Inuvik to Tuktoyaktuk Highway: Permafrost Monitoring Plan

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Executive Summary

The Inuvik to Tuktoyaktuk Highway (ITH) is a Government of the Northwest Territories (GNWT) 138 kilometre all-season highway project which has been planned, designed and will be constructed and operated to minimize disturbance to the active layer, underlying permafrost and ground ice features in the project area. The GNWT has significant experience constructing, maintaining, operating and monitoring highways built on terrain underlain by ice rich permafrost.

The ITH Permafrost Monitoring Plan (PEMP) was developed to guide monitoring efforts aimed at ensuring protection of active layer and permafrost conditions along the highway embankment, at watercourse crossing structures, in the exploited burrow sources and along temporary winter access roads. The PEMP also describes approaches that will be taken to effectively monitor the areas impacted by the ITH project.

The PEMP describes visual and ground temperature monitoring activities that will be conducted regularly throughout the summer and fall seasons and during operations. These monitoring activities will assist in adaptively managing the design and construction elements aimed at protecting ground thermal conditions. The monitoring efforts will also assist in identifying specific areas where mitigative or restorative efforts will be required. This plan contributes to the adaptive management approach for the project committed to by the GNWT in the regulatory framework.

Innovative remote and ground sensing techniques will be tested for broader application along the ITH and to other northern transportation infrastructure projects. Information and data collected under the PEMP will add value to broad regional permafrost-related studies in progress by the climate science, geoscience and transportation infrastructure research community.
Table of Contents

1 INTRODUCTION ........................................................................................................................... 1-1
  1.1 PURPOSE ..................................................................................................................................... 1-1
  1.2 TIMING OF CONSTRUCTION ..................................................................................................... 1-2
  1.3 DOT STAFF AND CONTRACTOR TRAINING ............................................................................. 1-2
  1.4 LESSONS LEARNED FROM TUKTOYAKTUK TO SOURCE 177 ACCESS ROAD DESIGN AND CONSTRUCTION .................................................................................................. 1-2

2 MONITORING ..................................................................................................................................... 2-1
  2.1 BORROW SOURCES ................................................................................................................... 2-1
  2.2 WINTER ACCESS ROADS .......................................................................................................... 2-1
  2.3 HIGHWAY EMBANKMENT ........................................................................................................... 2-1
  2.4 WATERCOURSE CROSSING STRUCTURES ............................................................................ 2-2
  2.5 ANALYSIS ..................................................................................................................................... 2-2
  2.6 REPORTING ..................................................................................................................................... 2-2

Appendices

APPENDIX A ITH Construction Atlas
Abbreviations

AANDC .......................................................... Aboriginal Affairs and Northern Development Canada
DOT .................................................................................................................. Department of Transportation
GNWT .......................................................... Government of the Northwest Territories
ILA .................................................................................................................... Inuvialuit Land Administration
ITH .................................................................................................................. Inuvik to Tuktoyaktuk Highway
NWTWB ................................................................................................... Northwest Territories Water Board
NWT ............................................................................................................................... Northwest Territories
PEMP .............................................................................................................. Permafrost Management Plan
PMP ............................................................................................................................. Pit Management Plans
QA/QC ....................................................................................................... Quality Assurance/Quality Control
1 INTRODUCTION

1.1 Purpose

In January 2014 the Government of the Northwest Territories (GNWT) Department of Transportation (DOT) will begin construction of a 138 kilometre all-season highway from Inuvik to Tuktoyaktuk in the Inuvialuit Settlement Region of the Northwest Territories (NWT). The GNWT has significant experience constructing, maintaining, operating and monitoring highways built on terrain underlain by ice rich permafrost.

The Inuvik to Tuktoyaktuk Highway (ITH) is being constructed through terrain underlain with continuous ice rich permafrost. The ITH design and construction plan is based on keeping the permafrost in a stable, frozen state. The ITH project comprises: construction of the highway embankment; construction of 68 watercourse crossing structures; development of the borrow sources; and construction of temporary winter access roads. The ITH Construction Atlas is provided in Appendix A.

