PermafrostNet
NSERC | CRSNG

NSERC CRSNG

NSERC PermafrostNet Mid-Term report

Executive Summary

Tristan MacLean
NSERC PermafrostNet Director of Operations

www.permafrostnet.ca

Executive Summary

NSERC PermafrostNet is a strategic partnership network funded for 5 years from 2019 to 2024. At the mid-point of the network, we carried out an assessment of the network progress and reported this to our funder the Natural Sciences and Engineering Research Council of Canada (NSERC). The report covered the progress of the network towards its objectives, challenges encountered, including the impact of the covid-19 pandemic, how the network is managed, and decisions are made, the progress of training graduate students and post-doctoral fellows, the collaborations with partners, how the findings are disseminated and the financial status of the network. The report was reviewed by our partner organizations and feedback provided in November 2022. This executive summary includes feedback from partners and a brief update on the progress since the reporting end date in January 2022.

Mid-term report (June 2019 - January 2022)

The network is overseen, advised and managed by a number of governing bodies and individuals, including a Board of Directors chaired by Janet King, PhD, a Scientific committee, Knowledge Mobilization and Communication committee, and Equity, Diversity and Inclusion committee. The network is further supported by a Scientific Director, Prof. Stephan Gruber, Deputy Scientific Director, Theme leaders, a Director of Operations, a Data Scientist and a number of sub-committees and additional governing bodies, such as the Strategy Committee and the graduate student and post-doctoral advisory committee.

The network research focuses on the big questions: Where and when is permafrost thaw occurring in Canada and what are the hazards arising from such change? To achieve this the research is organized into five interwoven themes requiring a critical mass and diversity of expertise that no single research group or government agency has. The network is a multidisciplinary arrangement of complementary expertise that works together with three aims; to quantify, understand and predict permafrost thaw and its consequences; to connect spatial scales from individual sites up to Earth-system modeling; and to prototype reliable and useful data and knowledge products for scientific research, engineering and application in government, communities, and industry.

The themes are overseen by Theme leaders and investigators at eleven different Canadian universities. By January 2022 the network had recruited 30 graduate students and four postdoctoral fellows (PDFs), and during 2022 a further two PDFs, one PhD and two MSc projects commenced. Now, in April 2023 we have 27 research studies ongoing, with five completed projects. In March 2020, shortly after the network began and recruitment was underway restrictions were imposed due to the COVID-19 pandemic. This led to difficulties filling research positions, conducting lab work, and undertaking fieldwork during the 2020 and 2021 field seasons due to travel restrictions. Despite this, some projects were able to shift focus to analyzing existing sample datasets, performing synthesis activities, changing study locations, or using satellite-based remote sensing to achieve project goals. This work has been laying the foundation for advances in permafrost science and engineering practice across diverse topics such as data interoperability, numerical modelling and prediction, and practical applications of scientific theories for adaptation to permafrost thaw. In addition, results are already emerging, with papers published in journals such as Arctic Science, Remote Sensing, Permafrost and Periglacial Processes, the Journal of Open Source Science, and Nature Reviews Earth & Environment.

Over 40 partner organizations have been supporting this networked permafrost research since 2019. By January 2022, these organizations had reported in-kind contributions to research

activities totalling $1,781,578, and the impacts of this network-based approach has been demonstrated by additional contributions of $665,502. The value of the network to our partners was expressed in their feedback to NSERC. The Yukon Geological Survey (YGS) find the networks role in coordinating permafrost data management across multiple jurisdictions is extremely valuable, with the leadership of the network Data Scientist Nick Brown particularly appreciated. YGS also found that collaboration with Dr. Lewkowicz and colleagues at Yukon University studying a thaw slump near Takhini river had been a high-profile project that has helped YGS to raise awareness with their senior government officials about the impacts of climate change on their infrastructure. The Standards Council of Canada reported that research results will inform the Northern Infrastructure Standardization Initiative, and "can be leveraged by SCC to inform future editions of existing standards or develop new standards to support stakeholders at all levels, from policy makers to community leaders, and to engineers as they work to adapt infrastructure to a rapidly changing climate." The Geological Survey of Canada have been involved in developing improvements to the Ground Ice Potential Map (GRIP) and "expect to benefit from the improved standardization of permafrost data collection, storage, interoperability, and language that will result from GRIP". The network benefits are also being felt by industry, with BGC Engineering Inc. planning to incorporate the network's results into development of a geo-asset and hazard management tool for transportation infrastructure in permafrost regions.

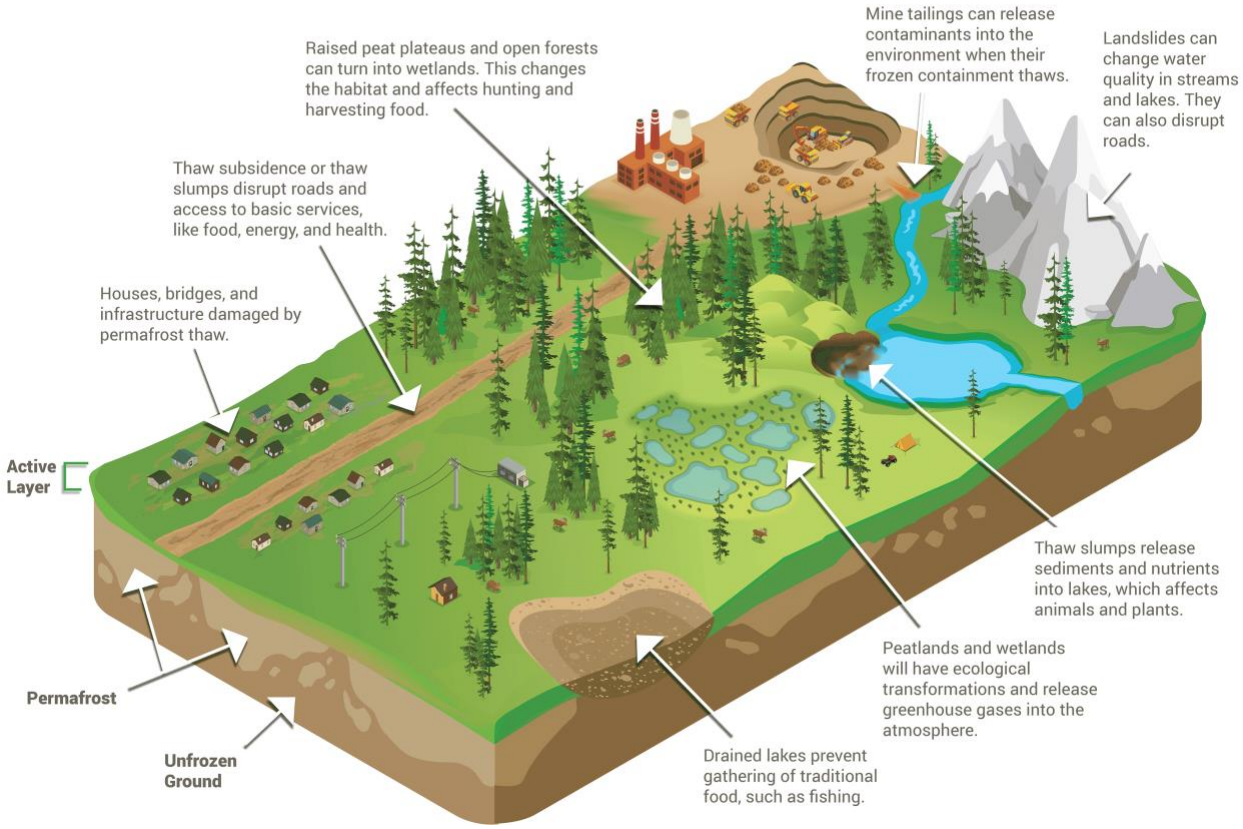
Since January 2022

The network has continued to progress both the research and the community building that makes a strategic partnership network more than just a collection of individual research projects. Researchers gathered at Kluane Lake Research Station in August 2022 to discuss issues in research, learn new skills and forge stronger connections to each other. For many of the trainees this was their first trip to the North and enabled them to see the impacts of thawing permafrost in-person and visit the Da Kų Culture Centre, to learn about the lives and traditions of the Champagne and Aishihik First Nations (CAFN) Dän (people). This was followed by the North Yukon Permafrost Conference, organised by the Tr'ondek Hwech'en First Nation, the First Nation of Na-Cho Nyak Dun, the Vuntut Gwitchin First Nation, and the Canadian Permafrost Association in Dawson City, YT. The conference provided opportunity to hear directly from members of the regions First Nations about their experiences with thawing permafrost and featured research presentations by network members and posters by 15 graduate students and post-doctoral fellows. In November 2022, the network held the Mid-Term AGM and an Open House at the Tree of Peace Friendship Centre in Yellowknife, NT. The Tree of Peace encourages cross-cultural understanding and awareness between Dene, Metis, Inuvialuit, and non-aboriginals. These events were combined with the Geoscience forum where students and investigators shared their research findings. On the global scale NSERC Permafrost has been fostering connections, sharing permafrost knowledge and stimulating discussion on issues vital to researchers by organizing the International Day of Permafrost, a one-day virtual event in March 2023 featuring 25 organizations from around the world and attendees across 28 countries, who came together to share their work, take part in breakout discussions and engage in a virtual poster session. The network is also supporting an initiative 'Toward a vision and strategy for Canadian permafrost knowledge' through a strategy committee that has been facilitating micro-engagements and strategic conversations, such as a panel on permafrost at the Canadian Science Policy Conference in December 2022.

As the network heads into the final two years of its mandate we expect to see even more significant results and outcomes of the hard work that has gone into bringing together and establishing this diverse and highly talented group of researchers as they tackle the impacts of climate change on Northern Canada.

Why we need to prepare for permafrost change

Northerners are already experiencing the rapidly increasing impacts of permafrost thaw. Here are some examples of the changes that can happen when permafrost thaws.



Permafrost is ground that has been frozen (below 0 °C) for at least two years. It is found below the surface layer of ground that freezes in cold seasons and thaws in warm seasons.

Nearly **half of Canada** sits on top of **permafrost.** Canada has the second most permafrost in the world after Russia.

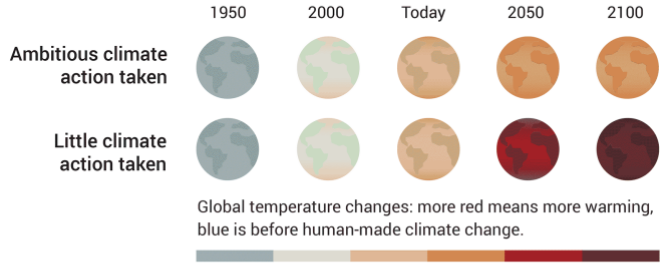
Permafrost is **hidden** for many Canadians – underground and in remote locations.

People are directly affected by permafrost change in this region.

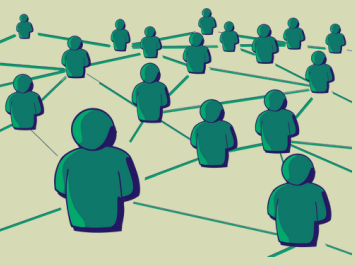
Indirect effects exist throughout Canada and the world.

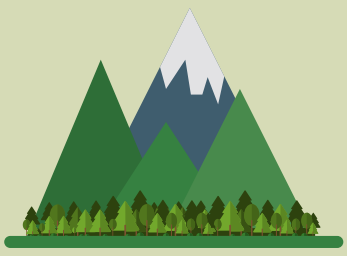
Scientists create additional knowledge about permafrost.

Understanding how and why permafrost thaws helps to also understand what changes are likely in the decades and centuries to come.



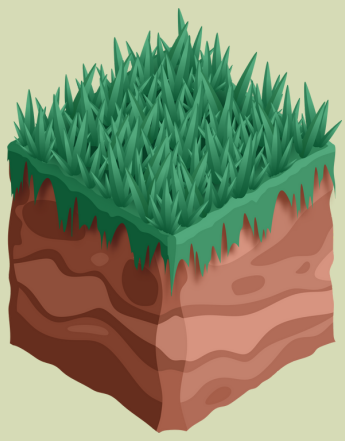
Global air temperatures will continue to rise for decades. Without ambitious climate action, they will keep rising. Thawing permafrost will cause serious problems to land structure, infrastructure, wildlife, and Northern communities.





NSERC PERMAFROSTNET

The journey of networked permafrost research



2019

Origins

The network started in June 2019 with the announcement from NSERC of the successful funding of the strategic partnership.

2020

The gatherings

The first AGM was held in November 2019 and recruitment of students and post-doctoral fellows got underway.

2021

The pandemic

In March 2020 the COVID-19 pandemic brought in travel,work and social restrictions. This led to difficulty recruiting trainees and carrying out fieldwork.

2022

Adapting to change

By 2022 the network was progressing well, having adapted to the pandemic restrictions and seing a return to fieldwork and in-person events.

2023

Coming together

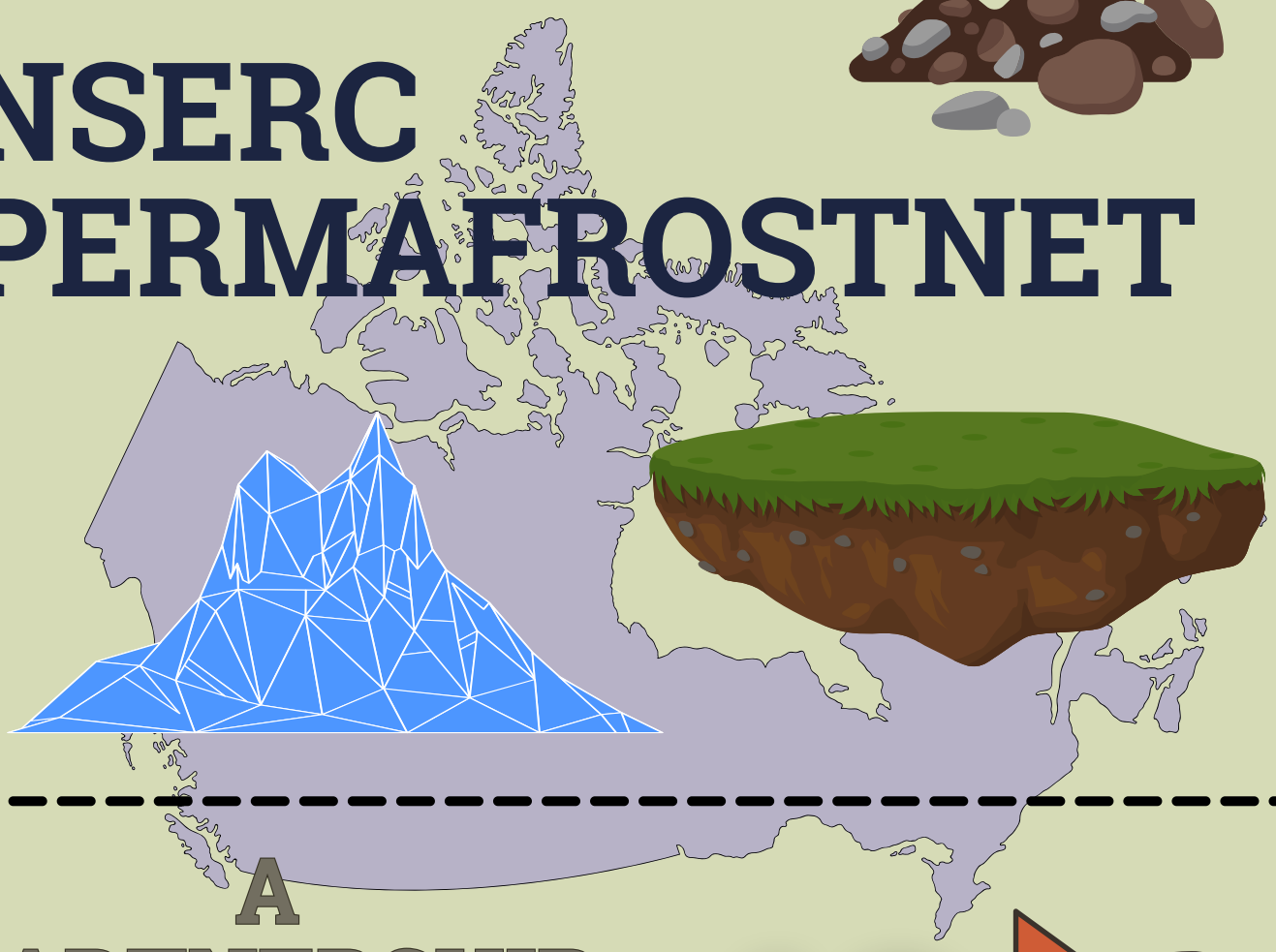
The latter half of 2022 saw significant gatherings of network members at Kluane Lake, in Dawson City and in Yellowknife.

