ROHL Global Networks

Permafrost Protection Plan

Yukon and Northwest Territories

Dempster Fibre Project

Submitted to MVLWB

Files MV2019X0027 & MV2019L8-0013

Document Overview	
Date Written	2022-03-16
Plan Owner	Engineering and Environmental
Date of Plan Review	2022-05-20
Date of Plan Revision	2022-06-10

Revision History

Date	Owner	Comments
April 14, 2022	ROHL Engineering and Environmental	V1.0 submitted to MVLWB for review
June 10, 2022	ROHL Engineering and Environmental	V2.0 Updated to incorporate recommendations from MVLWB public review

Conformity Table- Permits

LUP	WL	Requirement	Section of Plan
Part C, Condition 72	Part B, Condition 24	Develop a plan which will describe field level construction protocols and appropriate mitigation measures for the protection of permafrost.	2.0, 3.0

Conformity Table – Revisions

ID	Recommendation	Revision	Section of Plan
1	Include an introductory section to briefly describe and summarize the activities associated with the project (clearing, trenching, etc.)	Section 1.0 updated to include an introductory section describing the project activities	Section 1.0, page 6, 7
2	Develop an adaptive management response framework for inclusion in the Plan.	Section 2.0 “Adaptive Management Response Strategy” updated to include response framework.	Section 2.0, page 12, 13
3	Describe the purpose of probing, and the planned probing methodology. These details should be provided at the first use of the term pre-probing in the Plan.	Section 2.0 “Methods for Identifying Permafrost” list of methods and tools updated to include details of probing directly following the use of the term “pre-probing”.	Section 2.0, page 10
4	Compile all planned monitoring during and after construction so that the schedules and frequency of monitoring are clearly presented.	Section 2.0 updated to include a subsection on monitoring that describes monitoring activities and frequencies.	Section 2.0, page 11
5	Provide more details on training.	Section 2.0 updated to provide more details on training provided.	Section 2.0, page 8
6	A detailed description of soil characteristics is important to determine areas where specific mitigation activities are required. A transect outlaying these characteristics is advisable	Section 2.0 “Thaw Sensitivity” updated to clarify that maps displaying important characteristics related to permafrost will be produced for crews.	Section 2.0, page 9
7	Considering the elevated snowpack accumulation	Section 2.0 “Best Practices for Working in Permafrost” updated to	Section 2.0, page 11

	observed this year, extra caution should be undertaken throughout the construction phase as impacts to the active layer and permafrost/water table from increased insulating factors is likely to occur. These potential impacts to the active layer and permafrost are concerning and additional mitigation measures should be explored to reduce any further impacts.	include considerations for work in elevated snowpack accumulation.	
8	Ground probing by construction crews and environmental monitors should constitute an additional contribution to protecting permafrost, not the primary detection tool.	Section 2.0 “Methods for identifying permafrost” updated to clarify that probing by environmental monitors is the primary method used by ROHL to follow the design methods. In the design stage, engineering and geotechnical research conducted and incorporated into the planned route.	Section 2.0, page 10

Contents

1.0 OVERVIEW

Company Name, Location, and Mailing Address

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Purpose & Scope

The purpose of this plan is to outline the permafrost protection activities to be implemented throughout the duration of the Dempster Fibre Project (DFP). Permafrost protection activities will be conducted in any Project areas where permafrost is present, as well as in areas with a shallow active layer or ice-rich soil. Permafrost protection activities will support the preservation of permafrost underlying the project route. This plan is applicable to all construction crew personnel on the Project and outlines the activities associated with identifying permafrost, best practices for working in permafrost, mitigation activities for construction, and reclamation methods.

Effective Date

This plan will be effective from the date of approval by the authorities having jurisdiction and will expire on the date that the project is closed.

Revisions

Any revisions to the plan will be submitted to the Mackenzie Land and Water Board for approval and regulating agencies prior to implementing any changes.

Distribution

This plan and the most recent revisions will be distributed to all staff and contractors working on the project. The Plan will be presented and reviewed during an orientation prior to the start of construction. The Permafrost Protection Plan will be included as part of new staff orientation activities.

Licenses, Permits, and Fees

All permafrost protection activities associated with the construction, operation, and maintenance of the DFP will be done in accordance with this plan, and all applicable federal, territorial, and municipal laws and regulations.