The development of a Permafrost Monitoring Plan (PEMP) was a condition of Water License N7L1-1835 issued for the Inuvik to Tuktoyaktuk Highway (ITH) project by the Northwest Territories Water Board (NWTWB) on December 12, 2013.

Condition Part C # 7 of NWTWB Licence N7L1-1835 states:

“The Licensee shall within thirty (30) days of License issuance submit to the Board for approval a Permafrost Monitoring Plan. The plan shall address monitoring of active layer and near-surface permafrost impacts from the winter road construction to aggregate sources, as well as, the all-weather highway and watercourse crossings. The implementation of this plan shall inform the overall Adaptive management program of the project”.

The ITH PEMP was developed to guide monitoring efforts aimed at ensuring protection of active layer and permafrost conditions in the project area and along the highway embankment, at watercourse crossing structures, in the exploited borrow sources and along temporary winter access roads. The PEMP describes the approaches that will be taken to effectively monitor the areas impacted by the ITH project.

The PEMP will assist in adaptively managing the design and construction elements directed specifically at protecting ground thermal conditions in the project area and identifying specific sites where mitigative or restorative efforts may be required. Information and data collected under the PEMP will also add value to broader regional permafrost-related studies in progress by the climate science, geoscience and transportation infrastructure research community.
1.2 **Timing of Construction**

The majority of new construction activities will be conducted during late fall and winter when the active layer is frozen. Winter construction avoids damaging the natural ground surface and erosion of permafrost terrain. Overland travel is not permitted during summer months, with the exception of on previously constructed embankment and within the approved granular sources.

1.3 **DOT Staff and Contractor Training**

The PEMP will be reviewed with DOT Staff and the Contractor that will undertake the construction of the ITH. The purpose of this review is to ensure DOT Staff and the Contractor understand the intent of the PEMP and how to implement it, and to obtain feedback on possible improvements. In turn the contractor will be responsible for educating highway construction crews on the content of the plan and the importance of correct implementation.

1.4 **Lessons Learned from Tuktoyaktuk to Source 177 Access Road Design and Construction**

Valuable lessons have been learned from previously constructed roads in similar locations and conditions, particularly the Dempster Highway. The construction of the access road from Tuktoyaktuk to Borrow Source 177 provided valuable lessons that were incorporated into the design and will be used in the construction of the ITH. Lessons learned related to active layer and permafrost protection, are provided below:

- the nature of the ice-rich terrain is such that all initial embankment construction must be carried out in the winter when the active layer is fully frozen;
- the borrow sources will be mainly developed during the winter and overburden cover restored after extraction to minimize impacts to the ground thermal regimes in the borrow sources;
- geotextile placed on the original ground increases roadbed stability and improves embankment integrity;
- thermal modelling is an effective tool to ensure that embankment heights and profiles have been designed to insulate the ground from thaw penetration and to promote the agradation of permafrost into the embankment;
- effective maintenance of the highway embankment during and post construction will assist in the preserving permafrost conditions along the right of way; and
- the use of a 'fill only' design section with no cuts to the natural ground or stripping maintains the insulation value of the vegetative mat and organic soil to preserve the underlying permafrost. This intact vegetation cover provides excellent active layer and permafrost protection.
2 MONITORING

2.1 Borrow Sources

ITH embankment construction will require materials extracted from borrow sources located in proximity to the right of way. The Pit Development Plans approved by the Inuvialuit Land Administration (ILA) for work in ILA borrow sources, and by Aboriginal Affairs and Northern Development Canada (AANDC) for Crown granular sources clearly define the measures to be taken to protect permafrost and ground ice encountered during material extraction activities. These measures include covering any ice-rich material so that there is no unintended thaw flows and erosion as a result of permafrost degradation.

For the term of the land use permits the developed borrow-sources will be visually monitored throughout the summer and fall seasons to ensure that there is no erosion resulting from degradation of permafrost.