As we move forward the permafrost community is thinking strategically about future coordination to tackle thawing permafrost.

The results emerge

With projects well underway and some students now graduated the fruits of the intial hardwork are starting to pay off and we are planning for the legacy of networked research beyond 2025.

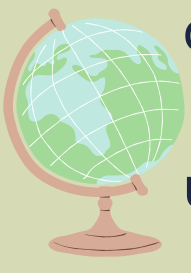
NSERC PERMAFROSTNET



A PARTNERSHIP

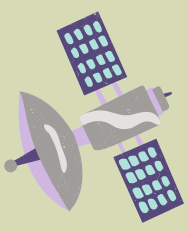
40

The network is made up of 40 partner organizations including 11 universities.



11

THEMES



Research is organized into five themes.

5

TRAINING

60

Over 60 people will be trained in permafrost research, techniques.

PROJECTS

30

There are over 30 research projects.

The findings of the network will be shared with a wide range of stakeholders.

further details on

WWW.PERMAFROSTNET.CA

Partners

Environment and
Climate Change Canada
Environnement et
Changement climatique Canada

FEDERATION
OF CANADIAN
MUNICIPALITIES

FÉDÉRATION
CANADIENNE DES
MUNICIPALITÉS

Standards Council of Canada
Conseil canadien des normes

PermafrostNet
NSERC | CRSNG

NSERC CRSNG

NSERC PermafrostNet Mid-Term report

June 2019 – January 2022

Tristan MacLean & Joe Melton
NSERC PermafrostNet Director of Operations
and Deputy Scientific Director

www.permafrostnet.ca

Strategic Partnership Grants for Networks
Progress Report

Due Date: March 30, 2022
Covers the Period: June 30, 2019 to December 31, 2021

Is your personal information below correct? (please enter an "x" in the appropriate box)

x **Yes**
No (please make the necessary corrections)

Dr. S.W. Gruber
Dept. of Geography & Env. Studies
Carleton University
1125 COLONEL BY DR
OTTAWA ON. K1S 5B6

Tel.: +1 (613) 520-2600, Ext.2562
E-mail Address: stephan.gruber@carleton.ca

Is the project information below correct?

Yes
x **No (supporting organizations and contacts have been updated) Highlighted in red**

Project title: NSERC Permafrost Partnership Network for Canada
File Number: NETGP 523228 - 18

Co-Investigators(s):

A.G. Lewkowicz, Professor, Geography, Ottawa
C.R. Burn, Professor, Geography and Environmental Studies, Carleton
B.J. Moorman, Professor, Geography, Calgary
C.R. Duguay, Professor, Geography and Environmental Management, Waterloo
D.G. Froese, Professor, Earth and Atmospheric Sciences, Alberta
J.L. Hayley, Professor, Civil Engineering, Calgary
T.C. Lantz, Associate Professor, Environmental Studies, Victoria
S. Kenny, Professor, Civil and Environmental Engineering, Carleton
J.R. Melton, Adjunct Associate Professor, Earth and Ocean Sciences, Victoria
D. Fortier, Professor, Géographie, Montréal
P.M. Roy-Léveillée, Associate Professor, Geography, Laval
B.T. Rabus, Professor, Engineering Science, Simon Fraser
O. Sonnentag, Associate Professor, Géographie, Montréal
R. Beddoe, Associate Professor, Civil Engineering, Royal Military College of Canada

Collaborator(s):

S. Wolfe, Geological Survey of Canada
S. Smith, Geological Survey of Canada
M. Lafrenière, Queen's

S. Kokelj, Northwest Territories Geological Survey
E. Humphreys, Carleton
C. Spence, Environment and Climate Change Canada
A.M. LeBlanc, Geological Survey of Canada
K. Karunaratne, Northwest Territories Geological Survey
J. McLaughlin, Ontario Ministry of Natural Resources and Forestry
R. Fraser, Canada Centre for Mapping and Earth Observation
T. Tremblay, Canada-Nunavut Geoscience Office
M. Geertsema, B.C. Ministry of Forests, Lands & Natural Resource Operations
F. Calmels, Yukon Research Centre
P. Lipovsky, Yukon Geological Survey
Y. Zhang, Canada Centre for Mapping and Earth Observation
A.J. Cannon, Environment and Climate Change Canada
M. Packalen, Ontario Ministry of Natural Resources and Forestry
S.C. Coulombe, Polar Knowledge Canada
P. Morse, Geological Survey of Canada
P. Pulsifer, National Snow and Ice Data Center USA
D. Stillman, Southwest Research Institute USA
M. Krautblatter, Technical University of Munich
S. MacDougall, Yukon Government, Transportation Engineering Branch
V. Amos, Inuvialuit Game Council
E. Hille, Aurora Research Institute
D. Cronmiller, Yukon Geological Survey

Supporting Organization(s):

J. W. F. Ketchum, Government of Northwest Territories, Northwest Territories Geological Survey (NTGS)
C. D. Relf, Yukon Geological Survey
L. C. Cheng, Environment and Climate Change Canada
S. Holzman, Government of Nunavut
C. Ponsart, Ministère des Transports du Québec
N. Couture, Geological Survey of Canada
G. Neale, Churchill Northern Studies Centre
A. E. Walker, Environment and Climate Change Canada
L. Arenson, BGC Engineering Inc.
L. J. Ham, Canada-Nunavut Geoscience Office
A. R. B. Bevington, BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development
R. Caves, MDA Systems Ltd.
B. Hanna, Government of Northwest Territories
Y. Kabir, Transport Canada
M. Idrees, Government of Yukon, Transportation Engineering Branch
B. Allin, Standards Council of Canada
D. R. Moore, Government of Northwest Territories
R. Turpin, Government of Yukon, Department of Environment
I. Egorov, National Research Council Canada
C. Stevens, SRK Consulting
A. McCulley, Tr'ondëk Hwëch'in
A. Amos, Gwich'in Renewable Resources Board
A. Church, Government of Yukon, Parks
S. J. O'Neill, Federation of Canadian Municipalities
D. Kasook, Inuvialuit Joint Secretariat

J. McLaughlin, Ontario Ministry of Natural Resources and Forestry
P. Shukle, Natural Resources Canada
P. Burke, Fort Severn First Nation

Table of Contents

Table of Acronyms

AEM	Airborne Electromagnetic
AGM	Annual General Meeting
ARI	Aurora Research Institute
ASTD	Atmospheric Science and Technology Directorate (ECCC)
BOD	Board of Directors
BEC	Board Executive Committee
CanESM	Canadian Earth System Model
CCADI	Canadian Consortium for Arctic Data Interoperability
CCS	Government of Nunavut Climate Change Secretariat
CCCS	Canadian Centre for Climate Services (ECCC)
CCMEO	Canada Centre for Mapping and Earth Observation
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CLASSIC	Canadian Land Surface Scheme including Biogeochemical Cycles
CMIP6	Coupled Model Intercomparison Project 6
CNGO	Canada Nunavut Geoscience Office
CNSC	Churchill Northern Studies Centre
CPA	Canadian Permafrost Association
CPERS	Canadian Permafrost Electrical Resistivity Survey
CREATE	NSERC Collaborative Research and Training Experience
CT	Computed Tomography
DEM	Digital Elevation Model
DO	Director of Operations (Network Manager in the proposal)
DOI	Department of Infrastructure, Government of the Northwest Territories
DOI	Digital Object Identifier

EDI	Equity, Diversity and Inclusion
EDIC	Equity, Diversity and Inclusion Committee
ERT	Electrical Resistivity Tomography
ESM	Earth System Model
FCM	Federation of Canadian Municipalities
FIPPA	Freedom of Information and Protection of Privacy Act
FLNROD	Ministry of Forest, Lands, Natural Resource Operations and Rural Development (BC)
FNNND	First Nation of Na Cho Nyak Dun
Fodar™	Foto detection and ranging
GEOBIA	GEographic Object-Based Image Analysis
GRIP	Ground Ice Potential Map
GRRB	Gwich'in Renewable Resources Board
GSC	Geological Survey of Canada
HBL	Hudson Bay Lowlands
HBR	Hudson Bay Railway
HPC	High-Performance Computing
HQP	Highly Qualified People/Person/Personnel (context dependent; also see discussion in Section 7)
IASC	International Arctic Science Committee
IGC	Inuvialuit Game Council
ICCRE	International Conference on Cold Regions Engineering
InSAR	Interferometric Synthetic Aperture Radar
IPA	International Permafrost Association
ITK	Inuit Tapiriit Kanatami
KMCC	Knowledge Mobilization and Communication Committee
KMCCoor	Knowledge Mobilization and Communication co-ordinator
LEAP	Training tomorrow's LEAders in Permafrost thaw and northern research

LiDAR	Light Detection and Ranging
MDA	MacDonald, Dettwiler and Associates Ltd.
MeHg	Methylmercury
MTQ	Ministère des Transports du Québec
NDS	Network Data Scientist
NRA	Northern Research Assistant
NRCan	Natural Resources Canada
NSERC	Natural Sciences and Engineering Research Council
NSIDC	National Snow and Ice Data Center, University of Colorado, USA
NTAI	Northern Transportation Adaptation Initiative (Transport Canada)
NTGS	Northwest Territories Geological Survey
OMNRF	Ontario Ministry of Natural Resources and Forestry
PACS	Permafrost ArChive Science
PCSP	Polar Continental Shelf Program
PCN	Permafrost Carbon Network
PDF	Postdoctoral Research Fellow
PDSP	Permafrost Data Science Platform
PERMOS	Swiss Permafrost Monitoring Network
PFT	Plant functional type (a form of metaspecies)
PI	Principal Investigator
PINGO	Permafrost Information Network of Ground Observations
POLAR	Polar Knowledge Canada
RCOP	Regional Conference on Permafrost
RKI	Infrastructure Canada Research and Knowledge Initiative
RMC	Royal Military College of Canada
RPAS	Remotely Piloted Aircraft Systems
RPAS-SfM	Remotely Piloted Aircraft Systems-Structure-from-Motion

RTS	Retrogressive thaw slump
SAR	Synthetic aperture radar
SC	Scientific Committee
SCC	Standards Council of Canada
SD	Scientific Director (same as PI)
SKOS	Simple Knowledge Organization System
SOPs	Standard Operating Procedures
SRK	SRK Consulting Inc.
TC	Transport Canada
Teams	Microsoft Teams business communication platform
TEB	Transportation Engineering Branch (Yukon Government)
TempCNN	Temporal convolutional neural network
TH	Tr'ondëk Hwëch'in Government
ToR	Terms of Reference
UAV	Unmanned Aerial Vehicle
YGS	Yukon Geological Survey

1.0 Progress towards objectives/milestones

1.1 NSERC PermafrostNet objectives

Permafrost underlies 35–50% of the Canadian land surface. Most of this area will experience persistent loss of subsurface ice in the 21st century, leading to irreversible landscape transformations, profound challenges for the design and maintenance of infrastructure and threats to the health of northerners. NSERC PermafrostNet prepares Canada for permafrost change by transforming Canadian permafrost science, its alignment with decision-making, and developing the needed foundational research and next practices. We define next practice as a collection of prototypes of future practice that account for expected change that may render current best practice deficient. A major component of the network trains the next generation of permafrost experts and translates and mobilizes knowledge.

Network activities are centred around one main question: *Where and when is permafrost thaw occurring and what are the hazards arising from this?* To address this central question, NSERC PermafrostNet builds a community of experts in Canada focused on permafrost research by training and connecting people. To accomplish this, the network has assembled a strong team of academic researchers from 12 universities, 31

collaborators and more than 40 partner organisations, incorporating territorial, provincial and federal governments, Indigenous communities, industry and international partners. To accomplish its research agenda, NSERC PermafrostNet activities are centred around five interwoven research themes:

- Theme 1: Characterization of permafrost
- Theme 2: Monitoring permafrost change
- Theme 3: Prediction of permafrost characteristics and change
- Theme 4: Hazards and impacts of permafrost thaw
- Theme 5: Adaptation to permafrost thaw

NSERC PermafrostNet's research themes collaboratively work to achieve three overarching objectives: i) quantify, understand and predict permafrost thaw and its consequences; ii) connect spatial scales from individual sites to national-scale prediction and assessment and from field measurements to satellite-based remote sensing and Earth-system modeling; and iii) prototype reliable and useful data and knowledge products for stakeholders and develop relevant next practices with them.

1.2 Network integration of research results to achieve objectives

NSERC PermafrostNet's research themes are designed to provide a critical mass and diversity of expertise that no single research group or government agency possesses. Through this intentional design of the network, we have been working to produce three major outputs: 1) data products; 2) synthesis reporting; and 3) next practices. Outputs are important integrators of research results and serve to translate and mobilize the knowledge generated by the network for application by partners and other stakeholders.

