuktoyaktuk are applicable). The dataset has not been used to date.

Gowan and Dallimore (1990)

Bodies of massive ground ice are commonly associated with deposits of granular materials in the Mackenzie Delta. The paper summarizes data on ground ice occurrences in granular deposits of glaciofluvial origin from geotechnical borehole data collected from previous investigations of potential granular resource deposits in the region. The paper suggests that a significant proportion of the ice bodies appear to occur within granular sediments. This may be observed during the geotechnical investigations program currently being undertaken at the seven potential borrow sources in March-April 2012.

Mackay and Dallimore (1992)

The paper describes the extensive coastal exposure of massive underground ice at Peninsula Point, southwest of Tuktoyaktuk. The paper suggests that the massive ice could be intrasedimental ice that grew beneath a frozen diamicton during the downward aggradation of permafrost, and that the water source was probably glacier meltwater, that flowed, under a substantial pressure, through permeable unfrozen sands. This study was not used for the EIS.

Cote et al. (2003)

All data points are shown on a series of 4 maps (Cote_2003_Maps.pdf) and the data are contained in excel (Cote_2003_database.xlsx) on 4 separate tabs. The file entitled *Shothole Documentation.pdf* contains documentation and descriptions about the data. Sediment characteristics were interpreted visually during the drilling process. Shotholes were judged to accurately represent the general spatial distribution of massive ice and icy sediments in the region. However, there are several cautionary notes:

a) Positional accuracy of each shothole is low because the data were collected prior to the advent of Global Positioning Systems (GPS). Data were hand-recorded on 1:50,000 scale paper base maps, which implies a level of human error as well as error associated with map distortion and degradation over time.
b) The digital base map provided in this Open File is at a scale of 1:2,000,000, which is adequate for display purposes only. The user should obtain base maps at a larger scale for spatial analysis. Most of the shothole locations are not in the vicinity of the Highway. Some shothole data points might be relevant, but have not been used for the preparation of the PDR and EIS to date.
c) It can be difficult to discriminate between sediments dominated by silts and those dominated by clays on the basis of field observations, one should be cautious in drawing conclusions relying on a distinction between these two classes.

Smith et al. (2005)

Open File 4924 presents a digital borehole geotechnical database for the Mackenzie Valley/Delta region. The database is a compilation of available geological and geotechnical data for over 13,000 boreholes that extend from the arctic coast to northwestern Alberta. Much of the data were collected during the 1970s as part of environmental assessment and geotechnical investigations related to proposed routes for the Mackenzie Highway and oil and gas pipelines. EBA's baseline data assessment used referred and resourced data from the PWGSC 1970 to 1975 reports, which form a large part of the database, and in large part is the only data relevant to the proposed highway project. Parts of this dataset is presented in the INAC Granular Material Inventory database.

Smith and Lesk-Winfield (2010b.)

This publication utilizes seismic shothole drillers' litholog records to document ground ice and massive ice thickness and extents in the Northwest Territories and northern Yukon. It also provides estimates of permafrost thickness in areas of thin extensive and sporadic discontinuous permafrost, identification of unfrozen sediments (existing and relic taliks) at depth in areas of thick permafrost cover, and depths of surface thaw in offshore Mackenzie Delta sediments. Limitations in the seismic shothole drillers' log data are clearly recognized in their application and to date have not been used in preparation of the PDR and EIS for the Highway. The information interpreted from the drillers' log records, if applicable, will perhaps best serve as a guide, by identifying key areas of interest and/or anomalous conditions that can be studied in follow-up field programs.

Wolfe et al. (2010)

The Geological Survey of Canada, Natural Resources Canada, and Indian and Northern Affairs Canada conducted a field program between 2006 and 2010 to address gaps in baseline environmental information in the northern Mackenzie Corridor. Ground thermal data were collected from seven sites along a proposed hydrocarbon development corridor between Inuvik and the Niglingtak anchor field. In addition, soil samples were collected at six new field sites for laboratory testing. Geotechnical and geochemical information, together with near-surface and ground temperature data from these sites, has been compiled and a relational database presented.

Two sites (T2 and T4) are located in proximity of the proposed Highway. Soil samples were collected to depths of 2.8 m at Site T2 and 2.5 m at Site T4. Fine-grained morainal soils were encountered at both sites, which is the most frequent terrain unit, and is consistent with mapping conducted by Rampton. Boreholes were advanced at the two sites in the later part of August 2008.

Active layers of approximately 0.9 m were identified, which is characteristic of the terrain and time of year. A 0 to 5 cm organic cover was noted and both sites supported a vegetative canopy with Dwarf birch tundra with willow and alder shrubs. Sites T5 to T7 digressed further from the proposed Highway and are located on upland terrain and deltaic terrain, which differ from the terrain the proposed Highway would cross. The fine-grained till soils contain visible ground ice in variable quantities and formations, typical of the region. Ground temperature data were collected at Site T4.

Reference:

Wolfe, S.A., S.L. Smith, J. Chartrand, S. Kokelj, M. Palmer, C. Stevens. 2010. OPEN FILE 6677. Geotechnical Database and Descriptions of Permafrost Monitoring Sites Established 2006-10 in the Northern Mackenzie Corridor, Northwest Territories.

IR Number: 137

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Frozen Ground**
(TOR Sections 6, 9 and Appendix A; EIS Sections 1.2,2, 3.1.1, 4.2.1)

Preamble

In Section 1.2 Development Overview, p6 (and elsewhere through the EIS), it is indicated that "Placement of frozen borrow material directly onto frozen ground (with geotextile separation layer);" is to take place.

NRCan notes that seasonal freeze-back of the active layer can be quite variable, reflecting various characteristics, including sedimentology, moisture content, snow and vegetation cover, etc. Freezing also progresses from both top-down, and bottom-up; however, the last material to completely refreeze occurs at depth.

Request

1. Please provide information on the method that will be used to determine that the active layer has completely refrozen prior to initiation of deposition of borrow material onto the ground surface.

Developer Response: 137.1

The proposed construction approach is to place frozen material, in winter, on the existing ground that has been cleared of snow, as illustrated in Photo 4.

Clearing the ground of snow promotes freezing of the existing ground surface prior to the placement of the fill material, which is itself frozen when placed. Thus, when fill is placed on the geotextile, which is rolled out directly over the existing ground surface, the ground is frozen as cold or colder as it would ever be under snow cover.

The frozen granular fill will only be placed directly on geotextile on the permafrost after the permafrost has frozen back. Normally one would wait several weeks until after there have been continuous freezing temperatures, so the earliest hauling would likely start in mid to late November. The site engineer and Project superintendent would verify the presence of frozen ground prior to placement of embankment fill.

The placement of a thick layer of frozen granular material directly on this frozen existing ground will have the effect of protecting the existing ground, under the roadbed, from exposure to temperatures above freezing, when the weather warms in the spring and summer.

In addition, snow from the forward working surface of gravel-fill operations is removed several days ahead to allow the surface to properly freeze-up, and to allow construction of the working ice road parallel to the highway under construction (see Photo 4). The construction operation involves laying approximately one metre thick embankment to allow packing without any damage to the subgrade, and the next layer comes several weeks after. This time gap enhances further removal of heat from the original ground and the new fill. The entire new portion of fill road is kept free of snow during

the entire winter, which is normally sufficient to permit the original ground surface, the active layer below and the new fill to freeze solidly as per design specifications.

Thus, the boundary between the permafrost and the frozen active zone will migrate into the road embankment as a result of employing this construction approach. Other than the extreme outer toe of the embankment, the seasonal active zone in future years is expected to remain fully frozen within the embankment itself. As the embankment will be constructed of generally non-ice rich material, its thaw stability will mitigate or eliminate movement of the roadbed in future years.

Photo 4: Typical winter construction approach showing frozen fill being placed over geotextile positioned on frozen ground cleared of snow

IR Number: 138

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Snow Drifting/ Accumulation**
(TOR Sections 6, 9 and Appendix A; EIS Sections 2, 3.1.1, 4.2.1 and 4.5.1)

Preamble

Snow is a critical component of permafrost dynamics, and often controls the degree to which ground surfaces are insulated from extreme cold-temperatures, contributing to the thermal regulation of ground temperatures. Difference in vegetation cover relating to success at capturing snow can strongly influence permafrost temperatures, in turn, making them more or less susceptible to climate changes and summer active layer thaw (cf., Kokelj et al. 2007; Burn and Kokelj, 2009). In addition to vegetation-induced changes to snow-capture, construction of embankments, building structures, and plowing/ snow removal practices can all contribute to enhanced snow drifting/accumulation and result in thermal alteration of permafrost (Goodrich 1982; Fortier et al., 2011). Enhanced meltwater production from snow accumulations can also affect surface erosion and permafrost stability.

Snow accumulations and handling practices are discussed on p468; 4.2.1.2 Potential Effects Due to the Physical Presence and Operations of the Highway, and p623; 4,5.1 Climate Change, and it is acknowledged by the Proponent that snowdrift accumulations along the highway embankment have the potential to affect air/surface temperature regimes beyond the toe slope.

While snowdrift accumulation along the highway embankment is acknowledged by the Proponent to become a perennial issue, there is no research conducted or described that indicates the potential magnitude, spatial variability, and issues stemming from increased meltwater production that may arise from this Also, there is no indication that snowdrifting will be considered as part of camp design; nor is it indicated to be considered as part of alignment clearance practices, or eventual winter plowing practices of the established highway.

References

Bum, C.R. and Kokelj, S.V. 2009. The environment and permafrost of the Mackenzie Delta area. Permafrost and Periglacial Processes, 20: 83-105.

Fortier, R., LeBlanc, A-M. and Yu, W, 2011. Impacts of permafrost degradation on a road embankment at Umiujaq in Nunavik. Canadian Geotechnical Journal, 48: 720-740.

Goodrich, L.E. 1982. The influence of snow cover on the ground thermal regime. Canadian Geotechnical Journal, 19: 421-432.

Kokelj, Pisaric, M.F.J. and Bum, C.R. 2007. Cessation of ice-wedge development during 20111 century in spruce forests of eastern Mackenzie Delta, Northwest Territories, Canada. Canadian Journal of Earth Sciences, 44: 1503-1515.

Request

1. Please identify the potential magnitude and impact snowdrifting and seasonal snow clearing accumulations may have on permafrost stability adjacent to the road embankment, and in areas of seasonal construction camp development.
2. Please clarify if snowdrifting is or will be taken into account as part of operational best practices and camp design.
3. Please identify areas where increased snowmelt may lead to accentuated erosion/ponding of meltwater, and provide information on what potential remediation measures/alternate snow handling practices are contemplated.

Developer Response: 138.1

Please see Developer Response 93.1.

Generally, snowdrifting will occur where the road turns and along the sides of embankments that have elevational changes (e.g., up and down hills). Snowdrifting can also accumulate around construction camps. In these areas, it will be important for the contractor to use cat equipment to keep the snowdrifts plowed down and evenly levelled across the surrounding area. As long as any drifts are plowed down, there should not be any excessive water melt or ponding in the spring/summer.

In addition, to reduce heavy snowdrifting in specific locations as necessary, snowtraps can be constructed and maintained 30 metres from windward side of the highway/infrastructure. This substantially reduces the snow reaching the road.

Developer Response: 138.2

Keeping the snowdrifts plowed down will be an important procedure and component of the operating practices associated with camp operations during construction. Dealing effectively with snowdrifting saves extra costs, enhances productivity and reduces high-blade time of the equipment.

Developer Response: 138.3

Operationally, road clearing during the winter months will allow greater freeze back of the embankment itself, enhancing overall embankment stability.

As long as snowdrifts are plowed down regularly and evenly and the areas surrounding "drifting locations" are kept level, there should be no accumulated erosion/ponding of meltwater issues in the spring/summer. Ponding of the melt-water is also kept at minimum by providing 300% culvert installations allowing quick drainage. Winging of the snow is also timely and adequately carried out to avoid possible damage to the highway. Snow banks are kept as low as possible, typically below the top half of the embankment slope to minimize snowdrifting.

To minimize ponding along the roadway during melt, equalization culverts will be placed regularly to allow water to run away from the road edge, and not sit trapped against the embankment.

IR Number: 139

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Thaw Flow Slides**
(TOR Sections 6, 9 and Appendix A; EIS Sections 2, 3.1.1, 4.2.1 and 4.5,1)

Preamble

The Proponent has clearly identified the existence of and significant hazard posed by thaw flow slides within the proposed development area (e.g., p59; 2.4.2.4 Thaw Flow Slides; p624; 4.5,3 Landslides, and elsewhere throughout the EIS). It is also indicated that the proposed Highway routing has been chosen to "...carefully avoiding existing slides and steeper slopes that would be susceptible to failure."

The Proponent identifies the work of Aylsworth et al. (2000, 2001) as identifying the class and types of landslides in the development area. On p112; 3.1.1.4 Permafrost Conditions; Retrogressive Thaw Flow Slides that Figure 3.1.1-4 is indicated that "identifies the distribution of recorded landslides on the Tuktoyaktuk Peninsula and the proposed Highway alignments (Aylsworth et al. 2001); and on p624; 4.5.3 Landslides state that "Figure 3,1.1-4 compares the distribution of recorded landslides on the Tuktoyaktuk Peninsula (Aylsworth et al. 2001) to the proposed route options.

NRCan notes, this figure as drafted is both misleading and incomplete. The figure in Aylsworth et al. (2001) from which Figure 3.1.1-4 has been dratted clearly indicates that the majority of the proposed Highway alignments was outside their "limit of landslide inventory" and therefore falsely portrays an apparent absence of retrogressive thaw flow slides in much of the central Highway alignments. Further, additional records of thaw flow slides have been omitted by the Proponent in their presentation of landslides, including those identified by Mackay (1963; the same publication from which the Proponent has drawn their pingo distribution record from: p59; 2.4.2.5 Pingos), and the detailed mapping of Lantz and Kokelj (2008) in the western and southern sections of the Highway alignment.

Reference

Lantz, T.C. and Kokelj, S.V. 2008. Increase rates of retrogressive thaw slump activity in the Mackenzie Delta region, N.W.T. Canada. Geophysical Research Letters, 35: L06502.

Request

1. Please update Figure 3.1.1-4 to include the work of Mackay (1963) and Lantz and Kokelj (2008) to more accurately portray the distribution and implied relative risk of thaw flow slides within the proposed development area.
2. Clearly outline what the minimum setback distance best practice would be from both active and stabilized thaw flow slides, and on what basis such decisions would be made (e.g., a review of regional scarp headwall retreat rates and historical extents).
3. Provide information on what contingencies will be put in place to address risks posed by thaw flow slides, and how the development of such features that may impact the developing or completed Highway will be dealt with (e.g., burial of headwall scarp to insulate ice-rich materials; stabilization of toe slopes).

4. Clarify where borrow materials would be stockpiled that would be accessible year-round if headwall scarp-burial stabilization would be required.

Developer Response: 139.1

Figure 3.1.1-4 has been updated to include the work of Mackay (1963) and Lantz and Kokelj (2008).

KAVIK-STANTEC also mapped retrogressive thaw slumps as part of the 2012 terrain assessment report.

Developer Response: 139.2

The preliminary design undertaken in 2009/2010 considered and avoided, to the extent possible, field-observed active and stabilized thaw flow slides. Subsequently, the more detailed desktop terrain evaluation conducted by KAVIK-STANTEC (2012) determined that the current Highway alignment does still traverse a number of historic stabilized thaw flow slides. This and other information will be used in the detailed design stage to refine the Highway alignment. In the detailed design, to the extent practical, the Highway design team will apply a minimum setback of 50 m from known active thaw flow slides.