Project Activities

The Government of Yukon, Department of Highways and Public Works (YG-HPW) is the owner of the DFP. YG-HPW will oversee the construction of the Project that will see the construction of an approximately 800-km fibre optic line from Dawson City, Yukon, to Inuvik, Northwest Territories (NWT). The line will connect the Yukon to the existing Mackenzie Valley Fibre Link in NWT, creating a continuous network running through the Yukon, NWT and northern British Columbia. This new line will ensure the Yukon, NWT, and other northern communities will have access to a secondary fibre network in the event of a service disruption. It will also benefit the northern communities that tie into the line through satellite by providing redundancy.

Construction of this project will require the followings activities:

Clearing:

Using low-impact mulching equipment and hand clearing, trees and brush shall be cut to a maximum height of 0.15 meters above the ground, with a maximum length of residue of 0.30 meters. All riparian area vegetation control shall be hand cleared only. No residue shall be allowed to enter water courses or water bodies, and residue will not be allowed to remain on roadway surfaces. All residue to be removed no later than the end of each workday.

Conventional Bury:

Use vibratory plow to cut and create trench at a target depth of 1.0 m.
Appropriate plow train or tandem tractor configurations are allowed as necessary to complete work; configurations must ensure minimal ground disturbance.

Shallow Bury:

Use trencher (i.e. chain-wheel and/or rock-wheel) or vibratory plow to cut and create shallow trench at a depth >300 mm ‑ 1.0 m. Appropriate plow train or tandem tractor configurations are allowed as necessary to complete work; configurations must ensure minimal ground disturbance.

Sub-Surface Lay:

Use trencher (i.e. chain-wheel and/or rock-wheel) or vibratory plow to cut and create shallow trench at a depth >150 mm ‑ <300mm. Appropriate plow train or tandem tractor configurations are allowed as necessary to complete work; configurations must ensure minimal ground disturbance.

Surface Lay:

In ponds and waterbodies where means of burial are not feasible the facility will be laid in the surface and allowed to settle to the bottom. Only applicable in non-flowing waters.

Horizontal Directional Drilling (HDD):

HDD of all fish bearing-bearing streams, rivers, and other water bodies or challenging sections.

New Aerial:

New aerial cable installations will be installed in sensitive terrain or challenging conditions to minimized ground disturbance.

2.0 UNDERSTANDING AND IDENTIFYING PERMAFROST

Overview of Permafrost Characteristics on the Dempster Highway

Permafrost is found along almost the entire length of the Dempster Highway, with the exception of small sections along the first 80 km. Much of this permafrost is ice-rich and sensitive to disturbance. The

Dempster highway has a unique construction designed to minimize permafrost disturbance. Climate change has begun to accelerate permafrost degradation along the Dempster Highway and across northern Canada.

All Project personnel will undergo training in permafrost protection and awareness. This training will be included as part of the orientation prior to the start of construction activities, as well as new-to-site orientation. Training will be conducted on the contents of this Permafrost Protection Plan. A Qualified Environmental Professional (QEP) will conduct environmental training with all Project personnel prior to work beginning each year. The training will include outlining the concerns related to permafrost, placing emphasis on the unique characteristics along the Dempster Highway, the project tools available for identifying thaw-sensitive and ice-rich permafrost locations, mitigation measures for minimizing impact to permafrost, and reclamation measures for responding to disturbance.

Basics of Permafrost

Permafrost is ground that stays frozen (0ºC) for at least two consecutive years. It can be found in any kind of soil or rock. Permafrost is as hard as concrete when it is frozen, but ice-rich permafrost can turn into liquid mud if it thaws.

- Permafrost has ice mixed with frozen soil. Sometimes it contains more ice than soil. The ice can be small crystals in the soil, lenses of pure ice, or massive pieces of buried ice.
- Most permafrost along the Dempster Highway corridor is only a degree or two below freezing (0°C). This makes it very sensitive to thaw caused by disturbance. It is possible for permafrost to warm up, but not thaw, provided it stays below 0°C.
- Permafrost thaw happens when it warms enough so that the ice in soil melts and turns into water. This usually happens when the active layer thaw increases in thickness from the ground surface down. The more ice there is in the soil, the more sensitive it is to thaw. Thaw usually happens from the top downwards.

Active Layer Above Permafrost

The active layer is the thin layer of soil between the ground surface and permafrost that freezes in the winter and thaws in the summer every year.