Work in Theme 1 (Characterization) is devoted to improving the understanding of ground ice loss and its consequences through characterization of permafrost in Canada so that prediction can represent processes during thaw and have relevant subsurface input such as ground ice content. Theme 1 has been creating the Permafrost Information Network of Ground Observations (PINGO), a set of interoperable databases that can be jointly interrogated, along with the network data scientist (NDS; N. Brown). PINGO is one of the main network data products; the development of which relies upon Theme 1 for creation of the PINGO data standards and best practices documentation, with contributions from Theme 2. PINGO will be, or is already, used by the other themes as well as made available to researchers and stakeholders more broadly. It currently comprises an ERDDAP server for interoperable data exchange, a relational database (directly accessible only by those within the network), and an online data browser that can access each of these resources. As a way to promote the adoption of this technology stack by other permafrost researchers, the NDS has developed a containerized Docker environment which makes it easy to deploy the relational database and ancillary data input interface. Theme 1 has also been developing a database of electrical resistivity tomography (ERT) surveys whose results can be used to characterize permafrost conditions and track change. The Canadian Permafrost Electrical Resistivity Survey (CPERS) next practices and database will maximize interoperability with PINGO. Its development is aided by the NDS around technical requirements of CPERS and recommendations to achieve interoperability with other data centres and an International Permafrost Association (IPA) database currently under development. Other Theme 1 projects have been generating new datasets to contribute to PINGO that characterize thaw settlement and thaw consolidation and update the Ground Ice

Potential Map (GRIP) for the Mackenzie Valley and glacial lakes Mackenzie and McConnell, the colluvial hillslope yedoma of the unglaciated Klondike, and the eastern Canadian Arctic polar deserts. As the outputs from Theme 1, such as PINGO, CPERS and the data underpinning GRIP mature, these databases will be essential for other Themes' activities. Theme 1 has also been leading an effort of the Canadian Permafrost Association (CPA) to create a revised version of the Glossary of Permafrost and Related Ground Ice Terms, including contributions from Co-Investigators in Themes 3 and 4, the NDS and network partners (Lewkowicz 2021). In addition to updating the glossary definitions, the revised glossary will contribute to data interoperability efforts. Through experience gained collaborating with CCADI, the NDS is helping to structure the glossary in a way that is compatible with the simple knowledge organization system (SKOS) standard. This means that in addition to a static document, the glossary will exist as a machine-readable web resource and controlled vocabulary, which will make it easier to create consistent metadata, search for permafrost data, and link knowledge to other disciplines. This technology is already used by a number of other organizations, including the British Oceanographic Data Centre, CCADI and the Australian Research Data Commons.

Theme 2 (Monitoring) has the objective of revealing and quantifying permafrost change in Canada and understanding its varying rates and expressions at the land surface. Close linkages between Theme 1 and 2 are emerging and Theme 2 has already integrated borehole data from an early version of PINGO into the Permafrost Data Science Platform (PDSP). The common approach afforded by PDSP provides uniform and reliable access to databases and tools for data processing, visualization and simulation. The PhD project of Highly Qualified Person (HQP) F. Ghiami-Shomami (T2-PhD5; these project codes were used in the network proposal and can also be found here in Table 1) incorporates analysis of temperature-depth profiles with additional observations such as surface subsidence to develop, test and automate new methods and synthesize spatio-temporal patterns of change to generate a national picture of permafrost thaw through site-specific observations. Other Theme 2 projects are broadly integrating expertise across themes. The SFU radar-optical system forms the basis of two projects in Theme 2; however network members across Themes 1, 2, and 4 have been contributing to plan, develop and refine the utility of the technique to investigate permafrost change along linear infrastructure, including selection of field sites for method evaluation.

Theme 3 (Prediction) improves the accuracy and delivery of transient permafrost simulation so that its results can support stakeholder needs at local and national scales. Much of the work in Theme 3 has thus far been devoted to developing the needed modelling systems, including integration of observation-based information from Themes 1 and 2 to produce data products for Themes 4 and 5. Theme 3 has completed one MSc project devoted to understanding the changing ice regime of thermokarst lakes in the Old Crow Flats, Yukon (Shaposhnikova 2021). Other Theme 3 projects build upon Theme 1 data products such as PINGO for model development, validation and testing. Theme 3 involves developing permafrost ensemble simulations and a framework to provide more meaningful ways to measure permafrost model performance and enable the simulations to be accompanied by a measure of confidence. Additionally, Theme 3 projects are contributing to development of the Canadian Land Surface Scheme, including Biogeochemical Cycles (CLASSIC), an open-source community land surface model integrated into the framework. Another Theme 3 project is developing a methodology in conjunction with Theme 1 that will integrate their borehole ground ice observations to produce a new version of GRIP based on machine learning. In related work, A. Castagner (affiliated HQP) has developed a method for statistical estimation of

excess ice content from geotechnical data, important information for initial conditions used in ensemble simulations of permafrost thaw.

Theme 4 (Hazards and Impacts) seeks to understand the relevance and controls of the impacts and hazards driven by permafrost thaw and improve their prediction to support adaptation. The PhD project of HQP E. Stewart-Jones (T4-PhD1), devoted to improving understanding and prediction of thaw-induced mass movement in steep mountains, contributes to Theme 1's PINGO, as well as using simulation tools from Theme 3. Another Theme 4 PhD project is developing data products which are being integrated into PINGO with the assistance of the NDS, as well as next practices with respect to permafrost thermal characteristics and change in the mountains of Western Canada. Along with the NDS, the project is also producing open-source software tools for data handling: *HorizonPy* is a program for digitizing horizon lines from fisheye photography so that they can be used in surface energy-balance modelling and *tempcf* is a toolkit for cleaning and standardizing permafrost thermal data. Theme 4 is closely linked with Theme 5 through regular cross-theme meetings and project collaborations such as between the PhD project devoted to "Understanding and prediction of thaw-driven flash flooding and water quality change" (T4-PhD5) and a new Theme 5 project titled "Land use planning and mass-wasting hazards near Fort Severn and water quality change" (T5-PhD4).

Theme 5 (Adaptation) seeks to support northerners in adaptation to permafrost in transition. Theme 5's close linkage to Theme 4 resulted in a HQP cross-posted between themes (A. Kirkwood – T5-PhD4). Theme 5 also hosts meetings for network members involved with the Hudson's Bay Lowland Group (discussed more in Section 8), including the General Manager of the Hudson's Bay Railway (B. Young) and HQP from Themes 1, 4, and 5. Researchers from other Themes regularly join Theme 5 meetings, including the Theme 4 co-leads and HQP.

Other examples of network linkages include joint theme meetings held biweekly or monthly to provide theme members with full knowledge of how the projects interconnect, along with Annual General Meetings (AGMs) in 2019, 2020 and 2021, four data workshops (a database development workshop, a data workshop, a data hackathon, and a Regional Conference On Permafrost (RCOP) workshop), and science communication training courses (the science communication toolbox was a course of seven workshops in early 2021 see Section 7.2), and a Pitch and Polish writing course is running in early 2022).

The AGMs of NSERC PermafrostNet provide a forum for the Co-Investigators, HQP and partners to share information and enhance collaboration between Themes and more broadly within and outside the network. These meetings have featured updates on Theme progress from the Theme leaders, as well as HQP presentations, posters about individual research projects and policy panels.

In February 2020 a two-day database development meeting was held in Ottawa with Co-Investigators, HQP, government collaborators and the NDS. In May 2020, a three-day Permafrost Data workshop brought together the Canadian permafrost community to discuss permafrost data management, accessibility and harmonization. The event brought together 81 participants, including Co-Investigators (Co-I's) from each of the five themes, network partners and HQP. The workshop contributed to the network's objective of prototyping reliable and useful data products and the network outcome of strengthening the permafrost community by developing a shared understanding of challenges. Improved access to data and data interoperability both contribute to the

development of data products that are useful to a wide range of stakeholders. Also contributing to these objectives and outcomes are a series of monthly meetings organized by the NSERC PermafrostNet NDS and attended by representatives from provincial and territorial governments. These meetings are designed to ensure cross-pollination of information between organizations and increase interoperability between the data produced at each data centre. These meetings have enabled the formation of a permafrost data *community of practice* in line with the network's outcomes of building permafrost data management expertise in partner organizations and reducing fragmentation in the Canadian permafrost community. To further facilitate integration of research, the network successfully applied for a Compute Canada Research Platforms and Portal grant (valued at $43,122). The award provides persistent Compute Canada servers where researchers from multiple themes have been able to take advantage of a shared computing platform. This also permits easy sharing of tools and software, including those developed by the NDS, and provides a central resource to host diverse data required by the research projects.

The network is also catalyzing collaborations across the broader permafrost science community. This is evident from four major initiatives led by PermafrostNet members. Two projects recently funded through Transport Canada's Northern Trade Corridor Fund focused on the proposed central Mackenzie Valley Highway right-of-way and Inuvik Tuktoyaktuk corridors (Co-I Froese and partners), and the Hudson Bay Lowlands (Co-I's Hayley (PI), Roy-Léveillée, Beddoe and Kenny); both of which are described in Section 8. Other collaborations include the recent NSERC Collaborative Research and Training Experience (CREATE) LEAP (training tomorrow's LEAders in Permafrost thaw and northern research) proposal and the Strategy Committee of the NSERC PermafrostNet Board of Directors (described in detail in Section 8).

Few universities in Canada offer dedicated permafrost courses and, in many disciplines and domains, researchers and professionals work on permafrost-related questions without having had access to permafrost training. Recruitment in NSERC PermafrostNet and its partners highlighted this gap. An NSERC CREATE LEAP proposal was created to address the gap in multidisciplinary academic permafrost training by proposing a means to develop technical and professional skills specific to Northern Canada. While unsuccessful in the most recent funding call, the proposal will be revised based upon reviewer comments and resubmitted as the training gap remains an important impediment to future permafrost science in Canada. In the LEAP consortium, 6/10 co-applicants and 9/13 collaborators are also in NSERC PermafrostNet, balancing broad inclusion and the reliability afforded by established collaboration. This proposed program will: (1) enable trainees to address research questions on permafrost thaw from the perspectives of physical processes, interactions and impacts; (2) develop new leaders addressing practical solutions and adaptation strategies for the effects of permafrost thaw; and (3) build collaborative partnerships and engage northern stakeholders. Training will be delivered through online learning modules and in-person northern field schools. Existing relationships with northern stakeholders will be intensified, and the training environment will foster the growth of new partnerships where knowledge sharing, co-creation, translation and transfer can flourish. For northern stakeholders, the training program will build capacity and shape effective partnerships that will promote important contributions to informed decision-making around mitigating the effects of climate change and permafrost thaw across northern communities. The re-submission of LEAP would carry forward many of the connections built in NSERC PermafrostNet until 2029.

1.3 Significant deviations from the original overall objectives

There have been several changes to the original objectives leading to new, cancelled or modified projects due to: 1) COVID-19 impacts, including difficulties in filling HQP positions; 2) co-investigator changes; and 3) project evolution due to scientific needs.

While the network funding started in July 2019, the first phase of the network was profoundly impacted by COVID-19 through delays in HQP recruitment and program starts, or remote starts due to HQP being unable to relocate to Canada; research lab closures due to university shutdowns; lost field seasons due to territorial governments closing their borders to field researchers and our obligation to keep partner communities safe; and an inability to hold in-person network meetings, among other impacts. The magnitude of COVID-19 impacts has made it challenging to achieve the level of network integration originally planned for the midway point of the network. Even with these challenges, the network has made significant progress co-ordinating research activities to ensure the network outputs and outcomes are realized, and equipping HQP with the essential skills and knowledge needed to ensure the successful completion of their projects.

The impact of COVID-19 on filling HQP positions has led to delayed starts for many projects. While it is generally anticipated that projects will start slower than the actual funding release from NSERC, COVID-19 impacts hit at a particularly challenging time for student recruitment. COVID-19-related impacts upon domestic and international travel and student visa processing made it difficult to recruit domestic and, especially, foreign HQP given the uncertainty of the evolving pandemic. These delays in recruitment meant that some projects had to be changed or abandoned (see appendix Table 1, Appendix M) to ensure HQP will be able to finish within the network timeline and funding.

There have been several Co-Investigator changes since the start of the network. Theme 4 saw Prof. M. Turetsky leaving the position at Guelph to become Director of the Institute for Arctic and Alpine Research (INSTAAR) at the University of Colorado Boulder in January 2020. Prof. Turetsky was leading an MSc project (T4-Msc2: Improving the management of permafrost hazards by using value of information theory) and a PhD project (T4-PhD3: Improved prediction of thermokarst in peatlands and abrupt loss of forests and lichen). Both projects were cancelled with the funds moved to other projects (see appendix Table 1, Appendix M). To ensure leadership and continuity of the theme, Prof. P. Roy-Léveillée stepped into the role of Theme 4 co-lead in November 2019. In March 2021, Theme 4 was further impacted by the unexpected retirement of the other Theme 4 co-lead Prof. S. Lamoureux (Queens). Prof. Lamoureux was originally tasked with two MSc projects (T4-MSc1: Scientific and stakeholder surveys to prioritise thaw impacts and hazards, T4-MSc4: Quantifying permafrost thaw-driven hazards contributing to water quality change), and one PhD project (T4-PhD5: Understanding and prediction of thaw-driven flash flooding and water quality change). Prof. Lamoureux was replaced by Prof. J. Hayley as Theme 4 co-lead in May 2021. The milestones associated with T4-MSc2 and T4-MSc1, formerly to be supervised by Drs. Turetsky and Lamoureux are now part of a new PDF project (T4-PDF1), undertaken by Dr. J. Holloway, who started in February 2022. The final MSc project impacted, T4-MSc4, is now part of T5-PhD4, which was developed by combining T4-MSc4 and T5-MSc1, and is occupied by HQP A. Kirkwood. Prof. Lamoureux's T4-PhD5 project was maintained in the network via co-supervision by network members for northern-based student E. Hille (HQP). As these changes in Co-Investigators occurred early in the network, they did not become obstacles for the continuity of HQP projects.

Other changes to the Co-Investigators include the move of Prof. P. Roy-Léveillée from Laurentian University to Université Laval in September 2020 and appointment as Partnership Research Chair on Permafrost Geomorphology in Nunavik. This move has been beneficial, enabling another university to join the network and bringing in $101,016 in additional funds. These funds are going towards student scholarships, fieldwork logistics and salaries of scientific and technical staff. Prof. Roy-Léveillée's HQP have found accommodation to complete programs at Laurentian University while still under Roy-Léveillée's supervision, while students under supervision who started after Roy-Léveillée's move are registered at Université Laval. Prof. O. Sonnentag's role in the network was changed from a collaborator to a network co-investigator in June 2020. Prof. A. Lewkowicz retired in December 2021 and has transitioned to emeritus status. Lewkowicz continues to engage fully with the network and supervises PDF T. Herring but has cancelled a planned PhD project (see appendix Table 1, Appendix M). The key collaborator, Prof. M. Allard, retired in 2019 and was unable to play as prominent a role as originally anticipated; his role as co-leader of Theme 5 was taken over by Prof. R. Beddoe (approved by the Scientific Committee at their October 2020 meeting) and his regional focus on Nunavik has been continued by Prof. P. Roy-Léveillée after her transition to Université Laval.

1.4 Scientific and/or engineering significance

During the first half of the network, NSERC PermafrostNet has been laying the foundation for advancements in permafrost science and engineering practice across diverse topics such as data interoperability, numerical modelling and prediction, and practical applications of scientific theories for adaptation to permafrost thaw. Despite restrictions on fieldwork, the network has continued to make advances by pivoting the schedule of project objectives to focus on data analysis and fundamental advances in systems that will benefit the field as a whole.

As part of the network's objective of prototyping data and knowledge products, NSERC PermafrostNet has adopted and contributed to a widely used set of standards to improve the interoperability of permafrost data. The CF Standard Names are a resource used by researchers across scientific disciplines to uniquely identify variables in a dataset. A total of 11 new permafrost-related terms have been added to the latest edition of the Climate and Forecast (CF) Standard Names; another 14 terms have been proposed and are under review. The new terms improve the usability of the resource for permafrost researchers across disciplines, particularly for site-scale and geotechnical data, and will contribute to the network's objective of prototyping data products. This also helps to *connect spatial scales* through data interoperability by providing the vocabulary necessary for field scientists and modellers to exchange data in a meaningful way.

Complementing the addition of permafrost-related CF Standard Names, NSERC PermafrostNet adapted and now operates a prototype of the OPeNDAP standard for distributing permafrost data using an ERDDAP web service. This software is widely used in other scientific disciplines and allows permafrost researchers—within the network and from the broader community—to take advantage of existing tools and expertise for accessing the data.