However, at the crossing of Hans Creek it may not be possible to fully avoid potentially active slide areas. Thus for such areas a long-term maintenance plan will need to be developed and employed to monitor and remediate possible movements over the life of the project.

Developer Response: 139.3

In circumstances such as those described in IR response 139.2 above, where a particular potential flow slide condition cannot be completely avoided by the Highway alignment, a site-specific monitoring program may need to be developed to detect possible slope movements. Such a proposed monitoring program would be expected to include ground survey monuments (e.g., imbedded steel survey markers) to allow detection of possible movements over time. The results of such monitoring (expected to be of a long-term nature), will assist in determining future mitigation actions that may need to be taken, such as stabilization of the ground conditions.

Developer Response: 139.4

As previously discussed in Developer Responses 92.2 and 92.3, most stockpiles of aggregate material will be located at the borrow sites to be developed for the Highway. It is anticipated that a number of these borrow sites (e.g. Source 177 and others to be determined) will remain in use after construction for maintenance needs and will have a permanent access from the Highway. However, in some areas, to avoid lengthy haul distances, stockpiles of aggregate or fill material will need to be located adjacent to the Highway (within the right-of-way), for summer Highway construction or Highway maintenance purposes.

It is anticipated that the location of year-round, accessible borrow material stockpiles would be addressed in a contractor's management plan or after construction.

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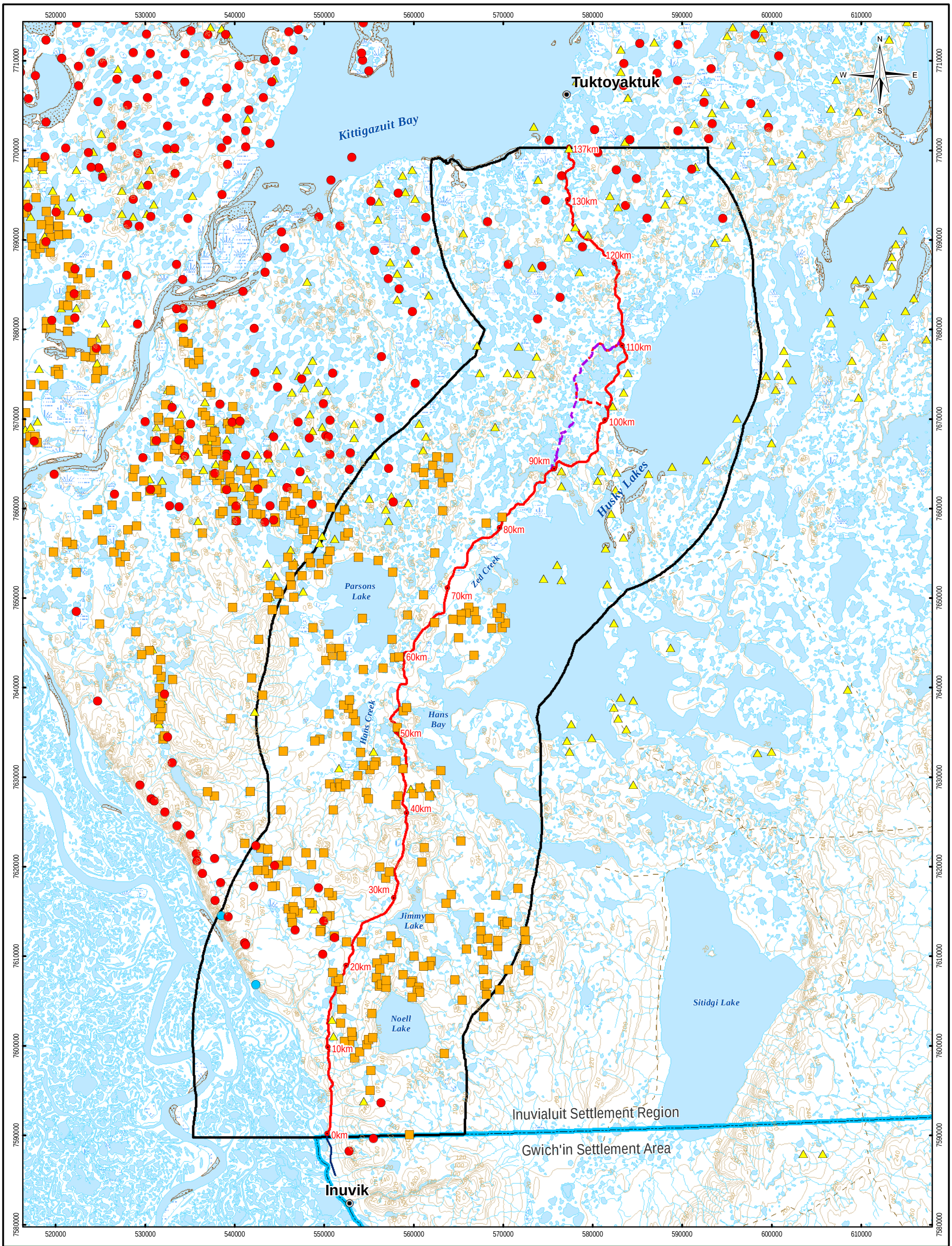


LEGEND

- Thaw Slump[1]
- Ground-ice Slump[2]

Landslide Class[3]

- Flow
- Slide
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- Gwich'in / Inuvialuit Boundary
- Trail
- Contour
- Watercourse
- Waterbody
- Wetland
- Sand

NOTES

1. Thaw Slump data: approximate locations based on Lantz, T.C. and Kokelj, S.V. 2008. Increase rates of retrogressive thaw slump activity in the Mackenzie Delta region, N.W.T. Canada. Geophysical Research Letters, 35: L06502.
2. Ground-ice Slump data: approximate locations based on Mackay, J.R. 1963. The Mackenzie Delta Area, N.W.T. Department of Mines and Technical Surveys, Geographical Branch, Memoir 8.
3. Landslide data: Geological Survey of Canada Open File 3917 (2001)
4. Base data source: NTS 1:250,000

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Distribution of Landslides on the Tuktoyaktuk Peninsula

PROJECTION: UTM Zone 8		DATUM: NAD83	
Scale: 1:400,000 (5 2.5 0 5 10 Kilometres)			
FILE NO.: V23201322_IR2_Map001_Landslides.mxd			
PROJECT NO.: V23201322	DWN: SL	CKD: TS	REV: 1
OFFICE: EBA-VANC	DATE: March 21, 2012		

Figure 3.1.1-4 (updated)

IR Number: 140

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Retrogressive Thaw Slumps - Lake Interactions**
(TOR Sections 6, 9 and Appendix A; EIS Sections 2, 3.1.1, 4.2.1 and 4.5.1)

Preamble

Recent research by Kokelj et al. (2009) has pointed to a dynamic link between thermal changes in slumped sediments, expansion of lake bottom taliks (areas of unfrozen ground), and changes in lake level that can drive polycyclic behaviour in thaw slumps. This research suggests increasing importance needs to be affixed to changes in lake level that may arise from Highway development/maintenance activities.

The Proponent identifies that significant volumes of water withdrawal from nearby lakes will take place for domestic camp use, construction of winter roads, and dust suppression. In Section 4.2.4 Water Quality and Quantity; 4.2.4.1 Potential Effects; Water Extraction (Construction) — p491, the Proponent indicates that "Water withdrawal will be regulated by criteria set out in the Water Licence and the DPO (2010) Protocol for Winter Water Withdrawal in the Northwest Territories... As such, no adverse residual effects arc anticipated from this activity."

NRCan notes that the precautionary and regulatory approach proposed appears chiefly to address issues of fish health and fish habitat. There does not appear to be any consideration for potentially adverse environmental effects of changing lake levels either through water extraction (lowering), or increased channelling of surface water via culverts and other through-draining structures into adjacent lakes (raising). Lowering of lake levels may expose shallow, unvegetated slopes or benches to increased meltwater erosion and wave action, potentially leading to destabilization of toe slopes and reactivation of surrounding thaw slumps. Where increased drainage is diverted to lakes, lake levels may rise, leading to radial expansion of taliks, which as modelled by Kokelj et al, (2009) could lead to thawing of subadjacent ice-rich permafrost and reactivation of thaw slumping.

Reference

Kokelj, S.V., Lantz, T.C., Kanigan, J., Smith, S.L. and Coutts, R. 2009. Origin and polycyclic behaviour of tundra thaw slumps, Mackenzie Delta region, Northwest Territories, Canada. Permafrost and Periglacial Processes, 20: 173-184.

Request

1. Describe the potentially adverse environmental effects resulting from lake level changes brought on by pumping and/or surface flow diversions through the course of this construction and the operation of the proposed Highway.
2. Please explain, with respect to permafrost stability, what criteria may be established to determine the suitability of an individual lake to safely support water withdrawal/ diversion, and what volumetric limits/lake level changes may be implemented as part of best practices.

Developer Response: 140.1

As discussed in the EIS, water withdrawals from certain area lakes, ponds and water bodies are anticipated to be required primarily for the construction of winter access roads for Highway construction and for dust suppression needs during the long-term operation of the Highway.

All water withdrawals from designated lakes or waterbodies along the Inuvik to Tuktoyaktuk Highway will be conducted in conformance with the DFO *Protocol for Winter Water Withdrawal in the Northwest Territories*. This will ensure that possible effects on fish or fish habitats will be minimized and remain within accepted limits.

Surface water flows (overland flows) will be managed through an effective drainage design that includes the installation of appropriately sized cross culverts to divert and effectively manage Highway and surface drainage and to minimize possible ponding of water against the Highway embankment. Follow-up monitoring of the Highway will assist in determining the effectiveness of the culverts that have been installed and the possible need to install additional culverts as necessary to address possible ponding concerns.

Developer Response: 140.2

It is anticipated that conformance with the DFO protocol for winter water withdrawals and the relatively limited amounts of water to be withdrawn from any particular waterbody for dust suppression along the Highway during the summer months will ensure that the permafrost stability of the individual lakes or water bodies will be maintained.

IR Number: 141

Source: **Natural Resources Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Borrow Materials**
(TOR Sections 6, 9 and Appendix A; EIS Sections 2, 3.1.1, 4.2.1 and 4.5.1)

Preamble

Glacigenic sediments of various types, including ice-contact outwash and glaciofluvial sorted material, as well as sub-glacially deposited till (unsorted material) are typically mined from small, shallow borrow pits to construct road embankments and top-dress requirements of angular, sorted gravel, Glacial sediments differ in their distribution, thickness, sedimentological makeup, lithic content, and engineering suitability. Excavation and hauling of borrow materials can often comprise the greatest single cost associated with road construction, particularly in areas where suitable borrow materials are scarce and/or widely dispersed. Identification of new and/or more proximal sources of suitable borrow material have the potential to significantly reduce hauling costs and increase the pace at which construction can proceed.

In Section 2.6.8 Borrow Sources — p75 — the Proponent identifies the range of studies which have focussed on identification of granular materials in both the proposed development area and broader study region. They also indicate that these granular resource assessments have mostly been conducted between the mid-1970s to early 1990s, that it draws heavily on the work reported by Fujino (1993), and that "potential borrow sources have been identified along the Primary 2009 Route based on the granular material studies and investigations that have been undertaken over the years by ILA, INAC, Geological Survey of Canada, and Public Works Canada (3.1.1.3 Borrow Materials —p105), The EIS also identifies the types of material required for construction of the embankment and of the top-dress gravel layer, and distinguishes deposits based on criteria of "proven volume," "probably volume," and "prospective volume" as reflecting the degrees of understanding of existence, sedimentological character, and size.

Recent research by the Geological Survey of Canada has digitally compiled all available/existing seismic shothole drillers' log records from continental Northwest Territories and northern Yukon in database and various thematic geoscience reconstructions. Of direct relevance to the proposed Highway development, an assessment of potential granular aggregate resources (gravel; gravel ÷ sand; sand) has been publicly released (Smith and Lesk-Winfield, 2009; and updated to the final shothole database compilation in Smith et al., 2011). There is no indication that this available data (both preceding and following compilation of this EIS) has been considered as part of the borrow material assessment. Success in using drillers' log records to identify unknown and buried granular aggregate deposits was proven in northeastern British Columbia (Best et al. 2006). It is unknown why such information was not considered by the Proponent in relation to this proposal. The seismic shothole data are also the only regional source of lithostratigraphic information that permits an a priori generalized assessment of sedimentological composition (i,e., relative proportion of gravel, sand, fines), thicknesses, and lateral extents of both specific deposits and the character of different surficial geology units as otherwise represented in the EIS (e,g„ Table 2.3-1 Terrain Conditions Along the Primary 2009 Route — p55; Table 2.6.8-1 Information on Borrow Sources Along the Primary 2009 Route — p79).

NRCan suggests that the seismic shothole drillers' log-based reconstructions of potential granular aggregate deposits (Smith et al., 2011) be integrated into the regional assessment of borrow materials to be utilized for Highway construction and ongoing maintenance. NRCan further notes that in areas of petroleum exploration and access road development in sporadic discontinuous permafrost terrain of northern British Columbia, Alberta and southern Northwest Territories, the clay rich till (informally referred to as "blue clay") is the preferred material for roadbed construction, particularly in wet terrain. Desirable characteristics of this material are its widespread distribution and thickness, its ability to be highly compacted, its structural integrity, and the fact that it is relatively impermeable to water seepage, hence less susceptible to seasonal frost heave.

References

Best, M.E., Levson, V.M., Ferbey, T. and McConnell, D. 2006. Airborne electromagnetic mapping for buried Quaternary sands and gravels in northeast British Columbia, Canada. Journal of Environmental and Engineering Geophysics, v. 11, p.17-26.

Smith, I.R. 2011. The seismic shothole drillers' log database and GIS for Northwest Territories and northern Yukon: an archive of near-surface lithostratigraphic surficial and bedrock geology data. Geological Survey of Canada, Open File 6833, 1 DVD-ROM.

Smith, 1,R. and Lesk-Winfield, K. 2009. An integrated assessment of potential granular aggregate resources in Northwest Territories. Geological Survey of Canada, Open File 6058, 1 DVD-ROM.

Stnith, I.R., Bednarksi, J.M., Deblonde, C., Duk-Rodkin, A., Huntley, D. and Kennedy, K.E. 2011. Potential granular aggregate resources in Northwest Territories and northern Yukon: an updated assessment integrating seismic shothole drillers' logs and surficial geology maps. Geological Survey of Canada, Open File 6849, 1 DVD-ROM.

Request

1. Please explain if clay-rich tills from the area could be suitable embankment construction material.
2. Please clarify if any study included an examination of the sedimentological character and road embankment suitability of the regional till deposits.
3. Please clarify if the seismic shothole drillers' log-based reconstructions of potential granular aggregate deposits (Smith et al., 2011) will be integrated into the regional assessment of borrow materials to be utilized for Highway construction and ongoing maintenance.

Developer Response: 141.1

Clay-rich tills on the Tuktoyaktuk peninsula in the vicinity of the Highway are not considered to be suitable for highway construction. Such materials would typically be rated as Class 4, which are defined as poor quality material generally consisting of silty, poorly-graded, fine-grained sand with minor gravel (EBA 1987). Such deposits may also contain weak particles (clay) and these materials are not suitable for highway construction but can be considered marginally suitable for general non-structural fill.

Reference:

EBA Engineering Consultants Ltd. (EBA). April 1987. Inuvialuit Settlement Sand and Gravel Inventory and Recommendations for Development, A report prepared by EBA Engineering Consultants Ltd. for Indian and Northern Affairs Canada.