- The depth of thaw layer thickness varies seasonally, typically beginning to thaw in spring and reaching its maximum thickness typically in late summer to early fall.
- The thickness of the active layer varies across regional and local scales in association with different latitude, elevation, aspect, slope position and shape, soil texture and drainage, snowpack and vegetation cover. The active layer might be only 30 cm deep in areas with thick moss, and several metres thick in well drained, course-textured soils.
- The active layer is usually thicker than the largest rocks in the soil. Silt and clay, glacial till (a mix of rocks and clay), sand and gravel, and bedrock have increasingly thick active layers.
- If the active layer does not completely freeze back during the winter, underlying permafrost is thawing.

Ground Ice

Ice in permafrost soils can be invisible, small crystals, thin layers, wedges or massive bodies of buried ice leftover from past glaciers.

- Silt and clay usually contain a lot of ice. The ice can be crystals, lenses, wedges, and/or massive layers.

- Glacial till has less ice, mostly wedges and lenses with occasional pieces of buried glacier ice.
- Sand and gravel do not have much ice, but can sometimes have ice wedges.
- Bedrock does not have much ice, typically just in cracks near the surface.

Thaw Sensitivity

The sensitivity of permafrost to disturbances depends primarily on temperature, ice content and soil type. Permafrost protected by insulating ground cover, typically mossy organics, is more sensitive to surface disturbance.

- Relatively warm permafrost (i.e., warmer than -2^{o}C) with excess ice, typically found in fine-grained sediments and/or organic material susceptible to collapse or sinking, is referred to as "thaw-sensitive". Relatively warm permafrost is more susceptible to thaw due to localized and even minor disturbances to the ground surface, whereas cooler permafrost can withstand minor disturbances without appreciable effect. Permafrost along much of the Dempster Highway corridor is generally warmer than about -5^{o}C. Maps will be provided to crews that present permafrost characteristics, including anticipated active layer depths, and to highlight locations where specific mitigation activities will be required.
- Permafrost that is out of equilibrium with current climatic conditions and only persists in areas of thick, mossy organic cover is more sensitive to disturbance through ground disturbance (e.g., stripping or compaction of organics).
- Permafrost within fine-grained material is more likely to contain discrete bodies of ice and is more sensitive than that within weathered bedrock. Ice-poor permafrost is comparatively insensitive to disturbance.

Identifying Permafrost

Protecting permafrost is all about recognizing sensitive permafrost and protecting vegetation. Learning how to identify areas of sensitive permafrost is critical to knowing where vegetation damage could trigger permafrost thaw.

Permafrost and Terrain

Permafrost is widespread along the Dempster Highway. Active layer thicknesses vary according to soil types, slope direction, water, and vegetation.

- North-facing slopes generally have permafrost underlying thin active layers.
- South-facing slopes generally have permafrost underlying thick active layers.
- Alpine areas above tree line almost always have permafrost.
- Valley bottoms almost always have permafrost.
- Creeks often have a small, thawed area right under the water and fresh gravel deposits, but have permafrost deeper beneath and to the sides.
- Rivers have permafrost on the banks. Permafrost may or may not be present below the river bottom.
- Lakes generally do not have permafrost under the water. Small lakes may be underlain by permafrost.
- Swamps that freeze to the bottom every year generally are underlain by permafrost.

Permafrost and Vegetation

Vegetation acts as a blanket that insulates the ground in the summer. Different types of permafrost are found under different types of vegetation. Sensitivity of permafrost to disturbance and thaw can be reasonably predicted based on vegetation.

- Preservation of moss and low grassy vegetation is critical to protecting permafrost**.**
- Trees shade the ground during the summer and prevent the full heat of the sun from warming the ground surface.
- Sensitive permafrost can usually be recognized by thick moss, small spruce trees tilted at odd angles, and ponded water among grassy hummocks.
- Aspen and willows are usually indicators of thicker active layers.
- Active layers are usually thick in bare gravel, sand, and bedrock, so underlying permafrost is less sensitive to surface disturbance.

Permafrost and Snow

Deep snow insulates the permafrost in the winter. Unnaturally deep accumulations can prevent the active layer from fully refreezing. During the next summer, permafrost thaw is usually apparent.

- Natural snowdrifts that form down-wind of the highway embankment, especially in areas of windswept tundra, can achieve this insulating effect.
- Deep snow can delay thaw of the active layer in the spring and form ponds when it melts.