Work in Theme 1 has begun to produce results of significance, including a new rapid, non-destructive method of permafrost core characterization using multi-sensor core

logging and industrial computed tomography (CT) scanning for permafrost (Froese 2021). As part of CPERS, Theme 1 researchers have been establishing best practices for data acquisition and processing ERT surveys, which are essential to making justifiable interpretations of permafrost conditions and how they are changing.

ERT is used to map the resistivity of the subsurface which can help identify frozen regions. ERT survey design (electrode spacing, number of electrodes used, and array type) plays a big role in how well key features are resolved. HQP T. Herring and Prof. A. Lewkowicz (Herring 2021a) examined the use of forward modelling, which combines a resistivity model, physics and survey design to generate a simulation of ERT data. The forward modelling tool was demonstrated to be valuable to help guide survey design and aid interpretation of results.

Theme 1 HQP T. Herring is leading one of the working parties in an International Permafrost Association (IPA) action group creating an international database of ERT surveys to help researchers map spatial trends in permafrost conditions and see how permafrost is changing over time in response to climate warming. A global database of resistivity surveys can map permafrost conditions over large spatial and temporal scales, but all datasets must be processed in a consistent way. Their project is creating a workflow to process ERT surveys of permafrost in a consistent way that will work for most cases without modification. There are two key steps in ERT data processing: filtering and inversion. A new processing pipeline has been created that makes judicious choices in both steps to produce a generalized algorithm that works well for ERT data collected in a diverse range of permafrost environments (Herring 2021b).

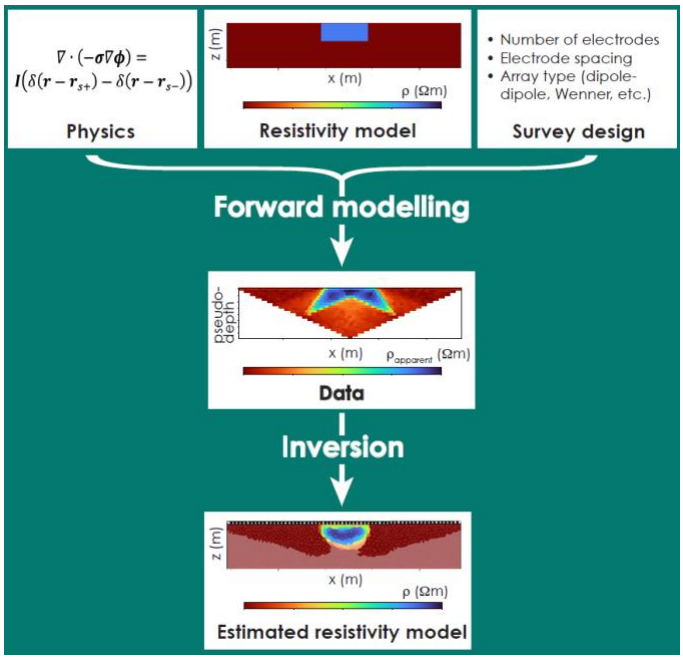


Figure 1. Developing a user-friendly forward modelling and inversion tool to inform electrical resistivity tomography studies of permafrost (Herring 2021a).

Peatland permafrost features, including peat plateaus and palsas, are particularly vulnerable to thaw in response to global warming because frozen organic materials consolidate when thawed, typically over ice-rich mineral deposits. ERT surveys, borehole records and other field investigations were carried out by Theme 1 HQP A. Chiasson to describe morphology and permafrost conditions associated with dendritic peat plateau networks, a common landform in the central Mackenzie Valley, Northwest Territories (N.W.T.) (Chiasson 2021). Field investigation of the peat plateaus in 2021 showed that the peat was about two metres thick, included structureless pore ice, and was overlaying

several metres of ice-rich diamict or glaciolacustrine sediments. Fine-scale mapping (1:1,000) determined that approximately 55% of the peat plateau has degraded over the last approximately 75 years. ERT surveys suggest the peat plateau's degradation is driven by thermal erosion of the plateau edges from the ice-rich diamict deposit underlying the peat deposit, but also by the formation of ponds and drainage in the peat plateaus.

Over the past 15 years, the foothills of the central Mackenzie Mountains (N.W.T.) have seen rapid increases in permafrost mass wasting event size and frequency. Theme 1 HQP J. Young's work has documented over the 2004 to 2020 period a 285% increase in the number of thaw-induced mass-wasting events, with increases of total disturbance area on the order of 600%. While the area has experienced general increases in summer air temperature and sustained precipitation regimes during this time, nearly all (94%) of the observed permafrost mass-wasting features occur in areas associated with intense forest fires between 1994 and 1998. This work underscores the importance of forest fires in understanding future thaw of forested northern permafrost areas and demonstrates the legacy of thermal disturbance from fires as a mechanism for hillslope failures in permafrost areas. Additionally, HQP J. Young has shown the presence of large, deep-seated permafrost failures in this area, likely driven by 'bottom-up' thawing at the base of permafrost (Young 2021). This style of slope failure is poorly understood in permafrost regions, but likely a type of failure that will increase with future warming. Comparisons against the currently available continental-scale permafrost mapping products show that ground ice and its thaw potential in hillslope areas is strongly underestimated.

H. Travers-Smith (affiliated HQP) completed an MSc at the University of Victoria in 2021. Although not directly supported by NSERC PermafrostNet, over the course of their MSc program they participated in many network activities (theme meetings, AGM, training, etc.). Their research used the Landsat archive to explore drivers of surface water dynamics across a 1.4-million kilometre squared area of western Canada. The results showed that terrain factors (ground ice content, forest fire, surficial materials) in areas of continuous and discontinuous permafrost have a larger relative impact on surface water dynamics than the direct effects of climate change. Travers-Smith's first manuscript was published in December 2021 (Travers-Smith, Lantz and Fraser, 2021) and the second data chapter is in revision for Environmental Research Letters.

Theme 2 HQP U. Ahmed's work has led to refinements in synthetic aperture radar (SAR) trajectories using optical Foto detection and ranging (Fodar™) data (Usman, Rabus and Kubanski 2021). Fodar, when fully calibrated, can produce digital elevation models (DEMs) with an accuracy superior to available global DEMs and comparable to DEMs derived from conventional photogrammetry and even lidar, but at much lower operational costs. The derived DEMs can be used to monitor landscape change due to permafrost degradation.

In their recent thesis, Theme 3 MSc HQP M. Shaposhnikova completed a novel study to introduce and implement a temporal deep learning approach for the analysis of time series of synthetic aperture radar (SAR) imagery (Shaposhnikova 2021). She used a combination of Sentinel 1, ERS 1/2, and RADARSAT 1 SAR imagery for the Old Crow Flats, Yukon, Canada to create an extensive annotated dataset of SAR time-series labeled as either bedfast ice, floating ice or land (example output shown in Figure 2). This dataset was then used to train a temporal convolutional neural network (TempCNN). Lake ice is a fundamental part of the freshwater processes in cold regions and a sensitive indicator of climate change. As such, in light of the recent climate

warming, monitoring of lake ice in Arctic and sub-Arctic regions is becoming increasingly important. Many shallow Arctic lakes and ponds of thermokarst origin freeze to bed in the winter months, maintaining the underlying permafrost in its frozen state. However, as air temperatures rise and precipitation increases, fewer lakes are expected to develop bedfast ice. The TempCNN results found extensive transition to bedfast ice caused by a growing number of catastrophic drainages within the examined time period (1993 to 2021) brought on by climate warming and thermokarst processes.

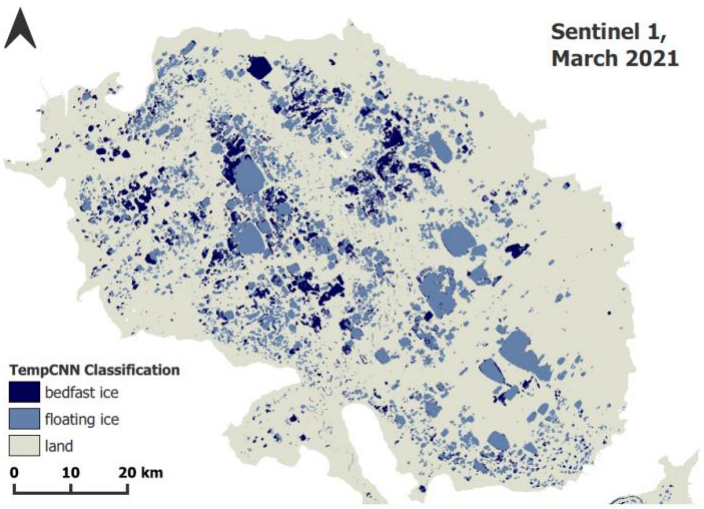


Figure 2. Deep learning framework created lake ice maps for Old Crow Flats (1993-2021) from SAR imagery (Shaposhnikova 2021).

Other advancements in modelling of permafrost change centred on improving model representation of land cover change and its influence on permafrost. The Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) is a major component of Theme 3 activities but is missing some important vegetation types common in permafrost environments. (Meyer et al. 2021) introduced new shrub and sedge plant functional types (PFTs; a form of metaspecies) into CLASSIC and evaluated the parameterizations at Daring Lake, a highly instrumented site in the Northwest Territories. The inclusion of these PFTs improved the model simulated ground temperatures, surface energy and water fluxes against observations.

NSERC PermafrostNet has developed a prototype software package designed to simplify the task of running large permafrost model ensembles on high-performance computing (HPC) systems. This software is intended to support research projects in Theme 3, but it can also be used by researchers in the wider permafrost community. Currently, it supports three models used by Co-Investigators in NSERC PermafrostNet and is configured to run on hardware provisioned by Compute Canada through a Research Platforms and Portals allocation to NSERC PermafrostNet. It is designed to be extensible to other models or HPC systems and the source code is freely available to be of maximum benefit to other researchers. Theme 3 HQP G. Jonat has been involved in some of the development planning meetings and intends to use the software in their PhD project. Because of delays related to the COVID-19 pandemic, it has not yet been used productively by NSERC PermafrostNet HQP, but it has been used by Prof. Bin Cao (Institute of Tibetan Plateau Research), who has taken part in Theme 3 meetings and is running simulations for the Lac de Gras region of the Northwest Territories.

A prototype data cleaning tool for ground temperature time series has been developed by NSERC PermafrostNet. This tool (*tempcf*), as part of the broader permafrost data ecosystem, is intended to help improve the flow of data from individual researchers into more standardized and reusable forms. This in turn will help *connect spatial scales* by

ensuring site-level data is available in a form that is usable by modellers. The tool has been used productively by NSERC PermafrostNet HQP in Themes 2, 3 and 4 as part of ongoing research and is being tested by network partners at the Geological Survey of Canada (GSC) and the Yukon Geological Survey (YGS).

Theme 4 HQP A. Clark studied a stretch of coastline off Richard's Island, Northwest Territories, that contains multiple retrogressive thaw slumps (RTSs) with varying degrees of activity (Clark et al. 2021). Ground movement information was generated by multi-temporal 2D and 3D geomorphic analysis of data from Remotely Piloted Aircraft Systems-Structure-from-Motion (RPAS-SfM) flights. Clark's study furthers geomorphological understanding of RTS processes by highlighting the complex relationship between planimetric and volumetric change along rapidly retreating Arctic coasts and demonstrates advancements in measurement practices for RPAS-SfM data sets. The development of these new remote techniques for early detection and monitoring of hazards can enable a reduction in their impact.

Numerous techniques have been developed to control ground temperatures and preserve permafrost underlying infrastructure. Generally, these techniques attempt to either limit heat intake or extract heat from the ground column. Some examples of the former include installing insulation to increase the thermal resistance of the infrastructure surface, covering it with high albedo surface materials, or installing sun sheds to reduce absorbed solar radiation. The Theme 5 MSc project of P. Jardine examines snowpack compaction as a method of improving the stability of infrastructure built in permafrost terrain. Snow typically has a lower thermal conductivity than ground surface materials. This causes most snowpacks to act as surface insulation, limiting heat flow out of the ground during the freezing season. The extent of insulation provided by the snowpack is negatively associated with the density of the snowpack and positively associated with its depth. HQP Jardine's MSc research assists highway maintenance staff in evaluating if snow compaction is an effective tool for mitigation of permafrost thaw beside highway embankments, including how repeated snowpack compaction affects snowpack structure and density and how modifying the timing and frequency of snowpack compaction impacts its effects on ground temperatures, snowpack structure and snowpack density (Figure 3).

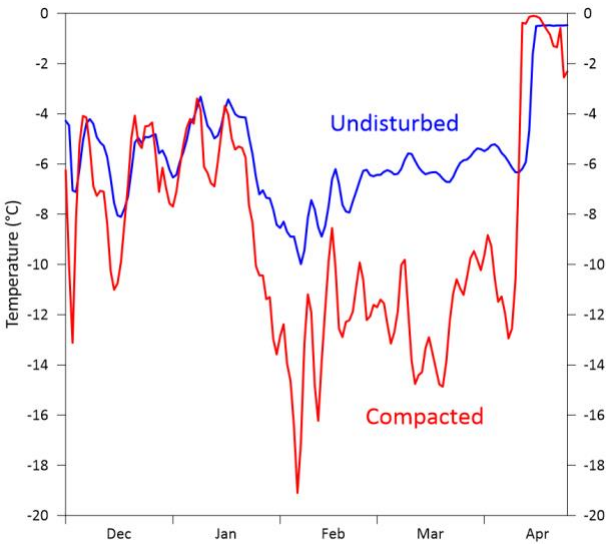


Figure 3. Permafrost temperature below compacted and undisturbed snowpacks – P. Jardine.

An affiliated Theme 5 HQP S. Gagnon, (a postdoctoral fellow supervised by D. Fortier) has been working on a mitigation technique to control permafrost degradation under road embankments and has a publication in press.

1.5 Significance to Canada

Northern Canada, the home and traditional territory of many Indigenous peoples, is changing fast. Climate change is inducing rapid permafrost degradation that is directly affecting the social, economic, cultural and environmental context for northern Canadians and is exacting a significant cost for Canada. A large proportion of Canada's vast mineral deposits, oil and gas reserves, and renewable resources from forestry, animal populations and fisheries are situated in the Arctic, where permafrost and its thaw affect the design, construction and maintenance of infrastructure, as well as land reclamation and waste management. It is then not surprising that Canada's Arctic Foreign Policy opens with the statement: "The Arctic is fundamental to Canada's national identity." The observed and anticipated impacts of permafrost and its thaw are profound and will persist for decades to centuries.

Canada's *Northern and Arctic Policy Framework* recognizes that climate change is threatening the resilience of existing infrastructure and presents challenges to constructing new infrastructure. The *Framework's* objectives look to strengthen community sustainability, enhance monitoring and integrate climate change resilience into new and existing infrastructure. The private sector is looking to more effectively manage permafrost change risks that impact resource, transport and community infrastructure development. Communities and individuals are looking to plan and adapt for a healthy and sustainable future. All these players require better and more accessible data, technical solutions and predictive capability, and capacity, to make well-informed decisions. This need for improved knowledge to underpin climate change adaptation and resilience is an emerging theme in many recent policies, for example in the National Inuit Climate Change Strategy as "Priority Area 1: Advance Inuit capacity and knowledge in climate decision-making".