Developer Response: 141.2

As reported in the EIS and by KAVIK-STANTEC (2012) a considerable number of studies have been published on the granular resources along the proposed Inuvik to Tuktoyaktuk Highway including AGRA Earth & Environmental (1987), EBA Engineering Consultants Ltd. (1983, 1987a, 1987b), Hardy BBT Ltd. (1987, 1990a, 1990b, 1991), Public Works Canada (1981), R.M. Hardy and Associates Ltd. (1977).

The results of these studies serve as the basis for the current investigation of seven potential borrow sites being conducted by KAVIK-STANTEC for GNWT DOT. This investigation includes a drilling program that is focussed on assessing the sedimentological character and potential borrow source resources present in seven of the more prospective borrow sources along the Highway.

References:

AGRA Earth & Environmental. 1997. Plan of Proposed Inuvik – Tuktoyaktuk Highway: Granular Borrow Sources, Scale 1:250,000.

EBA Engineering Consultants Ltd., 1983. Granular Resource Development and Management Plan for Tuktoyaktuk NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa. (INGRACAT Study No. 183EBA-T)

EBA Engineering Consultants Ltd., 1987a. Inuvialuit Settlement Sand and Gravel Inventory and Recommendations for Development, Inuvik, NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa. (INGRACAT Study No. 187EBA-I)

EBA Engineering Consultants Ltd., 1987b. Inuvialuit Settlement Sand and Gravel Inventory and Recommendations for Development, Tuktoyaktuk NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa. (INGRACAT Study No. 187EBA-T)

Hardy BBT Limited. 1987. Community Granular Management Plan – Tuktoyaktuk, NWT – Final Comparison of Potential Sources - Phase III. Report prepared for GNWT DPW Yellowknife, NWT.

Hardy BBT Limited. 1990a. Geotechnical Investigation of Potential Sand and Gravel Reserves Inuvialuit Settlement Region 155 South Deposit Tuktoyaktuk, NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa.

Hardy BBT Limited. 1990b. Geotechnical Investigation of Potential Sand and Gravel Reserves Inuvialuit Settlement 1407 (Caribou Hills) Deposit Inuvik, NWT. Report submitted to the Department of Indian and Northern Affairs, Ottawa.

Hardy BBT Limited. 1991. Report on Evaluation of Granular Resource Potential Mackenzie Delta Region. Prepared for Indian and Northern Affairs Canada (INAC), Hull, Quebec.

Public Work Canada (PWC) 1981. Geotechnical Investigation Mile 970 (km 0) to Mile 1059 (km 143) (Inuvik to Tuktoyaktuk) Mackenzie Highway Combined Data - 1976 to 1980. Submitted by R.D. Cook, P. Eng. 1981-04-15.

R.M. Hardy and associates Ltd. 1977. Granular material inventory, Tuktoyaktuk, Northwest Territories; report prepared for Department of Indian Affairs and Northern Development.

Developer Response: 141.3

As reported in KAVIK-STANTEC (2012) extensive seismic surveys have been conducted within the Mackenzie Delta region over the last few decades in relation to exploration by the petroleum industry. Seismic shothole log records are recorded by drill operators during geotechnical seismic operations when they auger/air-rotary drill holes to set explosive charges. Holes were drilled to varying depths, averaging 12-16 m (Smith 2010).

As the compilation of drillers log records is largely new, they have yet to be extensively field verified. Users of the shothole drillers' log data are thus cautioned to employ the adage that "if a record indicates a particular unit as being present, then it might well be there, but if it is not identified as being there, it does not necessarily mean that it is not there" - the driller may simply have not reported it.

That said, the use of these driller's logs in support of surficial geology mapping activities in the Mackenzie Delta region and other parts of northern British Columbia over the past five years have demonstrated them to be a reliable, albeit simplified, lithostratigraphic archive (Levson et. al. 2004; Smith and Lesk-Winfield 2009; Smith et al. 2011). Thus to the extent applicable, the shothole drillers' log-based reconstructions of potential granular deposits will be integrated into the regional assessment of borrow materials to be utilized for Highway construction and ongoing maintenance.

References:

Levson, V.M., Ferbey, T., Kerr, B., Johnsen, T., Bednarski, J., Smith, R., Blackwell, J., and Jonnes, S. 2004. Quaternary geology and aggregate mapping in northeast British Columbia: applications for oil and gas exploration and development: in, Resource Development and Geoscience Branch, Summary of Activities 2004. 12 pp.

Smith, I.R. 2010 Seismic shothole drillers' log records: A wealth of new permafrost-related geoscience information, Northwest Territories and northern Yukon, Canada. GEO2010: 63rd Canadian Geotechnical Conference & 6th Canadian Permafrost Conference. September 12-16, 2010. Canadian Geotechnical Society: Richmond, B.C. p. 1450-1457.

Smith I.R. and Lesk-Winfield, K. 2009. An integrate assessment of potential granular aggregate resources in Northwest Territories. Geological Survey of Canada, Open File 6058.

Smith, I.R., Bednarski, J., Deblonde, C., Duk-Rodkin, A., Huntley, D. and Kennedy, K.E. 2011. Potential granular aggregate resources in Northwest Territories and northern Yukon: an updated assessment integrating seismic shothole drillers' logs and surficial geology maps; Geological Survey of Canada, Open File 6849.

9.0 Transport Canada

IR Number: 142

Source: **Transport Canada**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Navigable Waters Protection Program (NWPP) Applications**

Preamble

A definitive route for the all-weather highway would assist in identifying the terrain, watercourse crossings, construction practices and the environmental factors that are to be considered for this project. The Navigable Waters Protection Program (NWPP) ensures the public's right to navigate Canada's waters without obstruction through the administration of the Navigable Waters Protection Act (NWPA). Transport Canada (TC) is a likely Responsible Authority for the environmental assessment of this project, as watercourse crossings that intersect this proposed all-weather highway may require approvals according to the NWPA.

Request

1. The Developer (GNWT, Hamlet of Tuktoyaktuk, and Town of Inuvik) will need to submit formal applications to the NWPP in order to obtain NWPP's approval, promulgation, or exemption for each specific work. The Developer shall also inform the NWPP of any design, construction, or operational changes accordingly. Please refer to the NWPP Internet site or contact the NWPP office for application requirements.

   http://www.tc.qc.ca/enq/marinesafety/oep-nwpp-menu-1978.htm

   Transport Canada
   Navigable Waters Protection Program Canada Place
   1100 - 9700 Jasper Avenue
   Edmonton, Alberta T5J 4E6
   Phone: 780-495-8215

Developer Response: 142.1

As discussed in Section 1.5.1.5 of the EIS, the Developer understands that in accordance with the Navigable Waters Protection Act and Regulations, the Project will require NWPA approvals, promulgations or exemptions for the construction of bridges across navigable waterbodies. It is anticipated that some of the larger streams in the Husky Lakes area, in particular Hans Creek and Zed Creek may constitute navigable waters.

The Developer is committed to submitting the necessary formal applications to the NWPP, and to inform the NWPP of any related design, construction or operational changes related to such applications.

10.0 Tuktoyaktuk-Inuvik Working Group

IR Number: 143

Source: **Tuktoyaktuk Inuvik Working Group**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Source 177 Access Road — Lessons Learned**
(EIS Section 1.5.1 p. 15)

Preamble

The all-weather access road from Tuktoyaktuk to Granular Source 177 was identified as the "pilot project" for the currently proposed Inuvik to Tuktoyaktuk highway construction project in terms of Regulatory Approvals, Environmental Management, etc. (p. 15) by the developer. In their response to the Environmental Impact Review Board's information request 59 the developer did provide some information for the lessons learned during the "pilot project" with respect to the monitoring of impacts on fish and fish habitat. It is expected that increased access to fisheries resources will result from the construction of the Inuvik to Tuktoyaktuk highway. This increased access could have negative impacts on the quality, quantity and sustainability of fishery resources of the area, in addition to the use of traditional fishing practices/areas of the local Inuvialuit. Consideration must also be given to the possible negative impacts the project poses to traditional and cultural fishing practices and attention must be given to monitoring these impacts as they will influence future fisheries management in the area.

Request

1. Please identify and provide a description of the impacts of Source 177 on the cultural fishing practices (i.e. how traditional fishing practices have been affected, etc.) and traditional fishing areas (i.e. how family fishing camps have been affected) that arose from increased access.
2. Please provide detailed information on any monitoring program(s) conducted during and following the construction of Source 177 that evaluated the impacts of increased access to the fishery resources on the cultural fishing practices and traditional fishing areas.
3. Please identify any "lessons learned" during the "pilot project" with respect to the management and monitoring of impacts to cultural fishing practices and traditional fishing areas of the Inuvialuit and explain how these "lessons learned" will be applied to management and monitoring programs during and after the construction of the proposed Inuvik to Tuktoyaktuk highway project.
4. Please explain how the developer has worked with local communities and organizations to mitigate, manage and monitor impacts to Inuvialuit traditional fishing practices and areas during the construction of Source 177 that resulted from increased access.
5. Please explain how the proponents plan to minimize and mitigate these impacts during construction of the Inuvik to Tuktoyaktuk highway project and;
6. Please explain how the proponents plan to work with local communities and organizations before, during and following construction to mitigate and manage the possible impacts resulting from increased access.

Developer Response: 143.1

Based on informal consultations with Tuktoyaktuk community representatives, it is the Developer's understanding that the existence of the Tuktoyaktuk to Source 177 access road has made it easier for community members to access the land in the area of the road. In particular, in 2010, personal communications between the Project Team and a number of Tuktoyaktuk residents indicated that the new all-weather access road facilitated berry picking and picnicking during the summer months, adding to their traditional food source. The Developer also heard that the presence of the road also helped people to travel to their cabins and traditional fishing and goose hunting areas along the shores of the Husky lakes.

Developer Response: 143.2

It is the Developer's understanding that no formal monitoring was conducted, or required to be conducted, during or following construction of the Source 177 access road, to evaluate the possible effects of increased access to the fishery resources or the cultural fishing practices and traditional fishing areas. However, this is a question that could be posed to the Tuktoyaktuk Hunters and Trappers Committee and/or the residents of Tuktoyaktuk during the public hearing phase of the review process.

Developer Response: 143.3

Please refer to the Developers response to IR 143.2 above.

Developer Response: 143.4

The Developer and/or its Contractor consulted with the community of Tuktoyaktuk and the Inuvialuit Lands Administration on a number of occasions regarding the overall progress of and activities associated with the construction of the Source 177 Access Road. However, there was no discussion pertaining to the management and monitoring of possible impacts to Inuvialuit traditional fishing practices and areas during this time.

Developer Response: 143.5

Please refer to the Developers response to IR 143.2 above.

Developer Response: 143.6

As indicated in the EIS and in a number of responses to information requests, The Developer recognizes the importance of working closely with the communities of Tuktoyaktuk and Inuvik and the various appropriate organizations in the area (including the HTCs, community corporations, the co-management agencies and resource management agencies) to address, mitigate and manage possible impacts resulting from increased access.

IR Number: 144

Source: **Tuktoyaktuk Inuvik Working Group**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Fisheries Management Post Construction**
(Sections 4.3.7 and 4.2.5 of the EIS)

Preamble

The Developer discusses in Section 4.3.7 of the EIS the potential effects of the project on harvesting and identifies that the highway will afford increased year round access to wildlife and fish resources and therefore could result in increased harvesting activities (p. 595).

Furthermore it is stated that the management of wildlife and fish resources along the highway will remain with the regional co-management bodies post construction and in Section 7.1.2 (Operations) the developer identifies that they are willing to cooperate with these agencies in their monitoring activities. It is understood and outlined in the potential effects and mitigation measures (Section 4.2.5.1) portion of the EIS that because the project spans over the course of two years that this will allow for adaptive management. In order to ensure the successful management of fisheries resources post construction an understanding of the baseline conditions for fisheries populations prior to construction is needed as well as a clear conception of how the various agencies will collaborate on future management and monitoring. It should be noted that there are two types of fisheries management that apply to the Inuvik to Tuktoyaktuk highway; 1) the management of sport fishing done by non-Inuvialuit (I.e. Tourists), and 2) the management of the subsistence fishery done by the Inuvialuit in the area. Pressure on both the above mentioned fisheries are expected to increase as a result of the highway construction and will require very different management regimes — Sport Fishing management and monitoring on crown lands within the ISR is the responsibility of GNWT ENR and is done through sport fishing licenses and on Inuvialuit Private Lands sport fishing monitoring is the responsibility of the local HTC's and the FJMC through applications to fish on Inuvialuit private lands. The subsistence fishing activities of the Inuvialuit are co-managed and monitored by the local HTCs, the FJMC and DFO, the management and monitoring of the subsistence fisheries within the ISR are lengthy process that require many resources (i.e. money, man-hours, etc.) and involve cooperation with the communities.

Request

1. Please explain in more detail how the developer proposes to work with regional co-management partners to ensure the impacts with respect to increased access to fisheries resources from the project are minimized during construction.
2. Please provide evidence that consideration has been given to the impacts of the project on the future management of the subsistence fishery at and around Husky Lakes due to increased access and;
3. Explain how the developer plans to work with the communities and co-management partners in the development of future fisheries management plans, etc. to ensure successful management of the subsistence fishery post highway construction.

Developer Response: 144.1

The Developer is currently engaged in discussions with the Department of Fisheries and Oceans regarding design mitigation options and operational monitoring for the project. At this time, the Developer's policy is to not allow its employees or contractors to fish while engaged in their employment activities. In addition, the Highway will remain closed to public traffic during the construction phase. Both approaches will minimize increased access to fisheries during construction.

Developer Response: 144.2

It is unclear what is being requested as 'evidence of consideration'. The Developer believes it has demonstrated its consideration of many aspects including consideration of land users. The EIS and additional filings [such as fish and fish habitat surveys] have been provided to the public registry. The EIS and additional filings discuss the context of the fisheries resource and its use by harvesters. The Developer also hosted Traditional Knowledge and Traditional Land Use workshops in Tuktoyaktuk and Inuvik in February 2012 during which time information pertaining to local knowledge and land use practices of the Inuvialuit participants was presented and discussed.

The Developer is responsible for minimizing the direct effects of its project on fish and fish habitat including water quality (in particular, sediment and erosion control). The Developer does not anticipated that there will be any direct effects of the Highway on the fisheries resources in the Husky Lakes that could affect the current subsistence fishery.

Developer Response: 144.3

The Developer has committed to preparing a fish and fish habitat protection plan for the construction phase. This plan will be developed based on consultations associated with the review process and follow-up consultations with the Department of Fisheries and Oceans, the HTCs and the Fisheries Joint Management Committee. In addition, the Developer has committed to continuing dialogue through an Action Plan [See also Developer Response 111]. However, the Developer does not have a legal mandate for fisheries management. These are the legal responsibility of the Department of Fisheries and Oceans and the Fisheries Joint Management Committee. The Developer is aware that these groups normally lead the preparation of fisheries management plans and are responsible for the conduct of research and studies. The Developer has a very limited role to play in the management of the fisheries resource in the ISR.

IR Number: 145

Source: **Tuktoyaktuk Inuvik Working Group**
To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**
Subject: **Residual effects assessment for fish and fish habitat**
(Section 4.2.5.3 p. 504)

Preamble

In Section 4.2.5.3 of the EIS the developer discusses the residual effects of the project on fish resources in the project area. These sections were reviewed and considered with specific attention given to the increase in harvesting pressure on fish resources as a result of increased access when discussing the Information Request phase of the public review. It was identified that the magnitude and duration of the residual impacts to fish resources would depend on how successful the developer is in the effective and swift mitigation of these issues (i.e. the magnitude of impacts to fish populations during the construction phase, and resulting from increased access, will depend on how efficiently the developer identifies and successfully reports the issue to the responsible management bodies). It would be prudent to identity how any impacts resulting from increased access to fish resources will be communicated from the field to the responsible management agencies during the construction phase.