Methods for Identifying Permafrost

The following methods and tools will be implemented to ensure construction crew and personnel have the knowledge and resources available to identify areas with a high potential for permafrost prior to conducting installation activities.

- Understanding the nature and distribution of thaw-sensitive permafrost along the highway corridor is critical to optimization of fibre optic cable (FOC) installation and the management of risk to permafrost. The project-specific Engineering and GeoTechnical Design provided by the Yukon Government will be used as a planning tool to identify areas that are likely to have permafrost. This information will be used to indicate areas where pre-probing will be conducted prior to installation.
- Distinguishing where thaw sensitive and thaw-stable permafrost is located is critical to protecting permafrost and installing buried cables. Environmental Monitors will conduct pre-probing of the planned route every 100m to determine achievable depths in ice-rich permafrost areas. In areas that are likely to have ice-rich permafrost, pre-probing will be conducted every 10-20m. This information will be used to support determining the timing of installation for achieving maximum burial depth and the method of installation to be used. Probing is conducted with a steel rod (<1.5 m long) that is pushed by hand into the active layer until it stops on permafrost. The probing by environmental monitors is the primary method that will be used in the field to follow the design methods. Engineering and Geotechnical design and research to identify thaw sensitive and thaw-stable permafrost was conducted and incorporated as part of the design process for the Project.
- Site supervisors will conduct visual examinations using the above discussed terrain and vegetation features to identify landscape features that support a high potential for permafrost along the Project route. Sites identified during visual inspections will be assessed with pre-probing prior to installation.

- Inference of general characteristics of ground ice can be made in areas with ice-wedge polygons, retrogressive thaw slumps, and areas already exhibiting permafrost thaw activity (e.g., thaw ponds). Where there are no surface indicators of ground ice, however, field investigations are required to assess ground ice conditions.

Best Practices for Working in Permafrost

The most reliable means of protecting permafrost from surface activities is to keep ground disturbance to a minimum. This section outlines the best practices for working in ice-rich permafrost areas that will be implemented throughout the Project to minimize the likelihood of impacting permafrost during construction activities.

- **Protection of surface organics:** Protection of surface organics during installation of the FOC is critical to the protection of underlying permafrost:
    - Removal of the organic mat should be avoided altogether during installation of the FOC.
    - Compaction of the organic mat should also be avoided, to the extent possible, as minor and localized thinning can promote the thickening of the active layer and degradation of underlying permafrost.
    - Tearing of the organic mat should be limited to the extent possible, and tears should be closed back over the narrow slice/trench immediately following installation of the FOC. Field crews should carefully inspect the installation behind the plow and manually restore the surface continuity of the organic mat over the slice/trench wherever necessary. In areas with large tears or complete removal of the organic mat, moss from a nearby area (without thaw-sensitive permafrost) should be immediately used to cover the exposed soil. The moss 'transplants' should be monitored carefully during the summer thaw seasons of the initial years that follow.
- **Managing surface water**: Every effort should be made to minimize the disruption of natural water movements through the active layer. Minimizing the width and depth of the slice/trench required for FOC installation will help minimize the potential for surface water pooling, as will minimizing the duration that the slice/trench is kept open. Ensuring that mineral soil not containing any snow or ice is backfilled beneath a restored organic mat will reduce the potential for permafrost degradation and channeling of surface water runoff.
- **Managing snowpack accumulation**: Site supervisors will conduct scouting ahead of the construction crews and will identify areas with elevated snowpack accumulation. In these areas, only low-ground pressure equipment will be used to minimize the compaction or organics and impacts to the active layer. In areas of particular sensitivity concern, horizontal directional drilling will be used. Lastly if an area is too sensitive to be crossed with the LGP unit and cannot be drilled, the network alignment can be altered to cross the road to a less sensitive area.

Monitoring

During construction, areas of sensitive or special concern and areas of ice-rich permafrost with a shallow active layer where installation has occurred will be visually monitored by environmental monitors on a minimum of a monthly basis to review the sites for signs of thaw or degradation related to project activities. These sites will be revisited in the following year after snow melt to review the site and to take additional probe depth measurements. These depths will be compared with previous years' measurements to determine whether thickening of the active layer has occurred. Visual inspections of these sites will continue to occur throughout the subsequent construction seasons. After construction, inspection and monitoring of the fibre line will be completed following NWTel's Inspection and Maintenance Program.