2.2 Winter Access Roads

Water will be extracted from authorized lakes proximal to the borrow sources and right of way to assist in the construction and thickening of winter access roads. The land use permits issued for winter access road construction and operation by ILA and AANDC clearly define the conditions and specific measures to be taken to protect surface vegetation, surface soils and permafrost during winter construction activities.

For the term of the land use permits all of the winter access road alignments will be visually monitored throughout the summer and fall seasons, to ensure that there is no significant scarring of the surface that could lead to erosion of the active layer, which could in turn result in degradation of the underlying permafrost.

2.3 Highway Embankment

The highway embankment will be constructed during the winter when the active layer is frozen as directed in the land use permits issued by the ILA and AANDC. The embankment is being constructed with a volume of material and resulting embankment height and slope that is designed to protect the integrity of the underlying permafrost.

The embankment will be visually monitored throughout the summer and fall seasons during construction and during highway operations, to ensure that there is no significant erosion resulting from degradation of permafrost. In addition ground temperature sensors will be installed at strategic locations along and adjacent to the right of way. These sensors will record ground temperatures at various depths to confirm overall ground temperature regimes, depth of the active layer and temperature of the permafrost. These temperature readings will occur during construction and into the operational phase of the highway. This quantitative temperature data will be shared with scientists and permafrost engineers who are
undertaking ongoing regional assessments of permafrost, geomorphic, hydrologic and related climate conditions in the NWT and Northern Canada.

2.4 **Watercourse Crossing Structures**

Water course crossing structures along the ITH right of way will consist of single span bridges or culverts. All watercourse crossings will be constructed in the winter unless open water is encountered, in which case watercourse crossings will be constructed in accordance with the summer watercourse crossing methods identified in the Sediment and Erosions Control Plan. To ensure that the drainage system is functioning as designed and to ensure that there is no significant degradation of the underlying permafrost crossing structures and bridge abutments will be subject to ongoing visual inspections. In addition instrumentation will be installed at bridge abutments to record ground temperatures at various depths to confirm ground temperature regimes, depth of the active layer and temperature of the permafrost. These temperature readings will be taken during construction and into the operational phase of the highway.

2.5 **Analysis**

Quality assurance and quality control (QA/QC) of visual and quantitative monitoring results will be maintained through appropriate training of DOT staff and contractor staff, periodic verification of field observations and monthly review of monitoring results. Metadata and reporting standards will be established so the data can be integrated with existing permafrost data from the region. The ITH project team will continue to work closely with the geoscience and engineering community to investigate and test innovative means of monitoring permafrost and ground thermal conditions throughout the project area. These may include remote sensing geophysical survey techniques to track ground subsidence and any changes in the depth of the active layer. There is broad interest in the research community to evaluate the performance and effects of the ITH, and of natural processes and changing climatic conditions, on regional thermal regimes, hydrology and geomorphic events in the project area.

The ITH represents a strategic platform to support research initiatives which in cooperation will improve ITH permafrost monitoring efforts. Analysis may include integration of ITH PEMP ground temperature data and field observations into existing Geographic Information System (GIS) – based studies.

2.6 **Reporting**

An annual report of all permafrost monitoring activities will be prepared for the period of construction. Reports will provide results of permafrost monitoring activities, indicate if any issues were identified, and describe corrective actions to address these issues. The reports will also provide updates on relevant permafrost monitoring work being carried out in the project area by other parties.

Data will be provided to the NWTWB in tabular format and copies of reports prepared in hard copy and electronic format (PDF).
APPENDIX A  ITH Construction Atlas
INUVIK – TUKTOYAKTUK HIGHWAY CONSTRUCTION PLAN

Year Three (North, South)

Acknowledgements: Original Drawing by KAVIK-STANTEC LTD: Base Data: Government of Canada

DISCLAIMER: All locations are approximate, please refer to the Highway Final Design for specific locations.

Winter Camp 1
Winter Camp 2
Winter Camp 3

Winter Camp 1
Year 1 Move and Year 2 & 3 Operational

Winter Camp 2
Year 2 Move and Year 3 Operation

Winter Camp 3
Year 2 Move and Year 3 & 4 Operation

Winter Camp 2
Year 2 Move and Year 3 Operation