Request

1. Please outline any assumptions used in the residual effects assessment and justification as to why they were applied during the assessment.
2. Identify how the developer plans to communicate (in real time) the "lessons learned" during the construction phase regarding the mitigation and monitoring of project impacts on fish and fishing practices to the responsible management agencies to support adaptive management.

Developer Response: 145.1

Section 4.2.5.3 of the EIS identifies nine types of activities that have the potential to result in adverse effects on fish and/or fish habitat. Six of these activities relate to the Construction phase and three to the Operations phase of the Project. In all cases, it was concluded in the EIS that residual effects would not be significant, indicating no anticipated reduction in productive capacity of habitat or reductions in fish abundance. These conclusions were based on the assumption that the design of structures and the development of site-specific procedures for working in or near water would be sufficient to protect fish and fish habitat. This is particularly true because almost all of the construction work is to be conducted in winter, which generally precludes mobilization of sediment particles resulting from erosion. Culverts will be sized and installed according to accepted and prescribed methods to permit the free passage of fish under normal flow conditions.

Despite considerable pre-planning and design, however, it is accepted that unanticipated erosion and fish passage issues may occur in some instances during all phases of development. As a result, compliance monitoring, involving trained environmental monitors, will be carried out throughout the construction period. Habitat conditions related to highway drainage and stream crossing structures will be monitored for a period of time following Highway completion, as determined in consultation with regulators, and, regular road, culvert, and bridge inspections will be conducted throughout the life of the Highway. These monitoring efforts will permit the timely remediation of

any potential problems related to fish and fish habitat. Specifically, the Environmental Management Plan (EMP) created for this project will clearly identify monitoring procedures, including reporting requirements, invocation of work stoppages, and environmental criteria. In summary, it is assumed that fish habitat protection can be achieved by understanding site specific conditions, suitable design, adherence to tested mitigation measures, and regular monitoring.

A further assumption has been made in the EIS that increased public access to the streams and lakes in or adjacent to the Highway corridor may result in increased fishing pressure, but that this will not necessarily result in a *significant* decrease in fish abundance or production. In this case, significance relates to the potential for adversely affecting existing traditional or commercial fisheries and/or reducing a population to a level where it is no longer self-sustaining. This assumption rests on the following information:

- very few of the stream crossings occur at watercourses that support runs of fish that would be sufficient to attract anglers;
- the stream crossing locations in the few perennial streams that do provide good habitat conditions would generally be used as seasonal migration corridors by spawning or spent fish moving to/from upstream lakes, rather than as holding or feeding areas;
- large lakes that likely support good fishing opportunities near the proposed corridor are few and will require access by off-road vehicles (ATVs);
- fishers from Tuktoyaktuk, in particular, already have access to the Husky Lakes where a variety of estuarine and freshwater fish species are available;
- the proposed Highway alignment will be routed beyond the one kilometre setback recommended by the ILA and the latest version of the Husky Lakes Management Plan; and,
- it is proposed to bring together Hunters and Trappers Committees, Elders, the Community Corporations, resource management agencies, co-management bodies, the ILA, and the proponents of the Inuvik to Tuktoyaktuk Highway to develop an Action Plan involving management and public information tools to avoid potential overexploitation of fish resources and adverse effects on fish habitat.

Developer Response: 145.2

As indicated previously in Developer Response 12.1 (in the first round of EIRB information requests), the Developer is committed to work closely with the ILA, the Tuktoyaktuk and Inuvik Hunters and Trappers Committees (HTCs); the Wildlife Management Advisory Committee (WMAC), the Fisheries Joint Management Committee (FJMC), the GNWT Department of Environment and Natural Resources (ENR), and selected environmental consultants to monitor environmental conditions and to validate conformance with the mitigation measures contained in the various environmental protection plans, licenses and permits that will be issued for the Highway construction project.

Through this integrated and interactive process, the Developer is committed to ensuring that any "lessons learned" will be effectively communicated to the responsible management agencies to support adaptive management over the longer-term life of the Highway.

In addition, as indicated previously in the Developer Response 32.1 (in the first round of information requests from the EIRB), it is generally accepted that public involvement at all stages of this process is required to achieve resource protection and sustainability. As such, the Action Plan will need to integrate public, government, and NGO input, to develop strategies to limit access to sensitive water bodies, and a public education program that will increase awareness of the consequences of human harvesting activities on fish and fish habitat.

Without a publicly supported Action Plan, any other mitigation measures imposed to restrict access and excessive resource exploitation are not likely to succeed. As such, the Action Plan is the key mitigation proposed to minimize indirect residual effects on fish and fish habitat.

IR Number: 146

Source: **EIRB**

To: **GNWT Department of Transportation, Town of Inuvik, Hamlet of Tuktoyaktuk**

Subject: **Development in Husky Lakes Cape Bathurst Area (IFA Section 8 and Annex D Area Number 2)**

Preamble

The Inuvialuit Final Agreement section 8(1) prohibits the approval of any development in Area Number 2 set out in Annex D of the Agreement. The IFA definition of development includes "any government project, undertaking or construction…" (see s.2 IFA). The exception for development in Area Number 2 of Annex D, set out in section 8(1) applies only to those activities that meet acceptable environmental standards as developed by the Environmental Impact Review Board (EIRB). The EIRB developed and circulated such standards in 2005 (please see below).

Request

1. Please prepare and file a map at suitable scale which shows the location of the proposed right of way and all alternative alignments and all proposed project activities and facilities in relation to Husky Lakes Area Number 2, as described in Annex D-2 of the IFA.
2. If any portion of the proposed highway, or any activity required to construct, operate or decommission the highway, is in Husky Lakes Area Number 2, please explain in detail how the proposed development and activity meets the environmental standards set out by the EIRB (EIRB 2005).

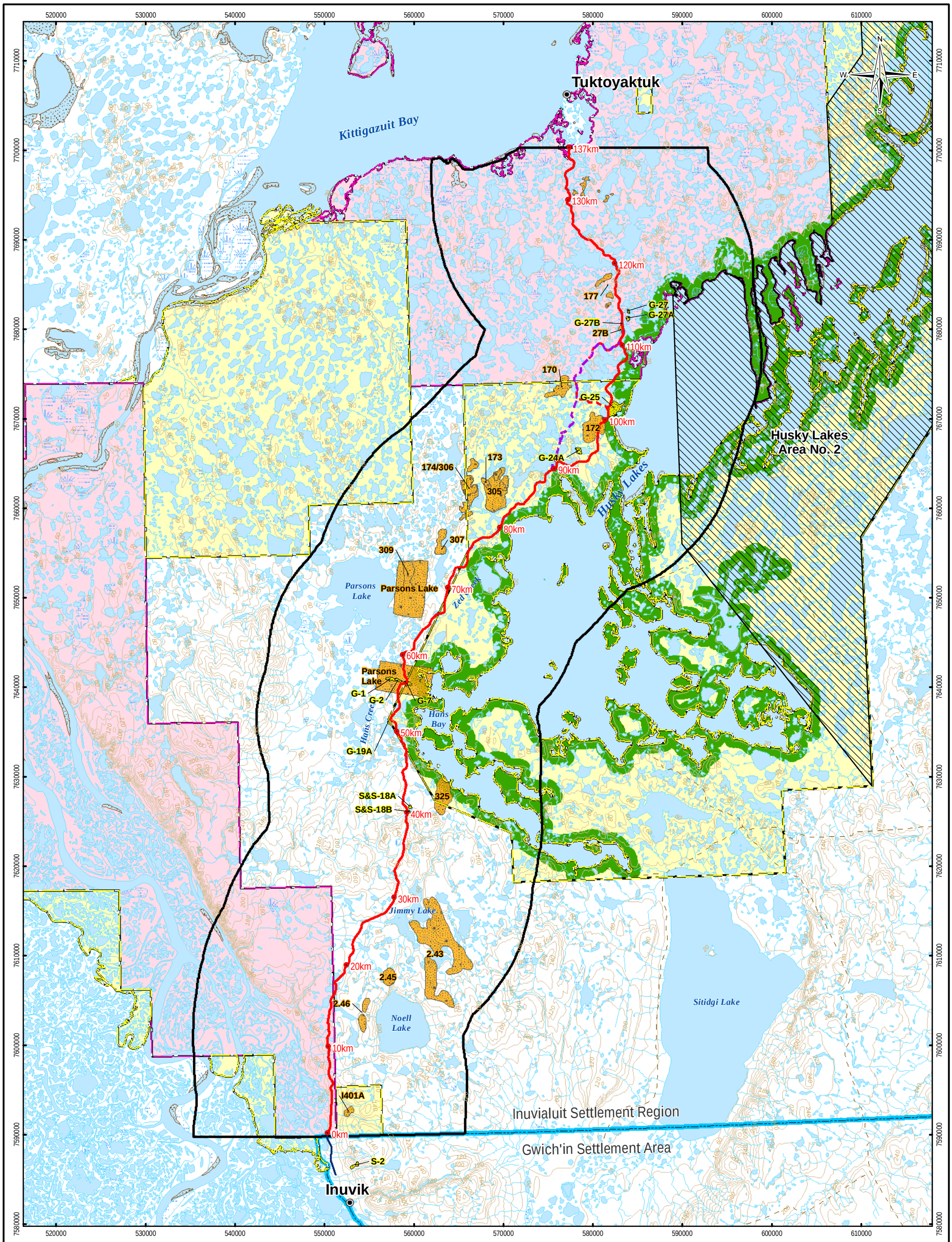
Developer Response: 146.1

Please see Figure 1, which shows the location of the proposed right of way and all alternative alignments and potential borrow sources in relation to Husky Lakes Area Number 2.

Developer Response: 146.2

As discussed in Section 4.3.8.1 of the EIS and as shown on Figure 1, Cape Bathurst-Husky Lakes Area 2 in Annex D is located outside of the proposed Highway right-of-way and any activities associated with the development.

Q:\Vancouver\GIS\ENVIRONMENTAL\V232\V23201322_TukRoad_EIS\Maps\InfoRequest_Round2\V23201322_IR2_Map006_Area2.mxd modified 3/26/2012 by stephanie.leusink



LEGEND

- Husky Lakes Area No. 2
- Regional Study Area (15 km buffer)
- Primary 2009 Route
- Alternative 1 (2009 Minor Realignment)
- Alternative 3 (2010 Minor Realignment)
- Navy Road
- Inuvialuit 7(1)(a) Lands
- Inuvialuit 7(1)(b) Lands
- Gwich'in / Inuvialuit Boundary
- Husky Lakes 1000m Setback
- HighwayBorrow Sources
- Potential Highway Borrow Sources
- 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
Husky Lakes Area No. 2 was delineated based on the description provided in the Inuvialuit Final Agreement, As Amended. January 1987.

ISSUED FOR USE

PROPOSED INUVIK-TUKTOYAKTUK HIGHWAY

Proposed Highway Development Footprint in Relation to Annex D (Area 2) of the IFA

PROJECTION	DATUM
UTM Zone 8	NAD83

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

FILE NO. V23201322_IR2_Map006_Area2.mxd

PROJECT NO.	DWN	CKD	REV
V23201322	SL	TS	0

OFFICE	DATE
EBA-VANC	March 26, 2012

Figure 1

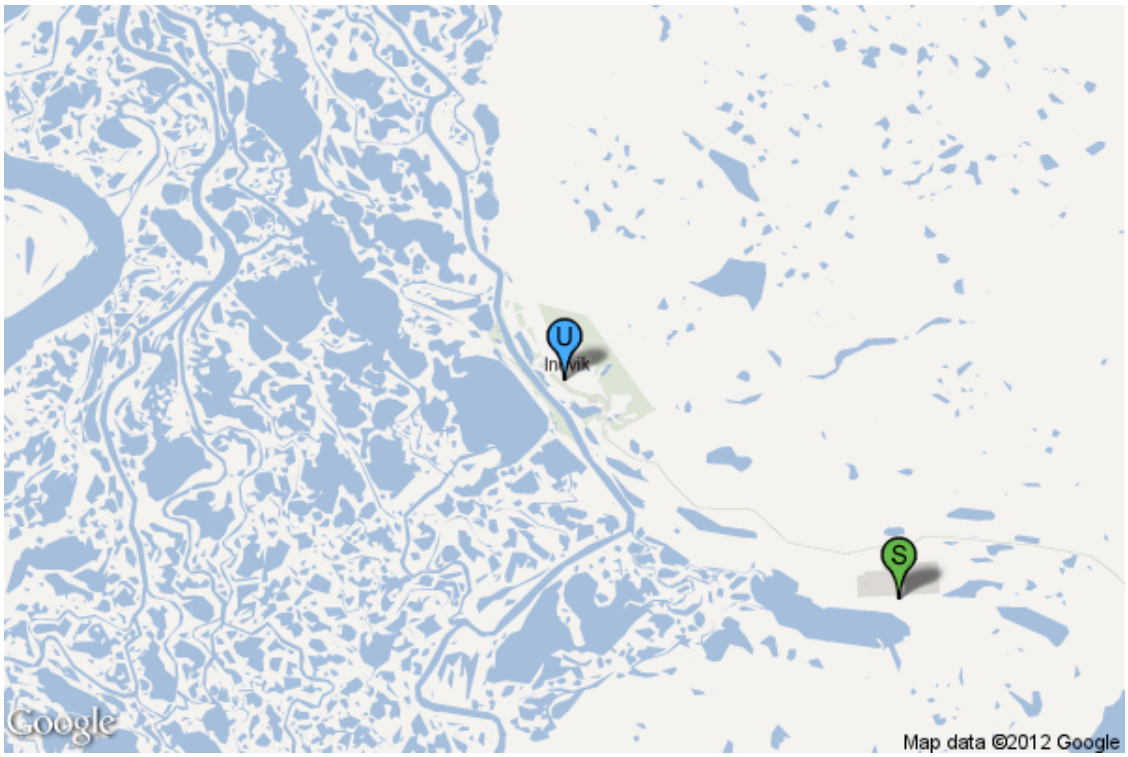
ATTACHMENT 1

Climate Change Scenario Data: Inuvik

This document was created on Tue Mar 13 18:30:40 2012 by CCCSN

Parameters

* User location: Inuvik, NT (68.36N 133.72W) [U]
* Nearest climate station (with at least 70% available data[note]): Inuvik A (id: 2202570) (68.30N 133.48W) [S] (distance: 12.06 km)



Background Information

The Localizer is a quick way of determining the multi-model mean projected change of temperature and precipitation on a monthly, seasonal and annual timescales for hundreds of locations across Canada. Your entered location is checked against the extensive Environment Canada network of observation stations during the period of 1971-2000, and the closest station (with at least 70% available data) is selected automatically. Note in some areas, even the closest station (with at least 70% available data) could be distant due to station density. This is particularly true in northern Canada. The localizer will indicate how far away your entered location and the observation station selected are from one another.

The Localizer uses the climatology of the observation station for the period of 1971-2000 as the baseline climate in all cases. The model projected changes between 1971-2000 and the future time periods (2020s, 2050s and 2080s) are then added to the observed baseline. This results in a projected future scenario which is 'bias-corrected' to the location. Monthly, seasonal and annual projected values of temperature and precipitation are calculated from the ensemble of models.