Best Practices for Permafrost Reclamation

The most immediate and pronounced effects of ground disturbance are most likely to occur in areas of thaw-sensitive, ice-rich permafrost. Field crews will note and photograph any obvious changes in ground conditions along the recently installed sections of the FOC. Understanding how the ground responds to FOC installation, in different terrain units, will contribute valuable information to approaches to FOC installation along subsequent sections of the alignment. Inspection also provides the opportunity for early detection of any changes that may warrant proactive remedial efforts. Documented changes in the rate of thaw or thickness of the active layer along the alignment of the FOC must be investigated before attributing them to disturbance caused by FOC installation. Based on a comparison with nearby undisturbed conditions, it may be demonstrated that the changes are not unique and reflect the ongoing effects of highway operation and/or the accelerated effects of climate change.

In the event that warming/thaw of permafrost is documented and attributed to disturbance related to FOC installation, measures should be promptly taken to mitigate further degradation and any impacts to infrastructure or the environment. This section outlines the reclamation activities to be implemented in the event that an impact to permafrost occurs as a result of Project activities.

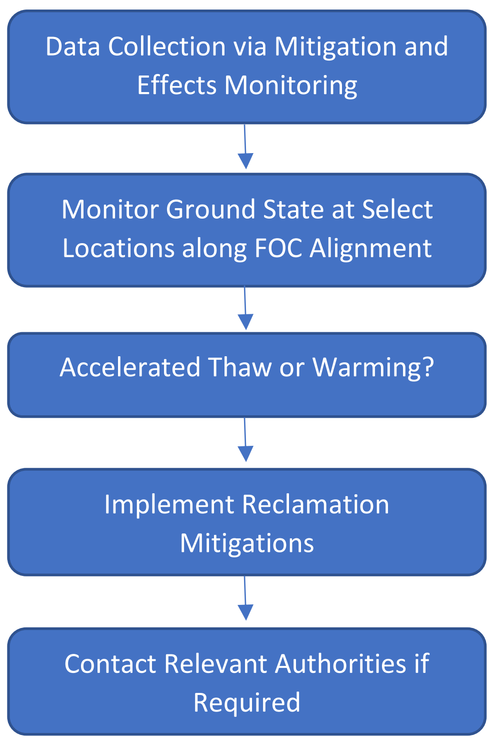
- **Re-establishment of organic cover**: Revegetation of any disturbed areas with native plant species should be completed as soon as possible. Any exposed soils without the insulating benefit of moss and surface organics should be manually covered as soon as possible with additional moss cover to reduce summertime heat transfer into the ground and discourage water pooling. If the issue is identified when snow is present, moss placement is best deferred until the ground becomes snow-free in the spring. Revegetation of any disturbed areas with native plant species should be completed as soon as possible.
- **Compaction of accumulating snow**: If the site of concern coincides with an area of snow accumulation alongside the highway, whether due to drifting by wind or routine plowing of the road surface, the snow should be dispersed or compacted as it accumulates. Maintaining a thin snowpack helps increase penetration of freezing temperatures into the ground and helps reduce the potential for thickening of the active layer.
- **Dispersion of surface water**: If water begins to pond in, or preferentially follow, the trench/slice within which the FOC has been installed, heat may be transferred more efficiently into the ground. Effort should be made to restore natural drainage patterns to the extent possible, such that surface water is not unnaturally concentrated in areas of particular concern to infrastructure or the environment. The manner in which drainage can be achieved is best determined through site-specific assessment All efforts to restore natural drainage patterns will be conducted following the procedures of the Project’s Erosion and Sediment Control Plan.

Adaptive Management Response Strategy

Adaptive management is an approach that links monitoring to management actions. Adaptive management for the Dempster Fibre Line project will combine knowledge collected from mitigation and effects monitoring, Indigenous Knowledge, and input from regulatory agencies to continuously improve management practices that protect permafrost from potential effects of the Dempster Fibre Line Project.

The purpose of monitoring active layer and permafrost conditions is to provide an opportunity to detect early, and respond to, any issues of concern. The appropriate response depends primarily on the type and rate of the documented change in relation to 'control' sites beyond the influence of existing highway (or other) infrastructure or FOC installation. It also depends on the sensitivity of the site and its surroundings, considering the proximity to highway infrastructure or sensitive habitat. Prompt action is critical to avoid significant thermokarst development, which is challenging to control once initiated.