This planning is made more challenging by thaw-related impacts occurring at the landscape scale due to climate change, and at the site level due to additional disturbance from human activity, infrastructure or wildfire. Effective solutions for economically competitive development of Arctic resources and resilient infrastructure need to be well informed and forward-looking, founded on multiple sources of reliable evidence and predictions. Permafrost knowledge and products, such as predictions of future permafrost conditions, are required to minimize risk for ecosystems and infrastructure in the long term. Equally, systematic monitoring - scientific and community-based - of permafrost in the built environment to reveal shifting ecological baselines is a prerequisite for evidence-based decision-making in a changing Arctic. With the significance of permafrost to Canada, NSERC PermafrostNet's early results are already providing demonstrable benefit to our ability to understand and project future change in these important regions.

Research and networking activities related to data curation and interoperability have increased the overall return on investment for data collection and improved access to data essential for informed decision-making and new research focused on better prediction. The collection of this data has represented significant investments of public funds and their incorporation into readily accessible and open repositories such as PINGO, and increasingly the data collections of YGS, NTGS, and GSC, leads to further utility of these historical investments within the network and its partner organizations. Projects in Theme 1 are contributing to this broader effort to include permafrost core properties for Canadian permafrost sites and ERT surveys of permafrost. This data will facilitate data sharing, enable and inform a new class of interpretation and prediction

(using machine learning, artificial intelligence, and deterministic models) of changing permafrost conditions over large spatial and temporal scales, and guide future permafrost research in Canada. It will also ensure that Canada takes a leading role in international efforts to collate and use ERT surveys to track permafrost thaw.

Other Theme 1 projects contribute to the ability to predict thaw settlement that is essential to protect Canadian infrastructure (HQP Z. Mohammadi) and add value to the geotechnical database built within the network through its use in method development. Further understanding of permafrost impacts derives from characterizing new types of landslides in hillslope environments (HQP J. Young), contributing to better understanding of hazards resulting from permafrost thaw in Canadian permafrost landscapes. Canada has extensive polar deserts in the eastern Arctic; the PhD project of HQP M. Gamshad investigates the ground thermal regime of Ward Hunt Island, Nunavut, a polar desert region, to explain modes of ground ice enrichment in the upper portion of permafrost. Thermistor cable measurements are complemented by numerical thermal modelling including scenarios of future climate change. Understanding these processes and their potential future change is important to determine the impacts of climate change on northern infrastructure located in Canada's polar deserts.

The prediction of permafrost characteristics and future permafrost change is important because it underpins evidence-based decision-making for adaptation. It is the basis for minimizing risk by reducing exposure in preferring some locations over others, reducing vulnerability in designing infrastructure and realistically planning maintenance costs. Among the important advancements needed to make simulation results more useful for adaptation, a better representation of key phenomena and processes in models is important for accurately translating climate change into anticipated impacts. To address this, Theme 3 has been advancing the process representation of CLASSIC, which also forms the land surface component of the Canadian Earth System Model (CanESM). The advancements in CLASSIC then directly impact the quality of future projections by CanESM and its family of models, including the Canadian Regional Climate Model. The specific advancements to CLASSIC already completed include incorporating shrubs (Meyer et al. 2021) to improve simulations of the impact of vegetation on the state of the Canadian permafrost region.

A cross-theme working group has formed around the Hudson Bay Railway (HBR), a rail corridor in Northern Manitoba built across a range of permafrost terrain and conditions. Every year, the rail line has a significant number of locations which undergo differential deformations and embankment instability ranging from minor track deviations and imposed train speed limitations to more costly interventions such as track closure until repair is complete. Recently, the HBR has used geocells, a common reinforcement technique in non-permafrost soils, to improve the support of railway on the degrading permafrost and underlying peat layer. In the MSc project of Theme 5 HQP P. Sharifi, thermo, hydro and mechanical processes using finite element analyses are considered to examine and predict thaw deformations, settlement and stability for future scenarios along a typical HBR rail embankment compared with a geocell-supported embankment near Churchill and Gillam. Their analysis found the performance improvement of using

geocell in terms of lateral deformation and crest settlement of the embankment increases continuously at a greater active layer thickness for embankments constructed on peat and excavated replacement method (ERM) beds - indicating the use of geocells in permafrost can provide significant improvements to the design life of the embankment. The performance improvement of geocell will be gradually diminished over the long term due to increasing dominance of permafrost degradation for both the peat and ERM beds.

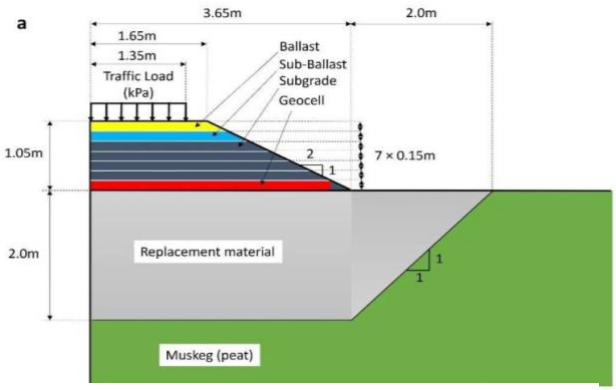


Figure 4. Cross section diagram of a geocell-supported embankment.

The Theme 5 MSc project of A. Schetselaar has found that climate change accounts for up to 75% of the cost of all highway maintenance for the Yukon Government (Schetselaar 2022). Substantial spatial variability in the natural environment means that these climate-related maintenance costs vary from site to site. Slides and washouts are particularly costly climate-sensitive catastrophic events. HQP Schetselaar led another study that examined historical climate model outputs and future climate projections from 29 scenarios run by seven ESMs for the Yukon and Mackenzie Valley and compared them with the observed record (Schetselaar 2021). Based upon four sites in the Yukon and N.W.T., projections of temperature may be following the higher future warming scenarios. This leads to the recommendation for increased investment in adaptation strategies such as design of thermosyphons to cope with rising winter temperatures and site investigation to identify thaw-stable sites. These early results are of significance for Canada, for example, by informing decisions related to Goal 3 - "Adapt to the impacts of climate change" - of Our Clean Future, the Yukon strategy for climate change, energy and a green economy.

The Hudson Bay Lowlands (HBL) may be one of the largest mercury (Hg) pools in the permafrost zone according to recent estimates. This is of concern to residents of the HBL who consume local fish due to the potential for this inorganic Hg to be converted to its organic, bioavailable, bioaccumulative and neurotoxic form methylmercury (MeHg) as permafrost in the HBL thaws. However, little is known about the abundance and distribution of MeHg, and it is unclear how permafrost degradation relates to the release and potential methylation of Hg. A part of their PhD project, HQP A. Kirkwood has been working to enhance scientific knowledge related to mercury mobilization potential and to linkages between permafrost thaw and mudflow developments in the Hudson Bay Lowlands. In both cases, they are developing spatial datasets that improve ability to understand and predict where related hazards may take place. This PhD project uses 35 peat cores (800 subsamples) collected in the continuous permafrost zone of northern Manitoba and Ontario at sites representing intact and degrading permafrost features (e.g. palsas/plateaus and fens) to map total mercury distribution in the HBL and relate environmental conditions created by thaw to the production of methylmercury. This work can be used in combination with the mapping of thaw-sensitive terrain to identify areas where mercury methylation may impact adjacent aquatic ecosystems if disturbed. Early results suggest Hg concentrations in the top 100 centimetres of the peat profile are lower than previous estimates of Hg derived from SOC pools for the circumpolar north with a storage of approximately nine milligram tal Hg metres squared (Kirkwood 2021).

2.0 Progress of research objectives

Table 1: Research progress of projects by theme. The original project short codes are included (e.g. T1-PhD1 indicates Theme 1 PhD project 1).

THEME 1: Characterization of permafrost
Theme Leads: Daniel Fortier and Duane Froese **Theme objectives:** Improve the understanding of ground ice loss and its consequences though characterization of permafrost in Canada so that prediction can represent processes during thaw and have relevant subsurface input such as ground ice content.
Theme 1 Projects (first 30 months)
PINGO: Permafrost Information Network of Ground Observations (M. Paquette, D. Fortier) - T1-PDF1
Status: In progress **(**started September 2020) **Objectives:** Development and implementation of PINGO: Permafrost Information Network of Ground Observations. **Progress:** ● Reworking glossary of permafrost terms in collaboration with the Permafrost Terminology Action Group of the Canadian Permafrost Association (CPA)(see Section 1.4). ● Development of the PINGO database in collaboration with the NDS and other network participants. ● Collection of ground ice data from co-PIs and collaborators underway.
Standardization of permafrost characteristics (M. Roustaei, D. Froese) - T1-PDF2
Status: Began January 2022 **Objectives:** Develop novel methods to extract ground ice and geotechnical data from permafrost samples using computed tomography and multi-sensor core logging methods. **Progress:** ● Staffing difficulties and delays with lab access due to COVID-19, project began January 2022 with the recruitment of Dr. M. Roustaei. ● Prior to Dr. Roustaei starting position, Permafrost ArChive Science (PACS) laboratory manager (J. Pumple) and Dr. A. Monteath (non-PermafrostNet funded PDF) completed one of the project objectives with the first inter-comparison between multi-sensor core logging and computed tomography scanning. ● Manuscript drafted for submission in April 2022.
Canadian permafrost electrical resistivity survey next practices and database (CPERS) (T. Herring, A. Lewkowicz) T1-PDF3
Status: In progress (started April 2021) **Objectives:** To develop and implement a database of ERT surveys in the permafrost regions of Canada so results can be used to characterize existing permafrost conditions and track change. **Progress:** ● Completed literature review of ERT studies of permafrost. ● Gained field experience supported by network flex funding. Spent three weeks in the Yukon while participating in 24 ERT surveys. ● Establishing next practices for ERT survey design. Results shared in a poster at the 2021 Regional Conference on Permafrost (RCOP) and an article

submitted to Permafrost and Periglacial Processes (presently in second review after minor revisions).
- Establishing next practices for data processing. Results shared in a poster at RCOP.
- Created initial version of ERT data visualization tool that will link to database.
- Collaborating as part of an International Permafrost Association action group on developing an international database of geoelectrical surveys on permafrost.

Effects of cryostructure on permafrost thaw and temperature-dependent properties (D. Froese) T1-PhD1

Status: Cancelled (see Appendix Table 1)

Strength and consolidation behaviour of permafrost sediments (S. Z. Mohammadi, J. Hayley) (formerly T1-MSc1, now a PhD project)

Status: In progress (started January 2020)
Objectives: To develop a framework and methodology to accurately determine thaw settlement across a wide variety of soil conditions.
Progress:
- Project has been converted to a PhD to build on the skills the student brings to the project.
- Literature review, thesis proposal and candidacy are completed.
- Collected and digitalized approximately 500 thaw consolidation test results and related index properties for tested samples from published literature.
- A preliminary framework for estimating permafrost thaw settlement is under development.

Characterizing the ice and water content of permafrost with dielectric methods (H. Fereydooni, S. Gruber) - T1-PhD2

Status: In progress (started January 2022)
Objectives: To improve our ability to (a) measure ice content in frozen soil; and (b) to quantify the thawing, i.e., the progressive loss of ice, in soil.
Progress:
- Field data has been retrieved from ring-electrode sensors and instrument repair (due to COVID-19 fieldwork delays) has been performed.
- Work with the lab instrument for dielectric measurements has begun.

Geomechanical properties of thawing permafrost (K. Rgh, J. Hayley) - T1-PhD3

Status: In progress (started January 2021)
Objectives: Quantifying infrastructure reliability subject to permafrost thaw settlement.
Progress:
- HQP Rgh began with a remote start in January 2021, due to COVID-19 restrictions, with an arrival in Canada in late August 2021.
- Completed course work including Permafrost Engineering and Advanced Geostats.
- Presently conducting literature review and refining objectives to ensure alignment with T1-MSc1.

Permafrost and ground ice conditions in the Hudson Bay Lowlands (T. Rahman, P. Roy-Léveillée) - T1-PhD4

Status: In progress (started September 2021)
Objectives: Improve understanding of ground ice dynamics in the Manitoba portion of the HBL, near Churchill, with a focus on characterizing and explaining the distribution of wedge ice and its implications for terrain vulnerability to thaw under climatic warming.
Progress:

- Reconnaissance field survey and preliminary instrumentation of field sites completed.
- Development of collaboration relationships with northern-based partners is underway.
- Preliminary assessment of wedge ice volume at designated test sites has begun.
- Coursework and thesis proposal requirements are progressing.

Permafrost conditions: Mackenzie Valley and glacial lakes Mackenzie and McConnell (A. Chiasson, D. Froese) - T1-PhD5

Status: In progress (started September 2020)
Objectives: To build a geological framework for permafrost in the central Mackenzie Valley based on the development of a permafrost land systems model.
Progress:

- Database developed and undergoing quality assurance/quality control.
- Updating surficial geology and GRIP map for the central Mackenzie Valley in collaboration with the N.W.T. Geological Survey.
- Fieldwork conducted in 2021 for collection of cores in central Mackenzie Valley.
- Physical properties analysis ongoing.
- First paper in development on degrading peat plateaus in the central Mackenzie Valley with N.W.T. Geological Survey partners.

Syngenetic permafrost of unglaciated Yukon (J. Young, D. Froese) (formerly T1-MSc2, now a PhD project)

Status: In progress (started April 2021)
Objectives: To develop a model for the origin of aggradational ground ice in colluvial settings in Mackenzie Valley foothills and unglaciated Yukon sites.
Progress:

- This project has been converted from MSc to PhD and moved forward to year three of the network to build on research investigating the rapid increase in thaw slumps in the central Mackenzie Mountain Foothills, N.W.T.
- The project builds on 25 years of site descriptions and extensive core collection at PACS from the Klondike. The project makes use of approximately. 11,000 boreholes that have now been digitized from the historic placer gold mining database developed by the Yukon Geological Survey (YGS). The Klondike database project is largely complete.
- Presently working through the PACS core collection to characterize ground ice contents of Klondike yedoma. These data will be used in the revised version of the GRIP of Canada to improve its representation of ground ice in the unglaciated area, which is strongly underrepresented in the present map.

Ground ice of the eastern Canadian Arctic polar deserts (M. Gamshad, D. Fortier) T1-PhD6

Status: In progress (started January 2020)
Objectives: To assess and analyze the thermal regime processes in the active layer of polar desert permafrost to map and determine modes of ground ice enrichment of polar desert soil.
Progress:

- Coursework and comprehensive exam completed.
- Presently working on the thermal regime of active layer and permafrost of polar desert to explain modes of ground ice enrichment in the upper portion of permafrost using temperature recorded by thermistors cables on Ward Hunt Island, Nunavut, arguably the northernmost ground temperature measurement in Canada.

- Also adapting the permafrost cell to simulate ground ice formation and testing it for consistency.
- Preparations are being made for the 2022 field season.

THEME 2: Monitoring of permafrost change

Theme Leads: Trevor Lantz and Antoni Lewkowicz
Theme objectives: Reveal and quantify permafrost change in Canada and understand its varying rates and expressions at the land surface

Theme 2 Projects (first 30 months)

Using repeat ERT to monitor permafrost thaw (A. Lewkowicz) - T2-PhD1

Status: Cancelled (see Appendix Table 1).