The number of models used for the ensemble varies with experiment: (A2-High Emission Scenario = average of 20 models; A1B-Medium Emission Scenario = average of 24 models; B1-Low Emission Scenario = average of 21 models). Research has indicated that the use of multi-model ensembles is preferable to the selection of a single or few individual models since each model can contain inherent biases and weaknesses (IPCC-TGICA, 2007). The use of the ensemble projection from the family of global modelling centres is likely the most reliable estimate of climate change projections on a large scale (Gleckler et al, 2008). Further refinement of climate change at individual locations (not using grid cell change) is possible using statistical downscaling techniques, but this methodology requires software and properly formatted input data to compute. Statistical downscaling software and input data for a few models (not the full suite of 24 models) is available elsewhere on CCCSN/RCSCC (cccsn.ca).

There are several steps used to obtain the multi-model ensemble mean. First, the average model values are calculated for each of the four time periods. The results from each model are then interpolated to a common resolution and grid projection. The common grid corresponds to the NCEP (National Centers for Environmental Prediction) resolution of approximately 200 x 200 km at mid-latitudes. The approximate size of the grid cell can be seen on the output page where sample annual tempera-

ture and precipitation change maps for the 2050s are shown. Your selected location is marked by the '+' symbol in the middle of the map. The proximity to other grid cells is indicated along with the approximate change for those neighbouring cells.

The changes between the model baseline period (1971-2000) and the future time periods are then calculated for each of the models. This differencing method corrects for model biases, since only the change between baseline and the future is considered. The average ensemble change of the models (for monthly temperature and precipitation) are then added to the station observed baseline values. The standard deviation indicates the degree of certainty in the future projected value for each location. Locations with low standard deviations indicate those areas where there is good model agreement in the projected change. Conversely, locations with high standard deviation values indicate locations with large inter-model variability. Assuming a normal distribution, the ± 1 standard deviation value indicates that 68% of the models fall within that estimated range.

The values presented in the Localizer allow users to quickly obtain climate change projections from an ensemble of Global Climate Models, from which to base further study. CCCSN/RCSCC assumes no liability for the use of this tool or data. Use of this information should be credited as seen in this statement. Feedback is always welcome at: feedback@cccsn.ca.

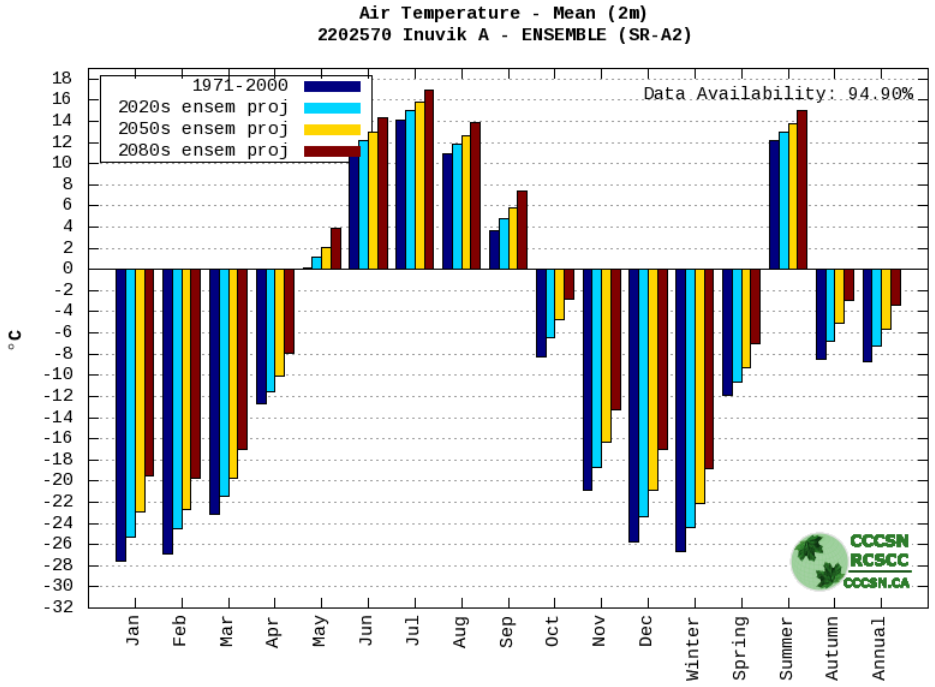
References

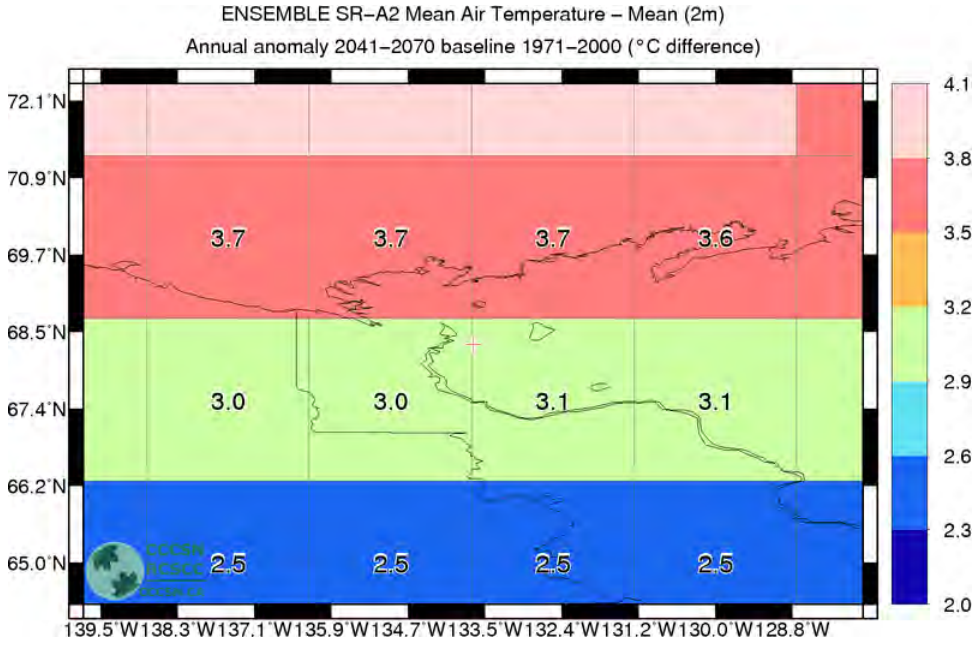
* IPCC-TGICA, 2007: *General Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment*. Version 2. Prepared by T.R. Carter on behalf of the Intergovernmental Panel on Climate Change, Task Group on Data and Scenario Support for Impact and Climate Assessment, 66pp.

* Gleckler, P. J, K. E. Taylor, and C. Doutriaux (2008) Performance metrics for climate models. Journal of Geophysical Research. Vol. 113. D06104.

SR-A2 Air Temperature - Mean (2m)

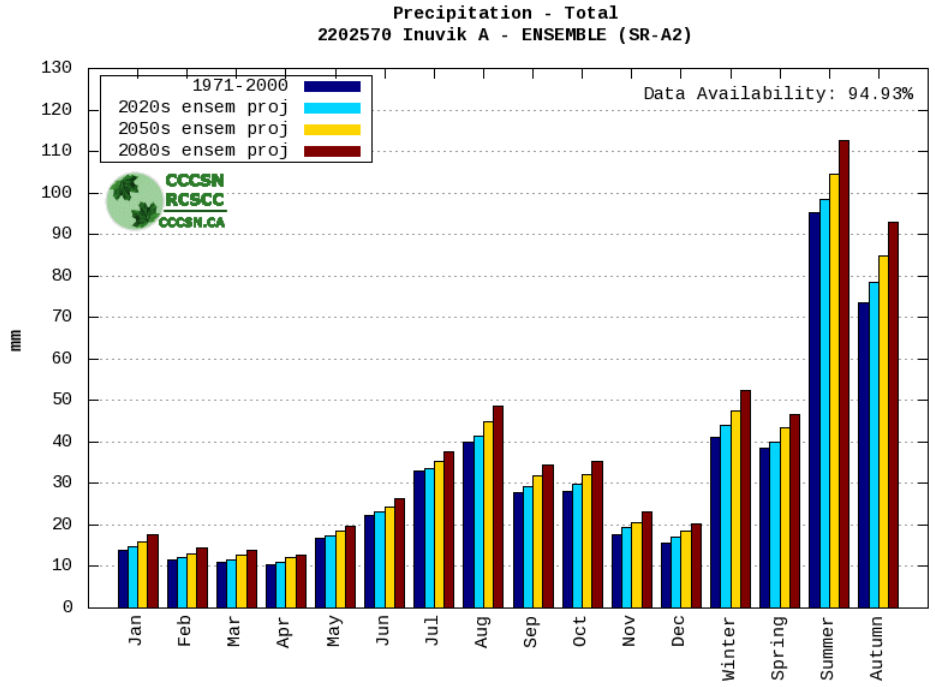
°C	annual	winter	spring	summer	autumn
1971-2000	-8.7	-26.7	-11.9	12.1	-8.5
2020s	-7.2 ± 0.6	-24.4 ± 1.0	-10.6 ± 0.6	13.0 ± 0.5	-6.8 ± 1.0
2050s	-5.7 ± 0.8	-22.1 ± 1.2	-9.3 ± 0.8	13.8 ± 0.8	-5.1 ± 1.2
2080s	-3.4 ± 1.2	-18.7 ± 1.9	-7.0 ± 1.4	15.0 ± 1.3	-2.9 ± 1.6

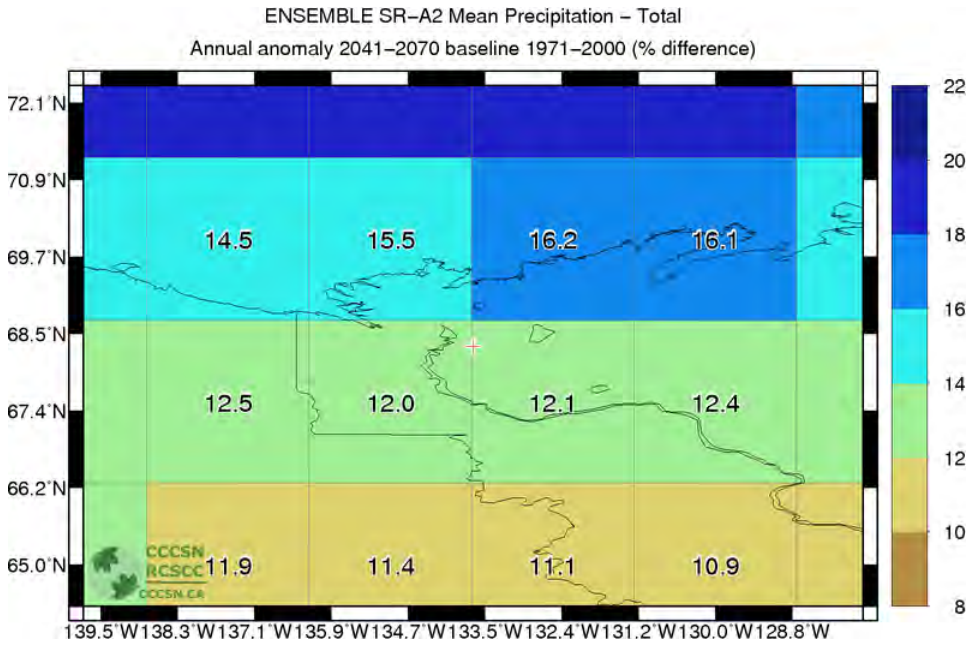




SR-A2 Precipitation - Total

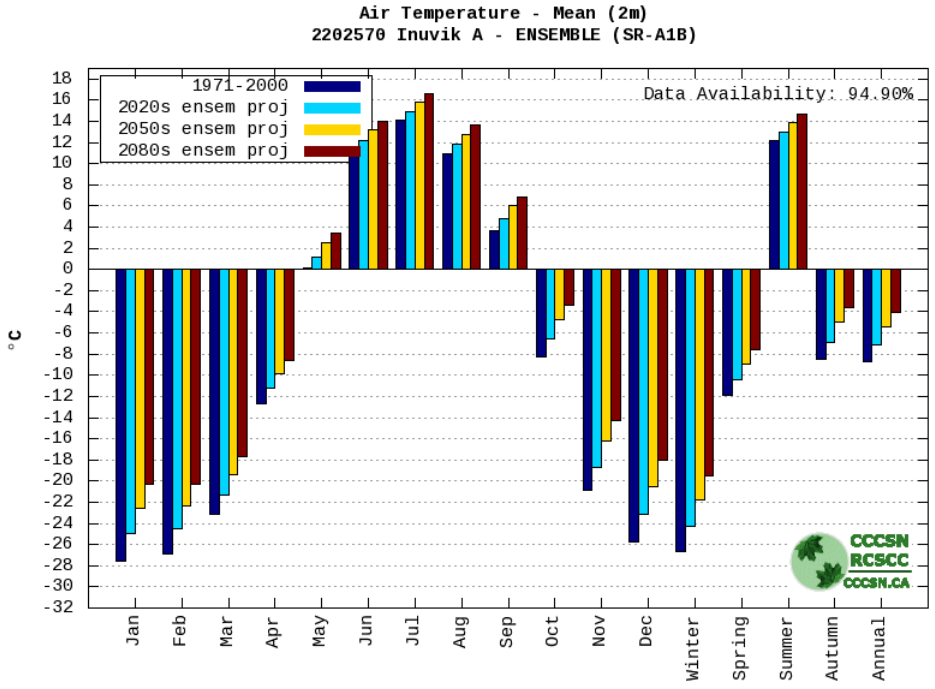
mm	annual	winter	spring	summer	autumn
1971-2000	248.4	41.0	38.4	95.4	73.7
2020s	259.3 ± 12.1	43.9 ± 3.0	39.7 ± 1.8	98.1 ± 7.5	78.1 ± 5.3
2050s	278.5 ± 17.2	47.5 ± 3.7	43.3 ± 3.5	103.7 ± 7.5	84.6 ± 7.5
2080s	301.9 ± 23.2	52.2 ± 6.7	46.3 ± 4.0	111.7 ± 9.7	92.4 ± 11.2

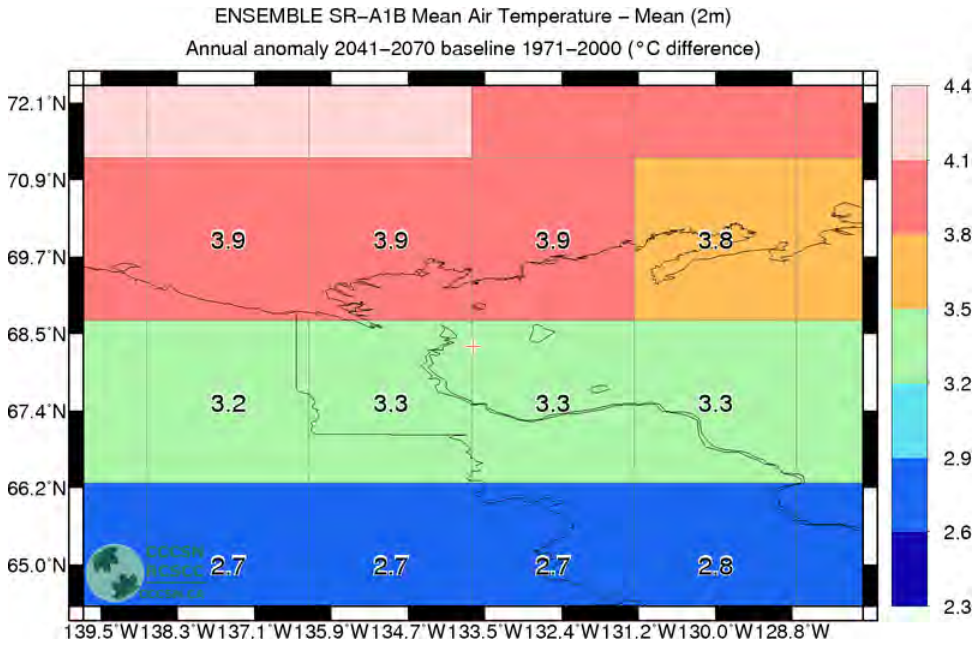




SR-A1B Air Temperature - Mean (2m)