The below flow chart presents a framework that guides the monitoring, trigger and risk-based response strategy based on basic observations and measurements at locations along the FOC alignment. The flow chart outlines how prompt and appropriate action can be taken before any changes begin to impact infrastructure or the environment.



3.0 MITIGATION MEASURES FOR CONSTRUCTION ACTIVITIES

General Mitigation Measures

This section outlines the permafrost protection activities to be implemented as part of construction activities:

- Installation of the cable will occur within the existing Right of Way (ROW) of all roads and highways along the Project route.

- Installation of the cable will not occur within the permafrost layer. All installation of cable will be within the active layer of the soil, as determined by the pre-probing investigations.
- Installation of the cable in high potential areas will be timed with the seasonal maximum thaw of the active layer to minimize the potential of impacting the permafrost underlying the Project route. If a section is found to have a shallow active layer and does not support conventional bury, the section will be skipped for the immediate timeframe, and the crews will return later in the season when a deeper installation into the active layer is possible.
- Environmental monitors will conduct pre-probing of the planned route to determine achievable depths in ice-rich permafrost areas.
- All brushing activities required will address trees and shrubs along the route to be followed by the plow, limiting impact to the mossy layer and organic cover of the ground. Brushing will include the use of low-impact mulching equipment and hand clearing.
- Disruption of the organic layer by equipment and foot traffic along the installation route and when moving equipment to/from the highway will be minimized as much as possible.
- Site supervisors will maintain weekly visual inspections of Project areas pre- and post-installation during construction to assess for signs of thaw and pooling water. Indications of pre-existing thaw or other disturbances will be documented, and if necessary, alternate placement methods will be discussed with the consultant and owner to avoid further impact. Any indications of permafrost impact due to construction activities will be remediated immediately.

Mitigation Measures Related to Plowing

This section outlines the permafrost protection activities to be implemented as part of plowing activities:

- Low ground pressure equipment (under 5 Psi or 35 kPa) will be used in areas where organic compaction will need to be keep to a minimum to reduce ground disturbance, including compaction during conduit/cable installation. For HDD, rig mats can be utilized in such areas.
- The plow will be equipped with a rounded shoe to enable it to ride on top of permafrost and to avoid damaging the permafrost while maintaining the pre-probe depth.
- Ground crew will visually monitor the depth of the sheer while following behind the plow train to ensure it is maintaining pre-probe depth.
- Immediately after installation of the conduit, the ground crew and clean-up equipment will restore the organic layer by backfilling and re-contouring the plow slot as necessary.
- Where possible, a bury depth of 1m using conventional bury will be the preferred method of installation. Conventional bury technique will be used when a bury depth of at least 300mm (30cm) in the active layer can be achieved.
- In areas where the achievable bury depth is less than 300mm (30cm), shallow bury technique will be used. With shallow bury, a smaller diameter conduit will be used, along with sandbags or cable weights to prevent movement and minimize impacts to the organic, active, and permafrost layers, as well as to prevent the erosion of sediments. Design changes will be communicated to the Owner and Consultant by following the reporting procedures outlined for the Project.

Mitigation Measures Related to Horizontal Directional Drilling

This section outlines the permafrost protection activities to be implemented as part of horizontal directional drilling (HDD) activities:

- HDD may, in some cases, be used in areas where pre-probe data and ground conditions indicate a heightened risk of permafrost disturbance.
- Once a permafrost area has been identified where an HDD crossing will occur, the drilling crew will set up rig matts if necessary to protect the organic layer from damage from the drill.

Mitigation Measures Related to Placement of Vaults and Tie-Ins

This section outlines the permafrost protection activities to be implemented as part of the placement of vaults and tie-ins:

- A backhoe or small excavator will peel off the organic layer, trying to keep it intact as much as possible and set to the side of the work area.
- Once a tie-in or vault has been completed, the backhoe or excavator will back fill and then place the organic material back to its pre-construction location as best as possible. Care will be taken to ensure no soil is exposed following the re-placement of the organic layer.
- When placing handholes in the active layer, the handholes will be placed at grade to minimize disturbance of the organics and the active permafrost. The handholes will have fill placed around them to offer protection against movement and to minimize water pooling inside.

4.0 PROCEDURE SIGNOFF

I have received a copy of all relevant documents related to the **Permafrost Protection Plan** for the **Dempster Fibre Project**. I have received answers to any questions and will complete the activities per the plan and as directed by ROHL.

Name	Signature	Date of Review