Inuvialuit and Gwich'in knowledge of permafrost systems (E. Street, T. Lantz) - T2-PhD2

Status: In progress (started September 2021)
Objectives: Work with communities in the Beaufort Delta region to document Indigenous knowledge of permafrost and permafrost-related change and inventory permafrost hazards.
Progress:

- Start date was delayed because COVID-19 limited potential for engaging northern research partners, an activity which is central to this project.
- Currently focussed on coursework, proposal development and preparation of the research ethics application.
- HQP Street is meeting with partners (Hunters and Trappers Committees and Renewable Resource Councils) in early 2022 to develop interview questions and discuss community research priorities.

Spatial monitoring permafrost change using Landsat (G. Francis, T. Lantz) - T2-PhD3

Status: In progress (started January 2021)
Objectives: Develop automated and semi-automated approaches to map thermokarst disturbances using satellite imagery.
Progress:

- H. Travers-Smith (UVic MSc student and NSERC PermafrostNet affiliate) developed a workflow to use the Landsat satellite archive to track changes in surface water across the N.W.T. resulting in two manuscripts. One is in review at Geophysical Research Letters, and the second submitted to Environmental Research Letters.
- HQP G. Francis has conducted literature review on thermokarst landscape change with full PhD proposal to be submitted in early 2022
- Presently developing machine learning methods to track the intra-annual and inter-annual expansion of thaw slumps in four regions of the Canadian Arctic. This part of the project involves collaboration with Dr. L. Huang, an NSERC PermafrostNet-affiliated PDF at UC Boulder.
- Also working with NSERC PermafrostNet partners to develop additional questions and methods to map thermokarst disturbances.

Measuring surface displacement using winter SAR (A. Plourde, B. Rabus) - T2-MSc1

Status: In progress (started January 2022)
Objectives: Understand dry snow cover and non-vertical movement contributions to improve Interferometric Synthetic Aperture Radar (InSAR) measurement accuracy of seasonal freeze/thaw and long-term thickness change of the permafrost active layer.
Progress:

- HQP Plourde joined the lab in November 2021 as visiting student prior to official MSc start to get integrated with the SARlab group and acquire InSAR processing skills.
- Interaction with J. Eppler (non-network HQP) who shared existing InSAR and ground instrument data.
- Processing InSAR test data with Python/Gamma SW-based software chain.

Airborne InSAR to monitor permafrost thaw near linear infrastructure (U. Iqbal, B. Rabus) - T2-PhD4

Status: In progress (started September 2020)
Objectives: Demonstrate the value and viability of biannual monitoring of linear infrastructure in permafrost terrain with airborne simultaneous SAR and optical structure from motion (SfM).
Progress:

- COVID-19 heavily impacted airborne SAR acquisitions in the Yukon (Fall 2020 campaign significantly reduced in scope; Spring 2021 campaign cancelled).
- Fall 2021 field season preparation and data collection was able to proceed but data has lower quality than expected due to COVID-19 impacts, including an outage of ground positioning system (GPS) base station KLRS, as well as significant technical issues with both SAR and optical system stemming from overdue maintenance.
- Spring 2022 field campaign is expected to see acquisition of full accuracy data sets required for the project.
- While unable to collect field data, the project progressed using older historic data with different thematic content. Progress both on oblique fodar (optical SfM) block adjustment refinements to Global Navigation Satellite System/Inertial Measurement Unit trajectories for SAR, as well as actual SAR data processing (focusing).

Interpreting ground temperature and subsidence for better quantifying permafrost change (Dr. F. Ghiami-Shomami, S. Gruber) - T2-PhD5

Status: In progress (started September 2020)
Objectives: To better derive information and knowledge from monitoring the ground thermal regime and surface subsidence.
Progress:

- HQP Dr. F. Ghiami-Shomami had a remote start due to COVID-19, arriving in Canada in December 2021 after more than a year of working with an 11-hour time difference to the research group.
- Conducting literature review and starting to use common data tools on PDSP, completed course on geocryology.
- Mostly based on work by the NDS and others in the research group, a database with borehole data is now integrated into PDSP and infrastructure to run models for synthetic time series is ready to use.

Towards a Permafrost Observation Platform (T. Lantz) - T2-MSc2

Status: Recruiting (planned start September 2022)
Objectives: Develop an observer driven permafrost monitoring platform.
Progress:

- Prof. Lantz circulated a description of this position in October 2021.

Synthesizing observations to develop a responsive monitoring network (T. Lantz, S. Gruber) - T2-PDF1

Status: Recruiting
Objectives: Synthesize national observations to develop a responsive monitoring network.
Progress:

- Profs. Lantz and Gruber first advertised this position in August 2021, but they have yet to find a qualified individual.

THEME 3: Prediction of permafrost characteristics and change

Theme Leads: Joe Melton and Claude Duguay.
Theme objectives: Improve the accuracy and delivery of transient permafrost simulation so that its results can support stakeholder needs at local and national scales.

Theme 3 Projects (first 30 months)

Simulating land cover change and its influence on permafrost with the Canadian Land Surface Scheme including Biogeochemical Cycles (CLASSIC) (R. Lefebvre, J. Melton, O. Sonnentag, G. Meyer) - T3-PhD1 (now an MSc project).

Status: Recruited (starting May 2022)
Objectives: Develop new high-latitude specific land cover types for CLASSIC.
Progress:

- ECCC PDF G. Meyer (network affiliated HQP) parameterized high latitude shrubs for CLASSIC (formerly called CLASS-CTEM) and evaluated the parameterization at Daring Lake, N.W.T.
- Dr. Meyer is evaluating pan-Canadian simulations with competition between the shrubs and other land cover types.
- Incoming HQP R. Lefebvre completed a four-month internship with Co-I's Melton and Sonnentag in May to August 2021. During this time, they set up and ran CLASSIC at Scotty Creek, N.W.T.
- The Scotty Creek simulations included a peatland-specific parameterization of *Sphagnum spp.* moss which will be an important initial stage in HQP Lefebvre's project adapting the moss parameterization to upland regions.
- *Referred journal publication* (Meyer et al. 2021).

Incorporation of excess ground ice and its impacts into CLASSIC (A. Mollasharifi-Targhi, J. Melton, C. Goldblatt) T3-MSc1 (now a PhD project)

Status: In progress (started September 2020)
Objectives: To introduce a parameterization of excess ground ice into the CLASSIC land surface model allowing simulation of thermokarst processes and their impact upon the ground thermal and hydrologic regime.
Progress:

- Completed required coursework.
- Implementing changes to CLASSIC so model soil layers allow for variable soil thicknesses as ground ice is lost.

SAR-based water products to support simulation of lowland thermokarst (M. Shaposhnikova, C. Duguay, P. Roy-Léveillée) - T3-MSc2

Status: Completed (MSc to be awarded at June 2022 Convocation)
Objectives: To apply a temporal deep learning approach (TempCNN) to thermokarst lake ice mapping (bedfast and floating ice) from SAR imagery, generate ice-regime maps, and analyze changes over a 29-year period (1993-2021) in Old Crow Flats, Yukon.
Progress:

- MSc thesis completed/defended (13 September 2021).
- Journal article submitted (Shaposhnikova, Duguay and Roy Roy-Léveillée in press).

Outcomes & outputs:

- MSc thesis: A temporal deep learning approach to bedfast and floating thermokarst lake ice mapping using SAR imagery: Old Crow Flats, Yukon, Canada. https://uwspace.uwaterloo.ca/handle/10012/17414

- Creation of a baseline dataset (1993-2021) for future studies on the dynamics of thermokarst lakes.

Simulating the development of lowland thermokarst (C. Duguay) - T3-PhD2

Status: Cancelled (see Appendix Table 1)

Fate of carbon in Canadian permafrost-affected soils (C. Gauthier, J. Melton, O. Sonnentag) - T3-MSc3

Status: In progress (started September 2020)
Objectives: Generate projections of future change in Canadian soil carbon stocks.
Progress:

- Performed a 'Sobol sensitivity analysis with CLASSIC to determine the soil C-relevant parameters that would be most appropriate for optimization.
- Implemented a version of the CLASSIC soil carbon parameterization in a Bayesian framework allowing optimization of model parameters against observations of soil carbon pools and fluxes.
- Processed and incorporated several databases of soil carbon pools or respiratory fluxes, including those available in PINGO.

Mapping and parameterizing permafrost terrain types (B. Zhang, B. Rabus) - T3-PhD3

Status: In progress (started September 2020)
Objectives: Demonstrate methods to create a new Canadian ground ice map with depth information and improved spatial resolution from existing boreholes and surface data.
Progress:

- Coursework and literature review completed
- Created initial simple but realistic parametrization of permafrost and a statistically relevant simulation of ground ice depth profiles.
- Implemented a heterogeneous (capable of utilizing both text-based as well as raster data) machine learning based ground ice mapping model. Currently, the model is driven by borehole data (from PINGO) as well as a geomorphological data base (raster layers).
- Additional raster input such as vegetation layers and direct SAR optical image input are being added.

Quantifying confidence in simulations of permafrost change (H. Macdonell, S. Gruber) - T3-PhD4

Status: In progress (started September 2021)
Objectives: To establish more rigorous testing for transient permafrost simulation so that results can be appropriately interpreted and used.
Progress:

- Prior to program start, HQP Macdonell completed the graduate course "Geocryology in a warming world" which was focused on simulating permafrost change and worked as a research assistant for fieldwork near Yellowknife and at Kelvin Camp. They helped to service hundreds of temperature data loggers and organize the resulting data.
- The project begins as a MSc with the option to decide to fast-track into a PhD in late summer 2022. The MSc project focuses on toolkit development and statistical methods development and testing. Methods and code from a previous MSc thesis are now being integrated to ingest interoperable observation data from the ERDDAP server run by the network and simulations results produced by the middleware GTPEM, which can run large ensembles of differing permafrost models on Compute Canada servers.
- GlobSim, the part of the toolkit for using reanalysis data to drive point-scale simulations, has been further improved to drive permafrost simulations

1980–2021 at any location in Canada. These software projects (https://gitlab.com/permafrostnet) are supported by the NDS.

Simulation-based climate services for permafrost environments (G. Jonat, S. Gruber) - T3-PhD5

Status: In progress (started September 2020)
Objectives: To provide simulation products of future permafrost change that can inform decisions, and/or serve as a starting point for further co-development of permafrost climate services.
Progress:

- Coursework and candidacy completed.
- Work underway to generate Coupled Model Intercomparison Project 6 (CMIP6) de-biased climate data for future scenarios at a point scale. As a proof of concept, the de-biasing techniques are developed and tested on one global earth system model (CanESM5), using ERA5-reanalysis data as reference observational dataset. Lac de Gras was picked as a case study region due to the availability of ground observation data.
- The workflow developed in this project will be incorporated into the software framework for point simulations GTPEM. GTPEM (https://gitlab.com/permafrostnet/gtpem) development is supported by the NDS.

THEME 4: Hazards and impacts of permafrost thaw

Theme Leads: Pascale Roy-Léveillée and Jocelyn Hayley
Theme objectives: Understand the relevance and the controls of impacts and hazards driven by permafrost thaw and improve their prediction so that it can support adaptation.

Theme 4 Projects (first 30 months)

Scientific and stakeholder surveys to prioritize thaw impacts and hazards (S. Lamoureaux) - T4-MSc1

Status: Cancelled (see Appendix Table 1 and Section 1.3)

Improving the management of permafrost hazards by using value of information theory (M. Turetsky) - T4-MSc2

Status: Cancelled (see Appendix Table 1 and Section 1.3)

Spatial prediction of thaw slumps (T. Lantz) - T4-MSc3

Status: Starting September 2022
Objectives: Identify determinants of terrain susceptibility to thaw slumping.
Progress:

- A description of this position was circulated in October 2021. Co-Investigator T. Lantz and Collaborator P. Morse are currently reviewing applications and are on track to have a student in place for September 2022.

Understanding and prediction of thaw-induced mass movement in steep mountains (E. Stewart-Jones, S. Gruber) - T4-PhD1

Status: In progress (started September 2020).
Objectives: To better understand permafrost and permafrost change in steep mountains of Canada and to support investigating corresponding climate control on landslides.
Progress:

- HQP E. Stewart-Jones started the project as an MSc.
- Coursework completed.
- Existing data from B.C. is in the process of being cleaned and imported so that it can be accessed via the ERDDAP server.
- HQP has gained experience with simulation tools and workflows.

- P. Blake, a resident of Whitehorse, Yukon, has been recruited to start in summer 2022 as a new MSc student and complete the remainder of T4-PhD1.

Understanding and prediction of thaw pond initiation and evolution pathways (P. Roy-Léveillée) - T4-MSc6 (new project, see Section 1.3)

Status: Recruiting
Objectives: Improve understanding of factors controlling thaw pond initiation and whether they will stabilize or grow (and at what rate).

Improved prediction of thermokarst in peatlands and abrupt loss of forests and lichen (M. Turetsky) - T4-PhD3

Status: Cancelled (see Appendix Table 1 and Section 1.3)

Early warning detection of slope failure to enable hazard forecasting (A. Clark, B. Moorman) - T4-PhD4

Status: In progress (started May 2021)
Objectives: Develop a high spatial and temporal resolution remote sensing method to predict and measure permafrost thaw slope hazards, evaluate the effectiveness of using GEographic Object Based Image Analysis (GEOBIA) to extend predictions to larger areas with coarser spatially extensive available satellite data, and map current and potential coastal slope stability across ice-rich permafrost coastal regions.
Progress:

- Site selection completed and in-situ data collected.
- Initial remote sensing models completed.
- Two journal articles in preparation (Clark, Moorman and Whelan in press a) and (Clark, Moorman and Whelan in press b) and one is now published (Clark et al 2021).

Understanding and prediction of thaw-driven flash flooding and water quality change (E. Hille, M. Lafrenière, P. Roy-Léveillée, S. Kokelj) - T4-PhD5

Status: In progress (started part time September 2019, full time since September 2020).
Objectives: To develop a conceptual framework for characterizing the sensitivity and response of Arctic streams and rivers to permafrost thaw.
Progress:

- The focus of this project changed in response to community partner feedback and the research interests of the HQP.
- The 2020 field season was affected by COVID-19 restrictions, but some data collection occurred from 10 peatland streams which were sampled every two weeks from July to October 2020.
- The 2021 field season sampled nine tributary streams within the Miner River network. Both the Rengleng River and Caribou Creek are located south of the treeline. Water quality samples were collected from Rengleng River every two weeks over the winter and spring months (March 2021 to June 2021) and once per month over the summer and fall months (July 2021 to October 2021).
- Samples are being analyzed for suspended and dissolved solids, carbon, major ions, nitrogen, phosphorus, dissolved organic matter fluorescence and ^{14}C.

Quantifying permafrost thaw-driven hazards contributing to water quality change (S. Lamoureaux) - T4-MSc4

Status: Merged into T5-PhD4 (see Appendix Table 1 and Section 1.3).

Permafrost recovery in drained lakes and ponds (D. Chiasson, P. Roy-Léveillée) - T4-MSc5 (New project, see Section 1.3)

Status: In progress (started in May 2021).

Objectives: Improve understanding of controls on permafrost recovery rates in drained basins.
Progress:
- 'Old' (100 to 1,000 years) drained lake basins were identified on Landsat imagery.
- Cores were collected in nine drained basins from the margins and centres.
- Air photo interpretation and development of basin typology to contextualize sample locations is on-going.
- Progress and further intentions communicated in community meetings in October 2021.