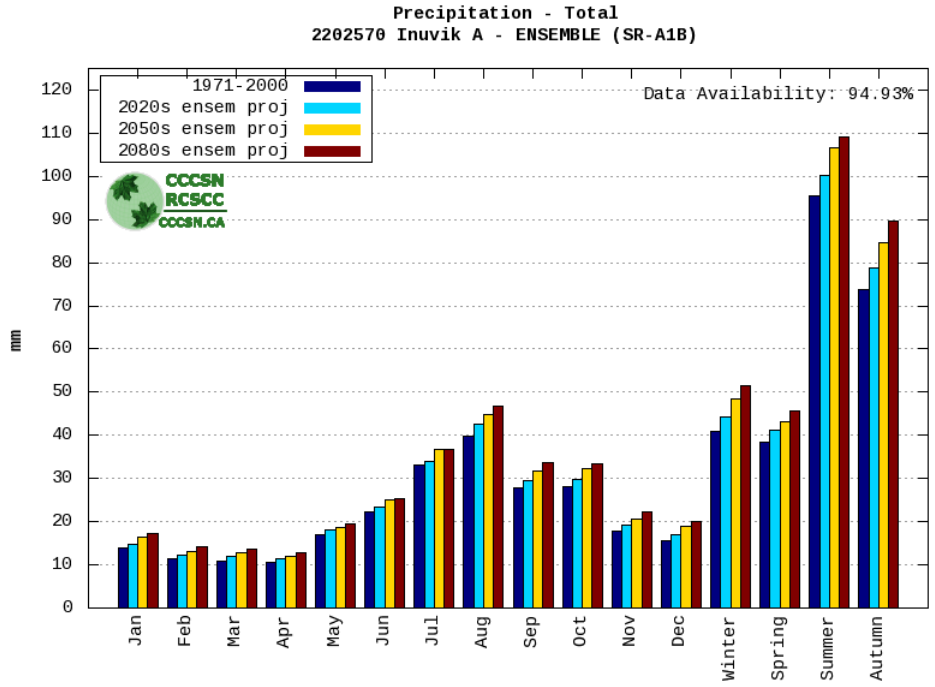
°C	annual	winter	spring	summer	autumn
1971-2000	-8.7	-26.7	-11.9	12.1	-8.5
2020s	-7.1 ± 0.5	-24.2 ± 0.8	-10.5 ± 0.6	13.0 ± 0.6	-6.9 ± 0.7
2050s	-5.5 ± 0.9	-21.8 ± 1.3	-8.9 ± 1.0	13.9 ± 0.9	-5.0 ± 1.3
2080s	-4.0 ± 1.2	-19.4 ± 1.7	-7.6 ± 1.4	14.7 ± 1.3	-3.7 ± 1.6

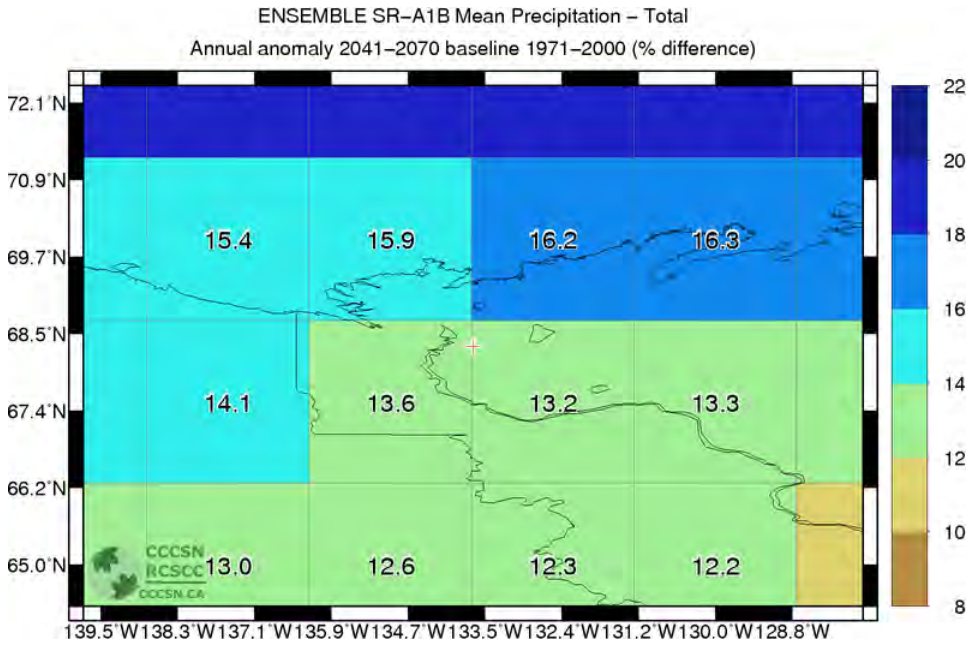




SR-A1B Precipitation - Total

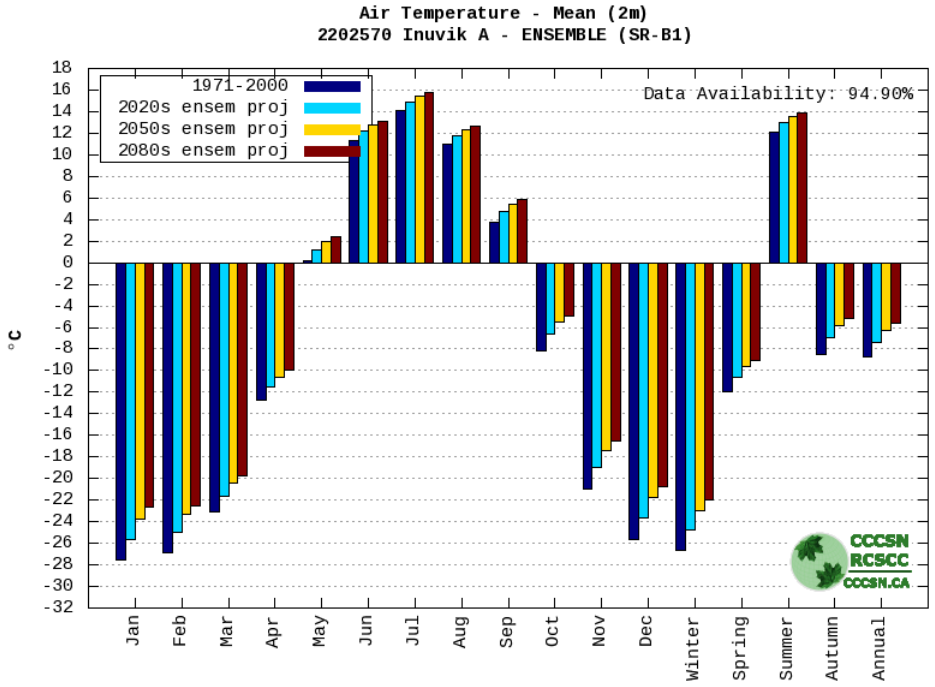
mm	annual	winter	spring	summer	autumn
1971-2000	248.4	41.0	38.4	95.4	73.7
2020s	263.4 ± 12.5	44.0 ± 3.0	41.1 ± 2.0	99.9 ± 6.5	78.5 ± 5.3
2050s	281.2 ± 15.5	48.2 ± 3.7	43.2 ± 3.0	106.1 ± 8.6	84.3 ± 7.0
2080s	293.5 ± 21.9	51.2 ± 6.9	45.5 ± 4.8	107.9 ± 9.2	89.8 ± 9.1

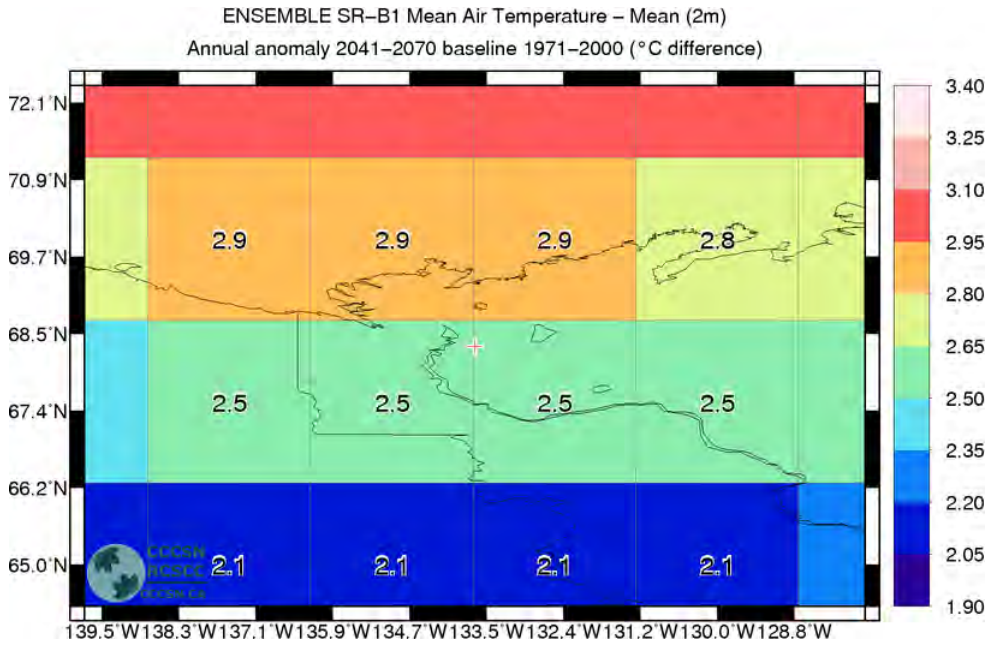




SR-B1 Air Temperature - Mean (2m)

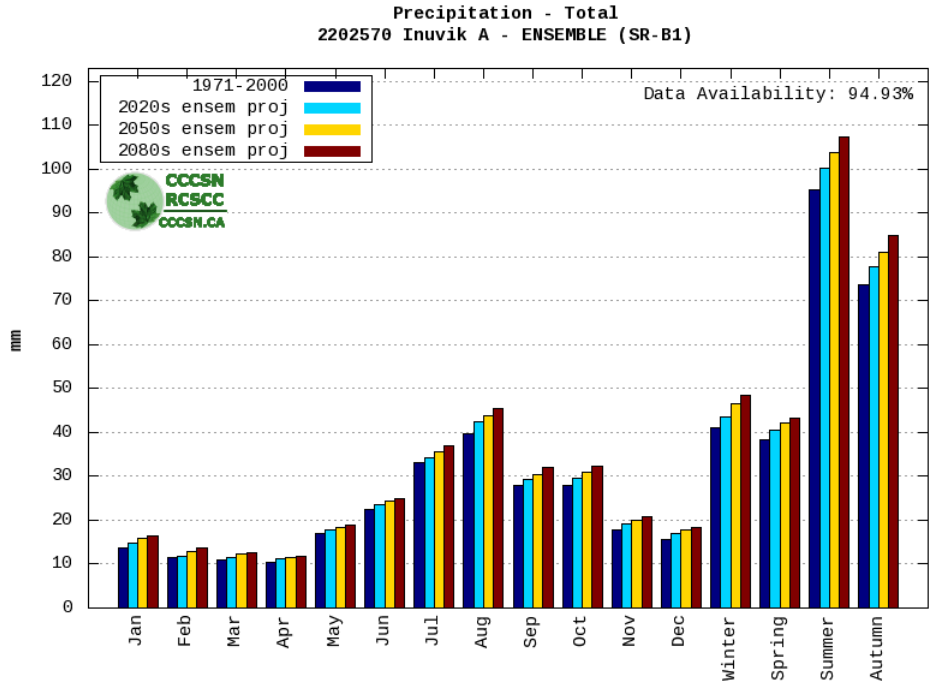
°C	annual	winter	spring	summer	autumn
1971-2000	-8.7	-26.7	-11.9	12.1	-8.5
2020s	-7.4 ± 0.5	-24.7 ± 0.8	-10.7 ± 0.5	12.9 ± 0.5	-7.0 ± 0.6
2050s	-6.2 ± 0.6	-22.9 ± 1.1	-9.7 ± 0.7	13.5 ± 0.7	-5.9 ± 0.7
2080s	-5.6 ± 0.9	-21.9 ± 1.3	-9.1 ± 1.0	13.8 ± 0.9	-5.2 ± 0.9

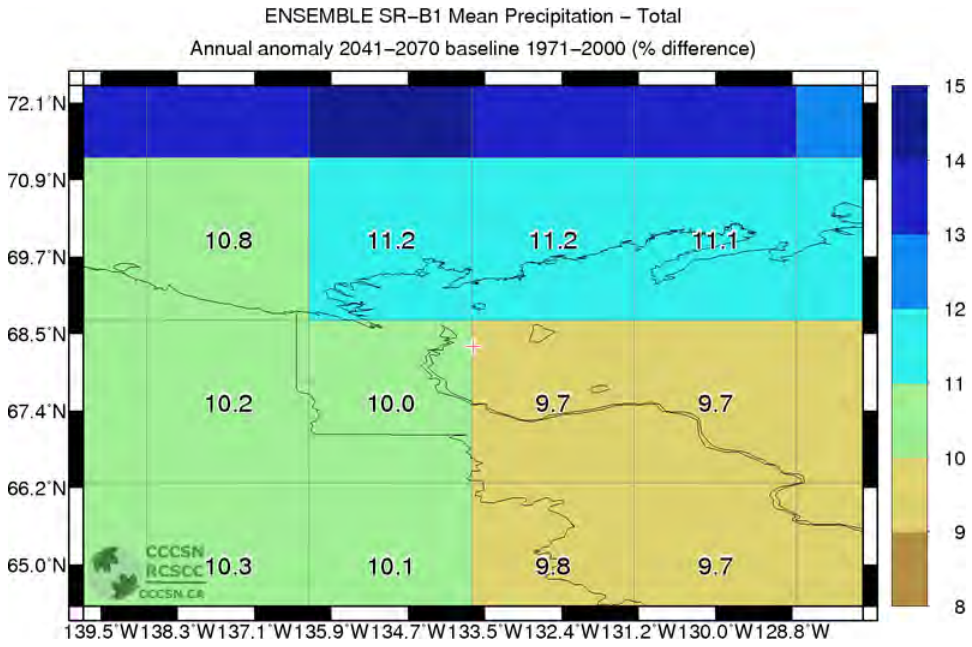




SR-B1 Precipitation - Total

mm	annual	winter	spring	summer	autumn
1971-2000	248.4	41.0	38.4	95.4	73.7
2020s	261.2 ± 10.4	43.5 ± 2.0	40.5 ± 2.0	100.0 ± 6.6	77.6 ± 5.1
2050s	272.4 ± 13.6	46.4 ± 2.5	42.1 ± 2.1	103.3 ± 7.3	80.9 ± 5.4
2080s	282.5 ± 13.0	48.4 ± 3.1	42.9 ± 2.6	106.6 ± 6.5	84.9 ± 7.7





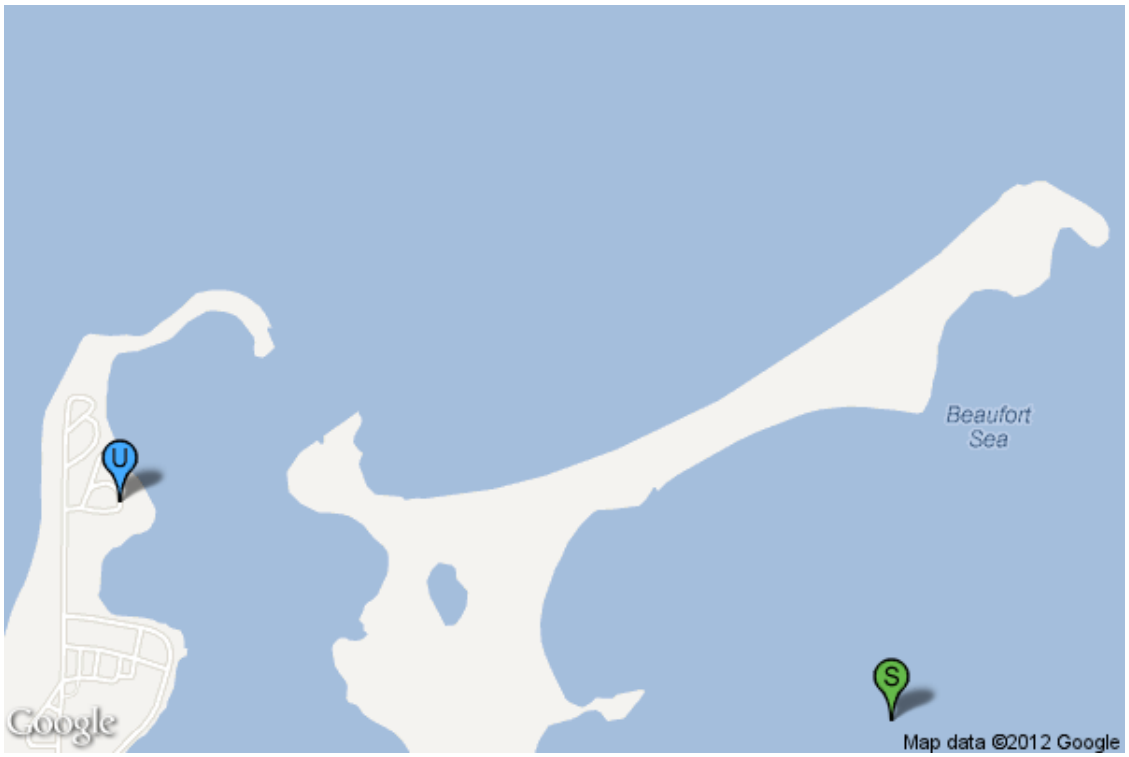
ATTACHMENT 2

Climate Change Scenario Data: Tuktoyaktuk

This document was created on Tue Mar 13 18:38:22 2012 by CCCSN

Parameters

* User location: Tuktoyaktuk Island, NT (69.46N 133.01W) [U]
* Nearest climate station (with at least 70% available data[note]): Tuktoyaktuk (id: 2203910) (69.45N 133.00W) [S] (distance: 0.85 km)



Background Information

The Localizer is a quick way of determining the multi-model mean projected change of temperature and precipitation on a monthly, seasonal and annual timescales for hundreds of locations across Canada. Your entered location is checked against the extensive Environment Canada network of observation stations during the period of 1971-2000, and the closest station (with at least 70% available data) is selected automatically. Note in some areas, even the closest station (with at least 70% available data) could be distant due to station density. This is particularly true in northern Canada. The localizer will indicate how far away your entered location and the observation station selected are from one another.

The Localizer uses the climatology of the observation station for the period of 1971-2000 as the baseline climate in all cases. The model projected changes between 1971-2000 and the future time periods (2020s, 2050s and 2080s) are then added to the observed baseline. This results in a projected future scenario which is 'bias-corrected' to the location. Monthly, seasonal and annual projected values of temperature and precipitation are calculated from the ensemble of models.

The number of models used for the ensemble varies with experiment: (A2-High Emission Scenario = average of 20 models; A1B-Medium Emission Scenario = average of 24 models; B1-Low Emission Scenario = average of 21 models). Research has indicated that the use of multi-model ensembles is preferable to the selection of a single or few individual models since each model can contain inherent biases and weaknesses (IPCC-TGICA, 2007). The use of the ensemble projection from the family of global modelling centres is likely the most reliable estimate of climate change projections on a large scale (Gleckler et al, 2008). Further refinement of climate change at individual locations (not using grid cell change) is possible using statistical downscaling techniques, but this methodology requires software and properly formatted input data to compute. Statistical downscaling software and input data for a few models (not the full suite of 24 models) is available elsewhere on CCCSN/RCSCC (cccsn.ca).

There are several steps used to obtain the multi-model ensemble mean. First, the average model values are calculated for each of the four time periods. The results from each model are then interpolated to a common resolution and grid projection. The common grid corresponds to the NCEP (National Centers for Environmental Prediction) resolution of approximately 200 x 200 km at mid-latitudes. The approximate size of the grid cell can be seen on the output page where sample annual tempera-

ture and precipitation change maps for the 2050s are shown. Your selected location is marked by the '+' symbol in the middle of the map. The proximity to other grid cells is indicated along with the approximate change for those neighbouring cells.

The changes between the model baseline period (1971-2000) and the future time periods are then calculated for each of the models. This differencing method corrects for model biases, since only the change between baseline and the future is considered. The average ensemble change of the models (for monthly temperature and precipitation) are then added to the station observed baseline values. The standard deviation indicates the degree of certainty in the future projected value for each location. Locations with low standard deviations indicate those areas where there is good model agreement in the projected change. Conversely, locations with high standard deviation values indicate locations with large inter-model variability. Assuming a normal distribution, the ± 1 standard deviation value indicates that 68% of the models fall within that estimated range.

The values presented in the Localizer allow users to quickly obtain climate change projections from an ensemble of Global Climate Models, from which to base further study. CCCSN/RCSCC assumes no liability for the use of this tool or data. Use of this information should be credited as seen in this statement. Feedback is always welcome at: feedback@cccsn.ca.

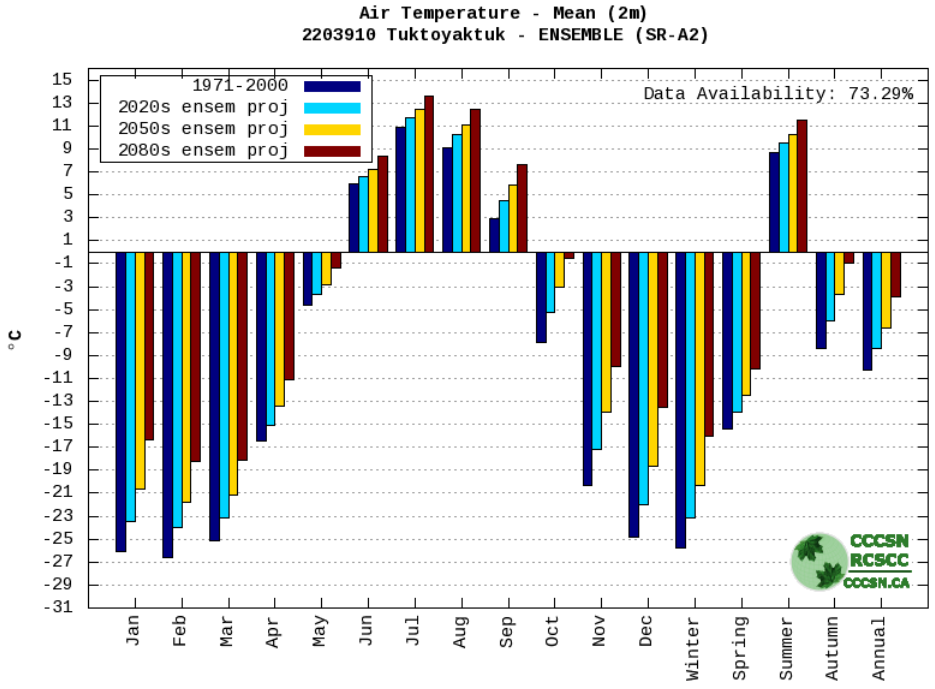
References

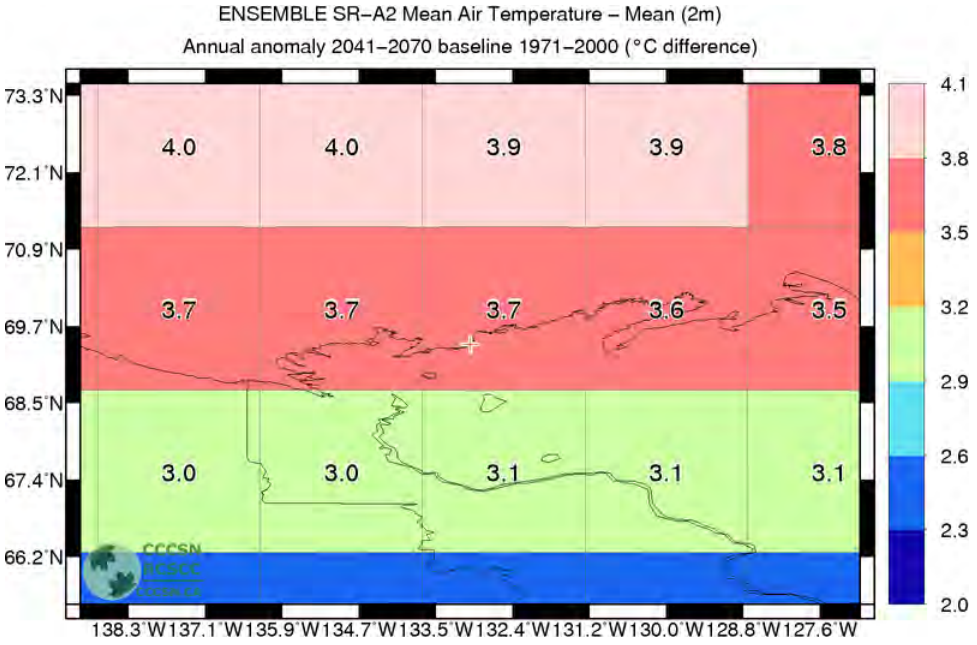
* IPCC-TGICA, 2007: *General Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment*. Version 2. Prepared by T.R. Carter on behalf of the Intergovernmental Panel on Climate Change, Task Group on Data and Scenario Support for Impact and Climate Assessment, 66pp.

* Gleckler, P. J, K. E. Taylor, and C. Doutriaux (2008) Performance metrics for climate models. Journal of Geophysical Research. Vol. 113. D06104.

SR-A2 Air Temperature - Mean (2m)

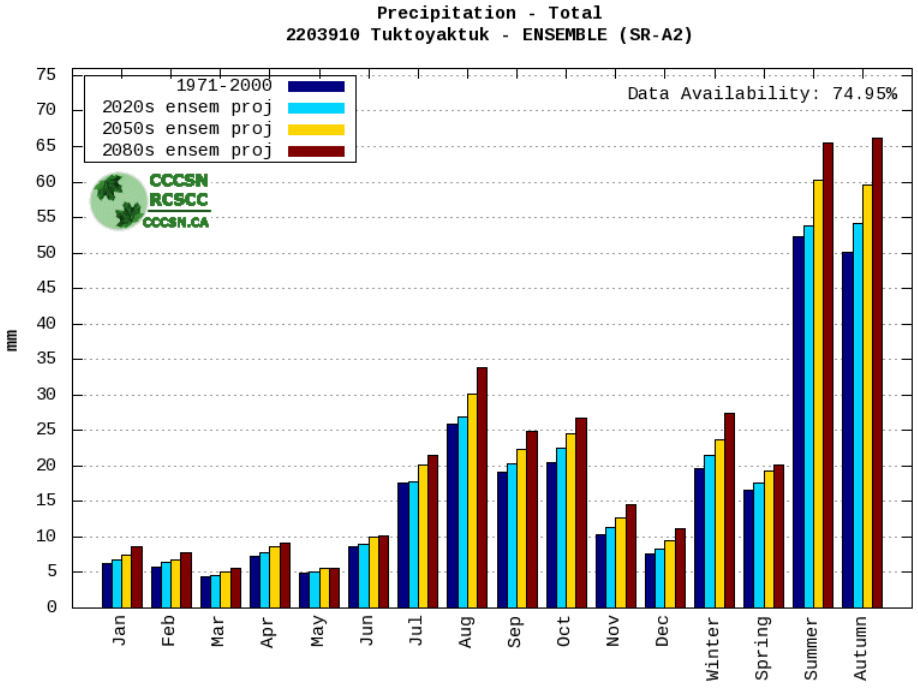
°C	annual	winter	spring	summer	autumn
1971-2000	-10.2	-25.8	-15.4	8.6	-8.4
2020s	-8.4 ± 0.7	-23.1 ± 1.1	-14.0 ± 0.6	9.5 ± 0.7	-6.0 ± 1.3
2050s	-6.6 ± 1.0	-20.3 ± 1.5	-12.5 ± 0.8	10.1 ± 1.0	-3.7 ± 1.9
2080s	-3.9 ± 1.6	-15.9 ± 2.5	-10.2 ± 1.3	11.4 ± 1.6	-1.0 ± 2.6