Stakeholder perspectives on permafrost hazard research and next practice (J. Holloway, P. Roy-Léveillée, F. Calmels, A. Lewkowicz) - T4-PDF1

Status: In progress (started in February 2022).
Objectives: Identify and prioritize thaw-related hazards from a stakeholder perspective and assess the information produced by the permafrost research community against stakeholder needs and priorities; draft recommendations for next research practice in predicting and adapting to permafrost hazards.
Progress:
- Working on developing a first questionnaire (stakeholder surveys) for ethics application.

THEME 5: Adaptation to permafrost thaw

Theme Leads: Chris Burn and Ryley Beddoe
Theme objectives: Support northerners in adaptation to permafrost in transition.

Theme 5 Projects (first 30 months)

Risk management of linear infrastructure in remote permafrost terrain: Churchill Railway (S. Majidi, S. Kenny) - T5-PhD1

Status: In progress (started September 2021).
Objectives: To support HBR decision-making under uncertainty through an improved understanding of climate change-related geohazards and HBR risk profile, expected asset vulnerability at specific site location(s), and effectiveness of selected adaptation strategies.
Progress:
- Completed course requirements and preparing for comprehensive exams in Fall 2022.
- Started the certification process to operate an uninhabited aerial system that will be used to capture field data using remote sensing techniques.
- Planning underway for a site visit to the HBR office in Spring 2022 to meet with HBR personnel, collect HBR data and information, and conduct a preliminary site visit along the railway to identify research sites.

Management of water in winter near linear infrastructure, Blackstone Uplands (C. Burn) - T5-PhD2

Status: Cancelled (see Appendix Table 1)

Timing of sump stability, western Arctic coast (R. Landriau, C. Burn) - T5-PhD3, converted to MSc project

Status: In progress (started September 2021)
Objectives: To assist the Inuvialuit Land Administration to assess the status of drilling waste disposal sumps in various settings within the Inuvialuit Settlement Region.
Progress:
- Coursework and proposal completed.
- Winter fieldwork to identify sites for summer investigations underway in late March 2022.

- Planning of field program in collaboration with Inuvialuit Land Administration ongoing.
- Logistical support from PCSP for fieldwork in summer 2022 has been secured.

Land use planning and mass-wasting hazards near Fort Severn and water quality change (A. Kirkwood, P. Roy-Léveillée) - T5-PhD4 (new project)

Status: In progress (started September 2019)
Objectives: Quantify permafrost thaw-driven hazards and their contribution to water quality change.
Progress:

- Compiled a collection of 50 peat cores from the Manitoba and Ontario portions of the HBL in partnership with the Ontario Ministry of Natural Resources and Forestry (OMNRF).
- 900 samples were analyzed for total and methyl mercury content.
- 200+ DNA extractions and quantitative polymerase chain reactions (qPCR) assays completed to be analyzed for microbial community role in mercury methylation.
- Completed reconnaissance field survey of alternative mass-wasting features along the Churchill River (MB), including collection of sediment grab samples.
- Presented paper on results at RCOP 2021.

Land use planning and mass-wasting hazards near Fort Severn - T5-MSc1

Status: Cancelled (see Appendix Table 1 and Section 1.3).

Thaw-related landscape change in Weenusk Traditional Territory (P. Roy-Léveillée) - T5-MSc2

Status: Recruiting
Objectives: Create maps of thaw-induced environmental change at the traditional territory scale that can be overlain with maps of sites with high local significance to support risk assessment and forecasting at the community level.
Progress:

- Discussions are in progress with Nunavik partners (KRG land management and Makivik corporation) to consider moving this project to a Nunavik community where it could be supported by complementary funds for field-work and community consultations.

Highway embankments and snow accumulation/manipulation, Blackstone Uplands (P. Jardine, C. Burn) - T5-MSc3

Status: In progress (started September 2019)
Objectives: Determination of the effectiveness of snow compaction for reducing ground temperatures beside highway embankments.
Progress:

- Conducted six months of fieldwork in the central Yukon at field sites near Mayo and at the south end of the Dempster Highway.
- Field investigations ended in early June 2021.
- MSc thesis being written; completion expected in late August 2022.

Digital image correlation for ground deformation at sensitive infrastructure (P. Sharifi, R. Beddoe) - T5-MSc4

Status: In progress (started September 2020)
Objectives: Evaluate how permafrost degradation impacts the performance of an unreinforced and geocell reinforced railway embankment and perform a slope stability assessment of the unreinforced and reinforced embankments under varying flooding conditions.
Progress:

- Numerical modelling scenarios to investigate the impact of geocells have been carried out. Currently finishing the analysis for rail deformation under

degrading permafrost, and the impact of high-water levels on the stability of the rail embankment.
- HQP P. Sharifi is concurrently writing MSc thesis along with simulation work with drafts of the first two thesis chapters complete.
- The inability to travel and do fieldwork for a second season has led to a change in his project that was formally accepted though the network governance.

Sustainable culvert design over degrading permafrost, Hudson Bay railway (S. Kenny) - T5-MSc5

Status: Recruited (Expected start September 2022).
Objectives: To establish an improved understanding of climate change-related flood hazards for the HBR, and to assess the expected asset vulnerability for a specific site location.

Asset management of linear infrastructure in southern and central Yukon (A. Schetselaar, C. Burn) - T5-MSc6

Status: In progress (started September 2020).
Objectives: Determine changes in transportation infrastructure maintenance costs in permafrost regions due to climate change effects.
Progress:
- Assessment of climate change within Yukon and adjacent Mackenzie Valley as compared with projections published in 2000 has been completed. The rate of temperature change corresponds to the highest projections.
- Climate aspects of the project were reported in a paper at RCOP and in a panel discussion with A. Schetselaar on the panel. A paper reporting this aspect of the study has been prepared and is being informally reviewed before submission.
- All maintenance financial data necessary for the project were received in Fall 2021. Analysis has led to presentations to the local chapter of the Canadian Meteorological and Oceanographic Society, the Transportation Engineering Branch of Yukon Highways, and the First Nation of Na Cho Nyak Dun in Mayo, YT.

3.0 Main problems encountered in carrying out the research

Identify the main problems encountered in carrying out the research during this instalment of the grant from the list below:

- ❑ *Technical or scientific problems*
- ❑ *Problems with direction of research or findings*
- ❑ *Involvement of partners*
- ❑ *Other (specify):* ***COVID-19***
- ❑ *No problems occurred during this instalment of the grant*

Describe the problems identified above and the steps taken to resolve each one.

COVID-19's impact has been felt throughout all aspects of society in Canada and globally. NSERC PermafrostNet, as a network with extensive fieldwork activities, is particularly sensitive. The network was in the early stages of ramping up operations and HQP recruitment when much of Canada went into lockdown in late winter of 2020. While the national and provincial restrictions have varied over the subsequent two years, the major impacts have been on network HQP recruitment, travel and fieldwork (impacts upon international activities are discussed in Section 8.2).

Due to COVID-19, student visa processing by the Government of Canada slowed dramatically, with the number of visas processed in 2020 falling to half the number in 2019. Additionally, prospective students struggled to complete their study permit applications due to limited or unavailable in-person services (e.g., required biometrics) and broad-scale travel bans prevented students with permits from assuming their positions. During this period, many HQP who were already accepted into their programs were unable to travel to Canada to start their projects. NSERC PermafrostNet quickly pivoted to remote working to ensure progress on planned activities. HQP who were unable to travel to Canada in person prioritized tasks that didn't require a physical presence in Canada, such as completing coursework remotely and conducting literature surveys. Due to the varying demands of projects such as those with a heavy lab-based or fieldwork component versus those based around modelling, the impacts of remote working were not evenly distributed throughout the network, e.g., Theme 3 was less impacted by field or lab access but still impacted by recruitment challenges.

Travel restrictions meant that network meetings were switched to remote options with all governance (e.g., BOD, BEC), committee and theme meetings continuing. While in-person meetings are hard to replace, the low cost, low carbon and smaller time commitments (due to no travel) of virtual meetings allowed some benefits from the necessary switch. Other major events or initiatives that moved to a virtual format include the 2020 and 2021 AGMs, the Science Communication Toolbox for Researchers series (see Section 9.4), and the Permafrost Data Workshop (Section 7.1). Network members also joined in virtual scientific conferences to maintain their connections to the broader scientific community, including a network virtual booth and presentation at Arctic Change 2020 (December 2020), the Northern Transportation Adaptation Initiative (NTAI) Annual Network Meeting 2021 (February 2021) and the 2021 Regional Conference on Permafrost (October 2021). Other impacts of travel restrictions were felt in closure of communities and territories to outside researchers, excluding the ability to carry out fieldwork.

Fieldwork was heavily impacted during the 2020 and 2021 field seasons. To ameliorate the impact of the lost fieldwork seasons and still achieve milestones laid out for projects, HQP shifted focus to analyzing existing sample datasets, performing synthesis activities, shifting the timing of fieldwork within the project, changing study locations, and using satellite-based remote sensing to achieve project goals.

The Equity, Diversity and Inclusion Committee carried out a survey of network participants in February 2022, the "Pandemic Challenges" survey, to find out more about the challenges and benefits that occurred during the pandemic. The inequitable impacts of the pandemic have been widely reported and this survey enables the network to identify how the pandemic has affected network members and possibly identify new and better ways of working in the future. Of the 40 responses (15 graduate students, two postdoctoral fellows, 10 Co-Investigators, six individuals from partner organizations, two collaborators and two network staff) 56% of respondents say they have spent the majority of their time working from home since the start of the pandemic, and the other 44% had a combination of working from home and attending a workplace, indicating a significant change in work patterns with no respondents spending the majority of their time in the workplace. Network members reported an average 5½-month delay in their projects with the top five challenges reported as: 1) collaborating and communicating with colleagues; 2) increased workload; 3) inability to "unplug" from work; 4) working environment; and 5) distractions at home. One of the long-form comments made by a respondent did highlight the benefits of network research during the pandemic "*... I've*

found it wonderful to connect, and have my students be able to connect, to people across Canada. Particularly for the students, I think this has been really helpful particularly during this time of increased isolation."

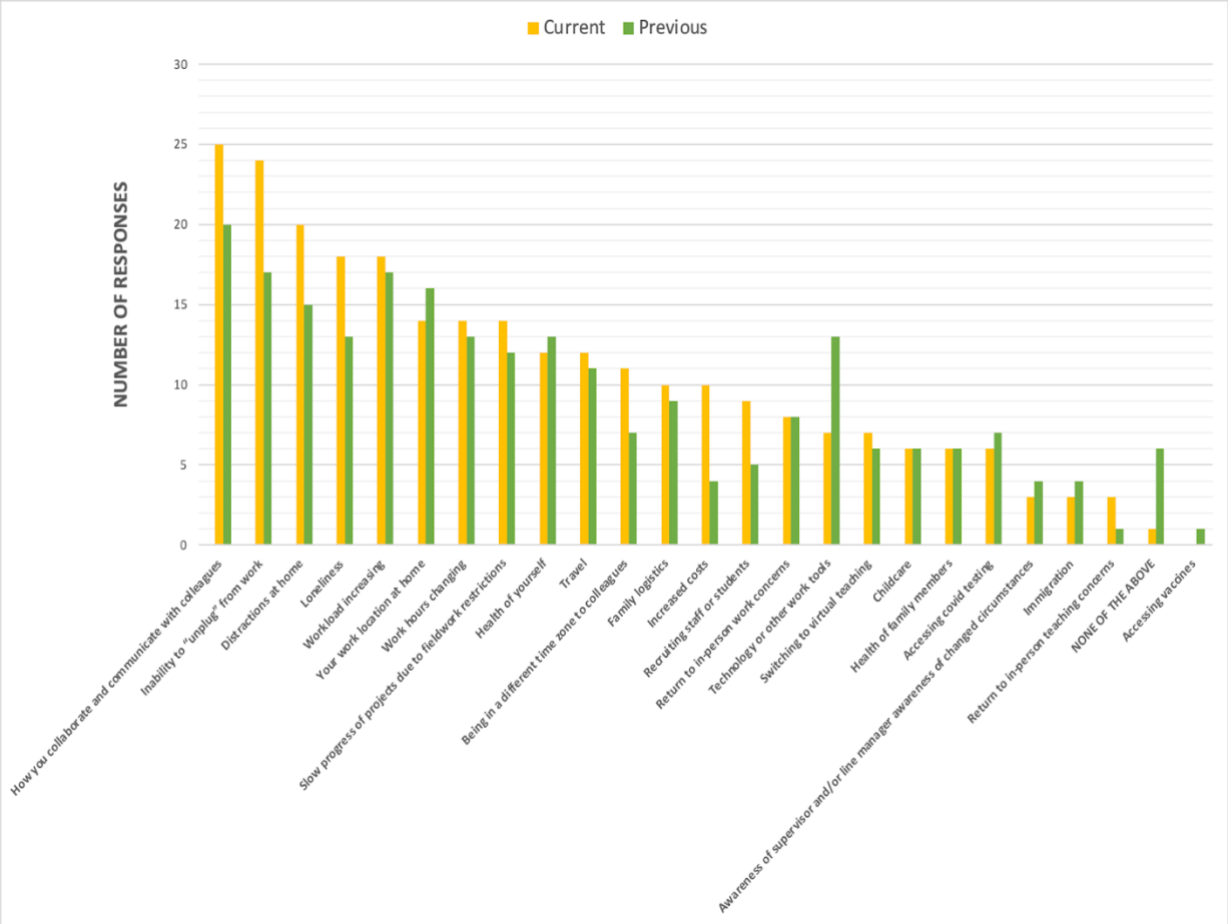


Figure 5. Current and previously faced pandemic-related challenges of network members.

4.0 Network management

NSERC PermafrostNet's governance and management structure follows the principles and structure described in the proposal. This structure was designed to create a collaborative research environment and to keep the evolving network on track, engaged, relevant, agile and accountable. The network's structure engages members of partner organizations to build and improve the connections and relationships between researchers and partners on multiple levels of these organizations. To best enable these interactions, our partnership network agreement (Appendix A), drafted with legal support from Carleton University's Industry and Partnership Services, identifies strategic and expert contacts within our partner organizations who can contribute to the network. We have also included a wide range of partner representation in our governance bodies (see Sections 4.3 to 4.6).

Our network organizational framework includes structures for the management of research, administration, data, partner relationships and financial issues. These structures ensure oversight and completion of objectives and milestones on time and within budget, while allowing for adaptation to changing circumstances. This flexibility has enabled NSERC PermafrostNet to respond well to the needs of the network during an ongoing global pandemic. The processes and agreed roles and responsibilities of contributors to the network have been defined in Terms of Reference (ToR) for the governing bodies and a set of Standard Operating Procedures (SOPs) have been developed and approved by the Board of Directors (BOD) (Appendices B-G and L). Recruitment of the Director of Operations (DO), Knowledge Mobilization and Communication Co-ordinator (KMCCoor), and Data Scientist (NDS) followed a clear and transparent protocol, and each was overseen by a small committee with participation from Co-Investigators and partners.

The following subsections describe in detail changes to the network organization from the original proposal, the network reporting structure, role of the DO, Scientific Committee (SC), Knowledge Mobilization and Communication Committee (KMCC), Equity, Diversity and Inclusion Committee (EDIC), BOD, Board Executive Committee (BEC), Theme leaders, Project Co-Investigators, NDS and a summary of reporting structure changes.