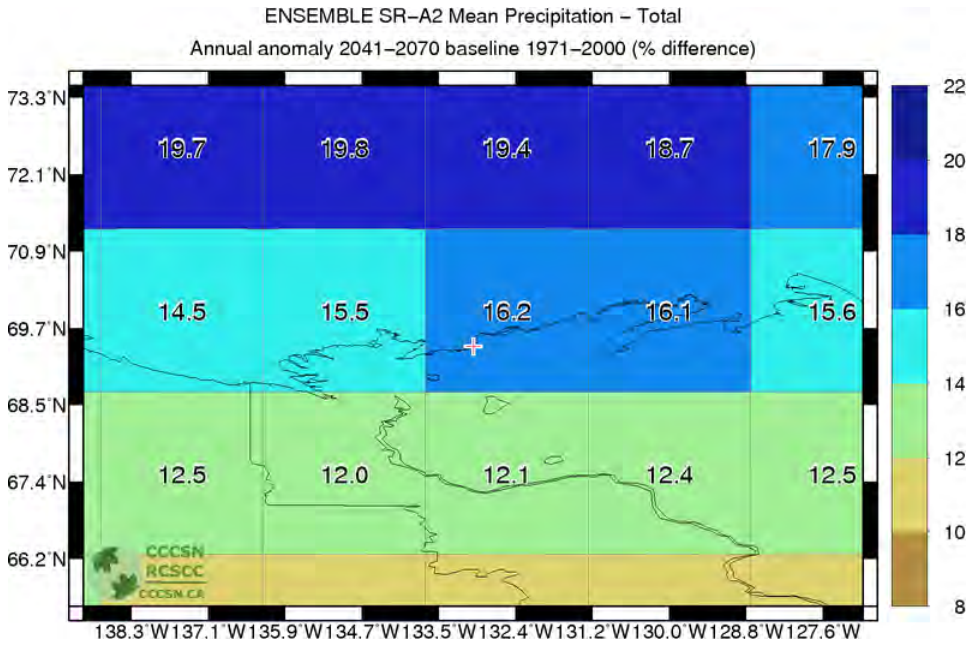




SR-A2 Precipitation - Total

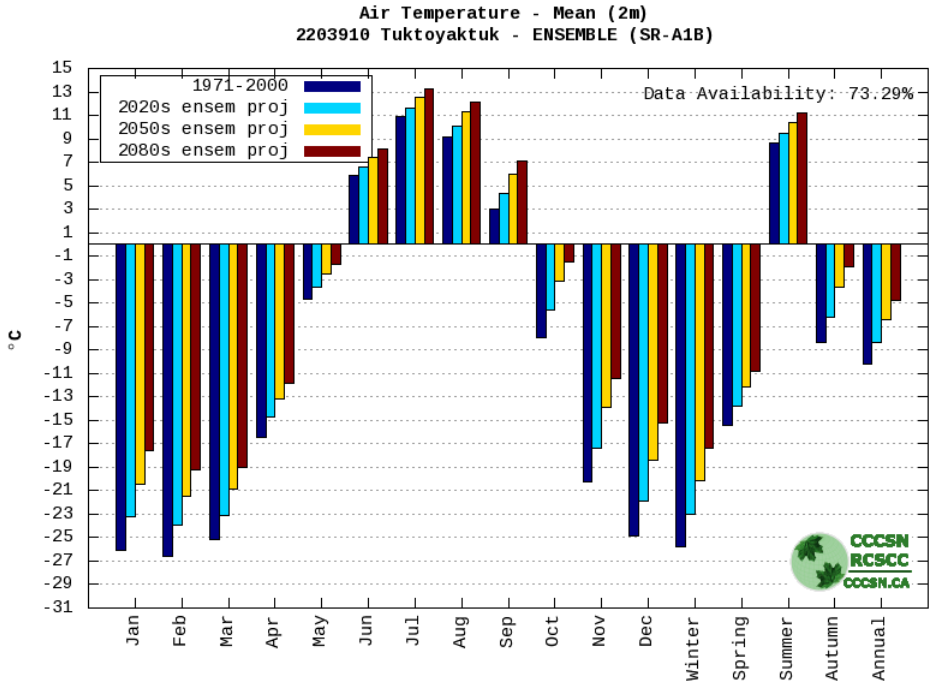
mm	annual	winter	spring	summer	autumn
1971-2000	138.6	19.7	16.6	52.3	50.1
2020s	146.6 ± 6.4	21.4 ± 1.7	17.4 ± 1.2	53.6 ± 4.8	54.1 ± 3.3
2050s	161.1 ± 9.6	23.7 ± 2.5	19.0 ± 1.9	60.0 ± 4.9	59.2 ± 5.4
2080s	176.8 ± 13.8	27.4 ± 4.4	20.0 ± 2.1	64.9 ± 6.9	65.7 ± 8.0

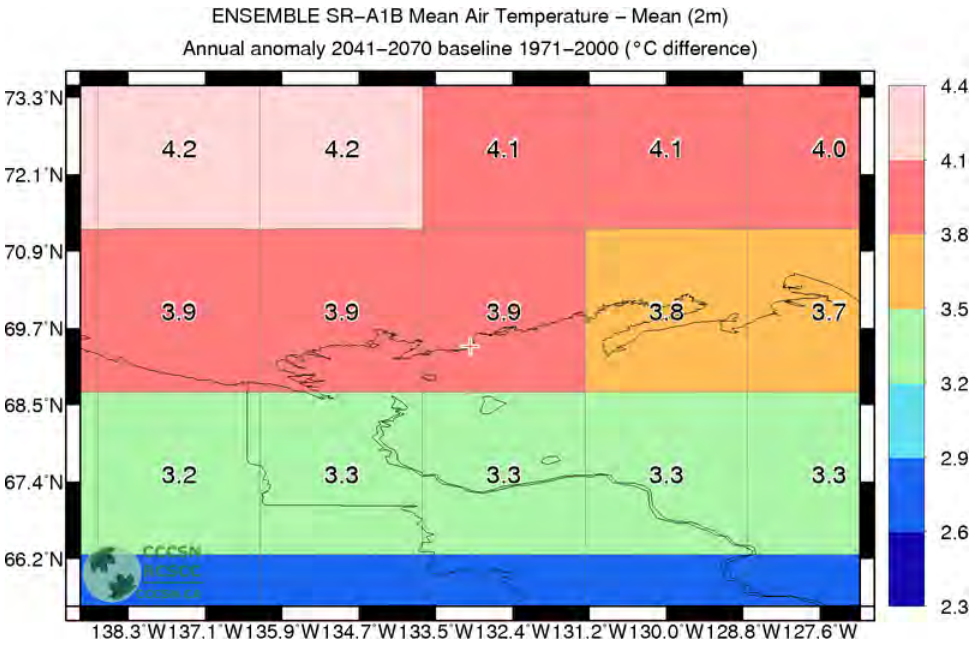




SR-A1B Air Temperature - Mean (2m)

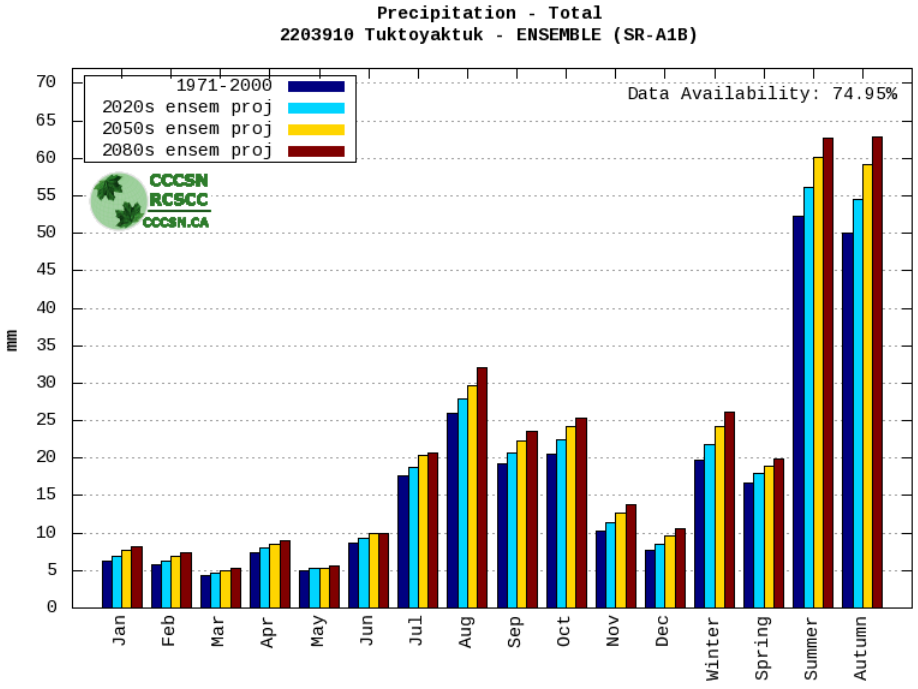
°C	annual	winter	spring	summer	autumn
1971-2000	-10.2	-25.8	-15.4	8.6	-8.4
2020s	-8.4 ± 0.5	-23.0 ± 1.0	-13.8 ± 0.5	9.4 ± 0.6	-6.2 ± 0.9
2050s	-6.4 ± 1.1	-20.1 ± 1.6	-12.2 ± 0.9	10.3 ± 1.1	-3.7 ± 2.0
2080s	-4.7 ± 1.4	-17.3 ± 2.2	-10.8 ± 1.2	11.1 ± 1.4	-2.0 ± 2.5

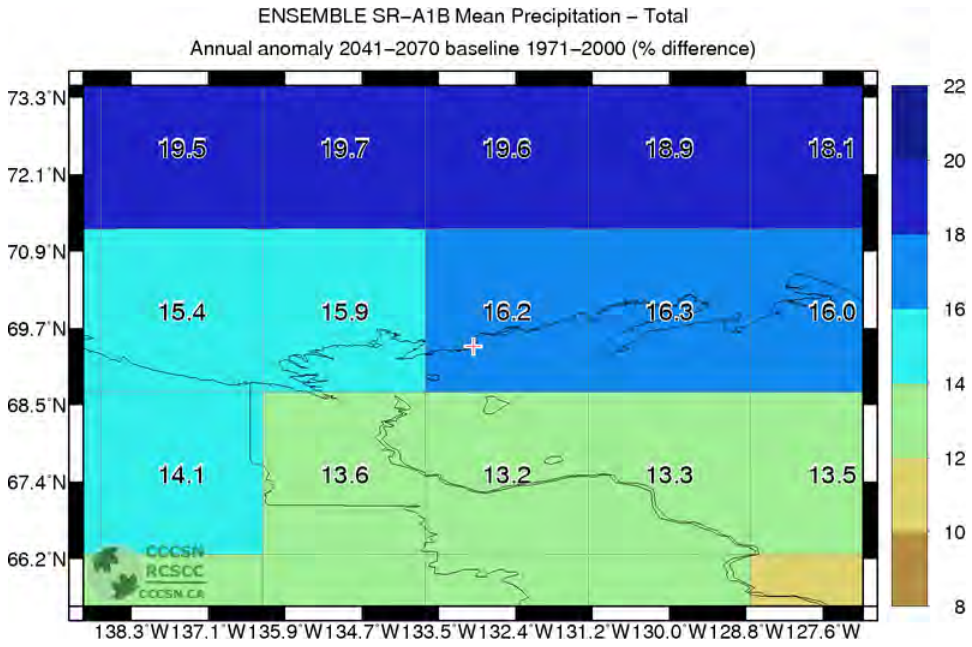




SR-A1B Precipitation - Total

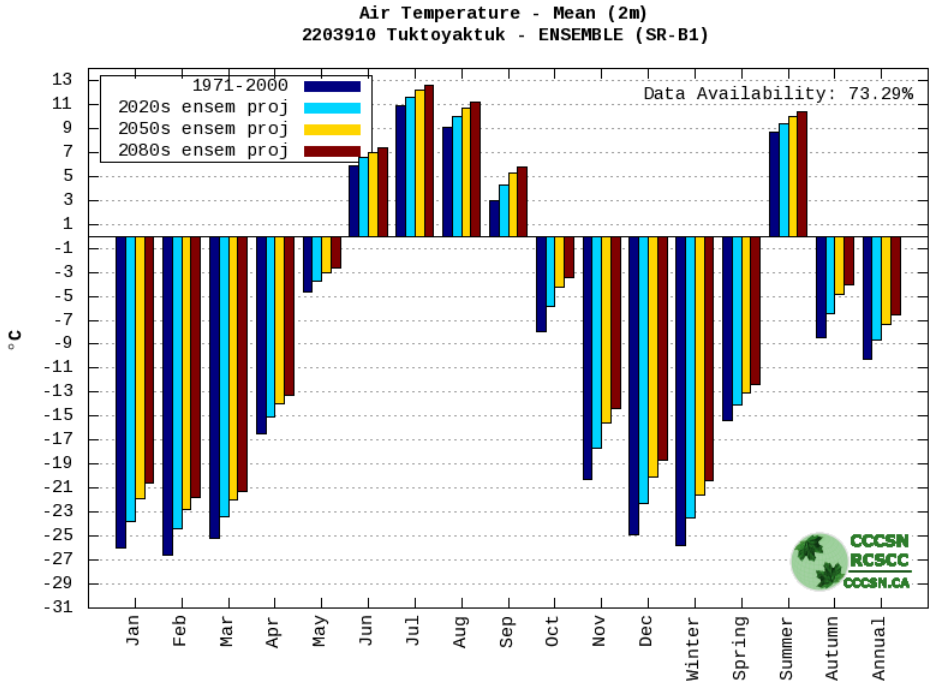
mm	annual	winter	spring	summer	autumn
1971-2000	138.6	19.7	16.6	52.3	50.1
2020s	149.5 ± 7.1	21.7 ± 1.7	17.8 ± 1.2	55.8 ± 3.6	54.5 ± 3.6
2050s	161.1 ± 9.6	24.1 ± 2.6	18.7 ± 1.6	59.7 ± 5.9	58.9 ± 5.1
2080s	170.0 ± 11.9	26.2 ± 3.9	19.6 ± 1.9	62.0 ± 7.2	62.7 ± 7.4

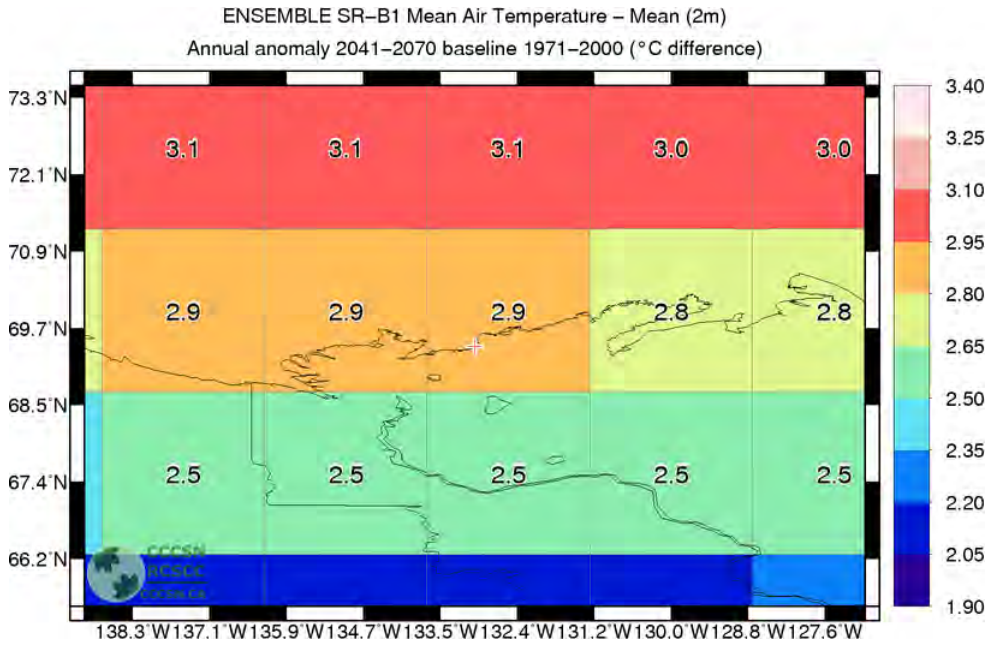




SR-B1 Air Temperature - Mean (2m)

°C	annual	winter	spring	summer	autumn
1971-2000	-10.2	-25.8	-15.4	8.6	-8.4
2020s	-8.6 ± 0.4	-23.5 ± 0.8	-14.0 ± 0.4	9.4 ± 0.4	-6.4 ± 0.7
2050s	-7.4 ± 0.6	-21.5 ± 1.2	-13.0 ± 0.6	9.9 ± 0.7	-4.9 ± 1.0
2080s	-6.6 ± 1.0	-20.3 ± 1.6	-12.4 ± 0.8	10.3 ± 1.0	-4.0 ± 1.5





SR-B1 Precipitation - Total

mm	annual	winter	spring	summer	autumn
1971-2000	138.6	19.7	16.6	52.3	50.1
2020s	147.9 ± 5.7	21.4 ± 1.6	17.5 ± 1.0	55.8 ± 4.7	53.4 ± 2.5
2050s	154.1 ± 7.2	22.6 ± 1.8	18.1 ± 1.3	57.2 ± 4.1	56.2 ± 3.5
2080s	160.5 ± 8.2	23.7 ± 2.2	18.7 ± 1.5	59.7 ± 4.3	58.6 ± 4.5