4.1 Reporting structure and network organization

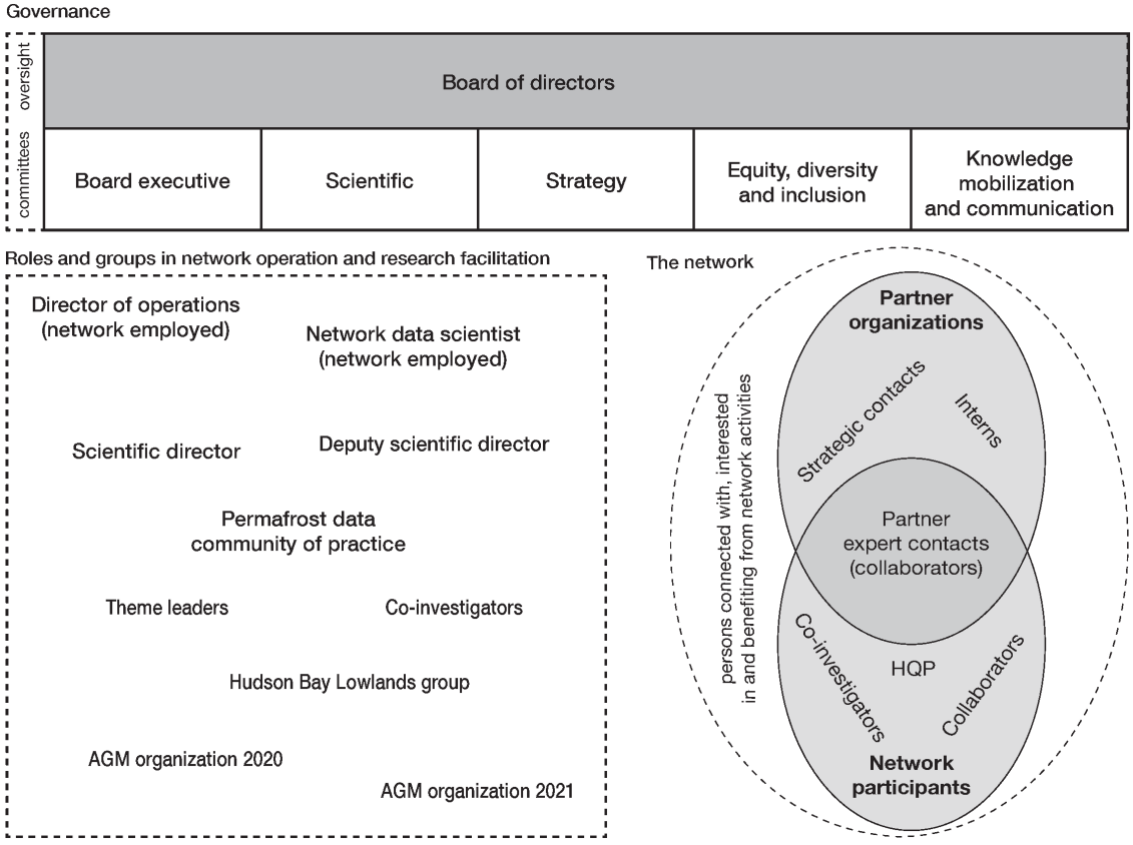


Figure 6. Network Organizational Chart and formal flows of information, as structured at the end of 2021.

The network's reporting structure has retained the original principle of oversight and approvals by the BOD, with reporting from the committees, co-ordinated by the DO in conjunction with the Principal Investigator (PI) and committee chairs (Figure 6). The PI chairs the SC, reports to the BOD and is responsible for providing scientific leadership and direction as Scientific Director (SD) of the network. Improvements and enhancements to the reporting processes have been undertaken following review and approval from the BOD, such as the design of biannual project report forms. The biannual reports are submitted by project Co-Investigators to the DO to provide updates on research progress, which are then used to inform the SC who oversees research progress. The Knowledge Mobilization and Communication committee (KMCC) and the Equity, Diversity and Inclusion committee (EDIC) meet regularly and report to the BOD. To ensure cross-committee communication and interaction, the KMCC and EDIC have a representative join each other's meetings. To enable agile and responsive decision-making, the frequency of meetings has been greater than originally proposed (it was originally envisaged the EDIC would meet annually). Furthermore, the role of Deputy Scientific Director (DSD), with a renewable one-year term, and the BEC were created to provide guidance on reporting and operations between BOD meetings. Other changes include a number of new formal and informal groups created to manage and co-ordinate the network, e.g. New [BOD] Member Selection Subcommittee, Theme Leaders (Section 4.8) and Co-Investigators biannual meetings, the Northern Engagement group, Hudson's Bay Lowlands group (Section 8), flex fund committee (Section 10.3), the permafrost data community of practice (Section 1.2), AGM planning committee, strategy committee (Section 8) and an HQP group.

The New Member Selection Subcommittee was formed at the inaugural BOD meeting in November 2019 to identify a chair for the BOD and to fill remaining positions or identify new members. The self-nominated members of this subcommittee of the BOD were D. Moore, C. Relf, M. Nichols and S. Gruber. The AGM planning committee has been chaired by Co-Investigators and HQP, with support from the DO. The Northern Engagement group was formed in late 2020 to strategize how the network can best realize its aspirations for northern engagement within the given funding limitations. The strategy committee was formed in Fall 2021 (see Section 8). The HQP group is an informal group that was created by HQP. The BEC is currently exploring ways to involve HQP in observing or contributing to the governance of the network, provide trainees with a role in the network and further enhance their wider skills training. The formal bodies have been codified, e.g. creation of a Terms of Reference for the Theme leaders (Appendix F).

4.2 Director of Operations (DO)

The DO provides administrative management of all financial aspects of the network, from day-to-day tasks to preparing financial and administrative logistics, support and advice to the BOD and other governing bodies. These responsibilities include hiring, purchasing, partnership management, reporting, data collection, tracking research progress, co-ordination of partner communications, planning network events and managing the KMCCoor and Administrative Assistant, as well as additional tasks where required. The role of the KMCCoor is to establish communication channels for the network (internal through networking applications such as Microsoft Teams (Teams), and external including the network website, newsletter and social media), design a communications and knowledge mobilization strategy, annual plan and logic model, co-ordinate activities and support the KMCC.

The network was launched in July 2019 and formally announced in August 2019. NSERC PermafrostNet hired S. McKey as the DO in September 2019. McKey was previously Executive Director for the Networks of Centres of Excellence Smart Cybersecurity Network (SERENE-RISC), at the Université de Montréal (2014 to 2018), and prior to that DO for the Internetworked Security Systems Network (NSERC ISSNet) at Carleton University (2008 to 2014). This wealth of experience in managing research networks and familiarity with Carleton University systems facilitated a swift start to network operations. McKey oversaw the establishment of a formal partnership agreement and developed reporting processes, SOPs, a conflict-of-interest policy and documentation for the governance of the network, while also organizing the first AGM and accompanying BOD and committee meetings in November 2019.

NSERC PermafrostNet hired Dr. T. MacLean as the KMCCoor in September 2019. MacLean was previously the DO for Evidence for Democracy and the author of a report on the funding of climate science in Canada. MacLean joined the network with 10 years of experience in science communication and public engagement, having previously worked for universities, research institutes and government funding councils in the U.K. and U.S.A. T. MacLean co-ordinated a successful application to NSERC's Science Communication Skills grant (valued at $20,000) to provide science communication training for network members. In January 2020, NSERC PermafrostNet hired an Administrative Assistant, E. Stockton, who was a PhD Candidate in the Department of Geography & Environmental Studies at Carleton University studying permafrost conditions along the Dempster-ITH corridor, Western Arctic Canada, under the supervision of Co-Investigator C. Burn and Collaborator S. Kokelj. E. Stockton supported the DO with a range of tasks, including reporting on meetings, designing forms and collecting data for management and administration of the network until March 2021. In September 2021, the network hired R. Hachey as a part-time Administrative and Communications Assistant. R. Hachey is a fourth-year Environmental Studies student at Carleton University with a minor in Geography who provides support for website content, events and co-ordination with network partners and stakeholders.

DO S. McKey retired in April 2021, leading to an open recruitment search, and Dr. T. MacLean was hired as the DO. Familiarity with the network and existing members enabled a smooth transfer of responsibilities and continuation of the existing processes and procedures managing the network. The existing knowledge mobilization and communication responsibilities and activities were either rolled into the DO tasks or delegated to other parts of the network. The foundational establishment of policies, procedures, partnership agreements, plans, forms and systems carried out by both DOs has enabled the network to enter its latter half with a leaner administrative team.

4.3 Scientific Committee (SC)

The SC membership was initially designed to consist of the SD ex-officio along with one network partner, two co-applicants, one external and one international representative. The membership of the committee has since expanded to eight members, initially consisting of Prof. F. Calmels (partner), Profs. J. Hayley and P. Roy-Léveillée (co-applicants), Dr. C. Dow (external), Prof. T. Schuur (international - Northern Arizona University, U.S.A.), with an additional member from CCADI (Prof. P. Pulsifer) and the DSD (Dr. J. Melton), who shares a vote with the SD. The ToR for the SC are in Appendix D and were approved by the BOD in November 2019. The membership was expanded to enable better integration of data expertise and progress on joint objectives with CCADI, along with enhanced capability through the addition of a DSD. The position

terms for the SC are for two or three years and renewable. There have been two changes to the SC membership during the reporting period. Prof. D. Froese replaced Prof. P. Roy-Léveillée (March 2021) and Prof. F. Calmels resigned (September 2021).

4.4 Knowledge Mobilization and Communication Committee (KMCC)

The Knowledge Mobilization and Communication Committee (KMCC) ensures adequate two-way communication between network members and partners, as well as ensuring outputs are communicated in formats suitable to the varied audiences and stakeholders. The committee provides guidance on knowledge mobilization and communication activities, gathers information on stakeholders needs from the sectors they represent, promotes the research and outputs of the network and proposes budgets to the BOD. The KMCC consists of K. Elliott (Chair, Carleton University), P. Morse (government representative), K. Karunaratne (indigenous organizations or government representative), E. Marquez (industry representative) and L. Fishback (network participant). J. Carl (Carleton University, Office of the Vice-President Research and International) was the initial chair of the committee, as planned in the proposal. They provided instrumental advice and guidance in helping the KMCC establish the network launch communications and branding, along with a strategic five-year plan and an annual plan for knowledge mobilization and communication. The inaugural meeting of the KMCC was held in conjunction with the first AGM in November 2019, after which the committee has convened a further five times. The KMCC oversaw the development of the logic model, strategic five-year plan, annual plan and launch communications by the KMCCoor in 2019. The position of the KMCC chair was assumed by K. Elliott in November 2020. K. Elliott was responsible for the Faculty of Science communications during the reporting period and in February 2022 was promoted to Manager of Operations and Communications in the Registrar's Office.

4.5 Equity, Diversity and Inclusion Committee (EDIC)

NSERC PermafrostNet's Equity, Diversity and Inclusion Committee (EDIC) is responsible for advising on best practices with respect to equity, diversity and inclusion (EDI), and strives to promote a diverse and inclusive network that fosters a culture of empathy, respect, and celebration of differences. The EDIC is a self-organizing committee, with an open and inclusive membership providing priority to underrepresented groups who express an interest in joining the group. The EDIC actively encourages network members to join the committee, rather than having quotas, to avoid overextending members or groups within the network. At the inaugural meeting in March 2020, it was proposed that the committee be open to HQP and affiliated students. The committee has been chaired by K. Pendakur (Standards Council of Canada) and intermittently on an interim basis by K. Swan (Carleton University). While originally planned to meet annually, the committee now meets semi-annually and on an ad-hoc basis as needed, and has met a total of ten times. The EDIC reports to the BOD via the DO, and to the BEC when required. Major accomplishments to date include the development of a core set of EDI Values that were developed in consultation with the entire Network, the launching of a survey to understand how the COVID-19 pandemic was impacting network members (briefly summarised in Section 3), and presentations to the network on EDI principles. The committee also developed a workplan, a digital feedback tool, and network statements on EDI issues e.g. Anti-Black racism. The committee has made valuable contributions to the network with their advice on the use of land acknowledgments, HQP terminology, gender inclusivity in French communications, the

content of annual meetings and training courses e.g., the science communication toolbox for researchers.

4.6 Board of Directors (BOD)

The BOD membership was initially designed to consist of 13 members: two external members (one of which is the chair), the SC chair (SD Prof. S. Gruber), a Co-Investigator, seven representatives from partner organizations, and two non-voting members, including the DO. The ToR for the BOD are in Appendix B and were accepted by the BOD in December 2019. The Board of Directors meets twice a year, with extraordinary meetings called if necessary. All Board materials are prepared and shared in advance of meetings, making use of a secure BOD area accessible via the network website. A private BOD Teams channel has been established to enable collaboration and discussion. Similar digital infrastructure has been designed and populated for the SC, KMCC and EDIC. To enable swift decision-making and approval of some network activities between BOD meetings, the BEC was established (discussed in Section 4.7).

The initial interim BOD Chair was Dr. C. Relf. Dr. Relf has served as director of the Yukon Geological Survey (YGS) since January 2008. The co-applicant position annually rotates and was initially held by Prof. T. Lantz and is now held by Prof. A. Lewkowicz. The DSD also sits on the BOD with a vote shared with the SD. For the partner organization positions on the BOD, Indigenous representation is currently from a member of the Inuvialuit Game Council (presently L. Ruben who replaced M. Kudlak). Industrial representation is from BGC Engineering (Dr. L. Arenson), federal government representation is from Transport Canada (M. Nichols), provincial government representation was from Ministère des Transports du Québec (A. Guimond), with territorial representation for Nunavut (L. Ham; Natural Resources Canada), the Northwest Territories (D. Moore; Government of N.W.T., Department of Infrastructure), and the Yukon (Carolyn Relf; YGS).

The BOD first met at the 2019 Network AGM in November 2019 in Ottawa. Following the first meeting, a search was undertaken by a subcommittee of the BOD to identify a candidate for Chair. The Chair Search Subcommittee was composed of Moore (Chair), Nichols, Relf and SD Gruber. The subcommittee first met on 9 December 2019. A list of 23 candidates was drafted and ranked and the top five candidates were proposed to the BOD. In December 2019, the BOD delegated the choice of Chair from the candidates proposed to the chair search subcommittee. Following approval by the BOD and discussions between the candidates and search committee members, and with NSERC approval, Dr. J. King took on the role of BOD Chair at the May 2020 BOD meeting. Dr. King is a former Associate Deputy Minister at Public Services and Procurement Canada. In this role, Dr. King was responsible for leading the renewal of federal science infrastructure up until July 2020. The search for an additional external member of the BOD is ongoing and the search subcommittee has met three more times (September and December 2020, January 2021).

4.7 Board Executive Committee (BEC)

The purpose of the BEC is to advance activities of the network through oversight of network operations between BOD meetings (ToR in Appendix C). The composition of the BEC currently includes the BOD chair, the SD, the DSD and the DO. The BEC responsibilities are ensuring implementation and completion of management, direction and fiduciary decisions of the network as approved by the BOD. The BEC, with guidance

and oversight of the BOD, provides: 1) leadership through overseeing implementation of BOD decisions, planning meeting agendas and materials, and providing guidance on reporting and operations between BOD meetings; 2) financial accountability to NSERC and contributing network partners through stewardship of annual network budgets, assessment financial reports prior to BOD review, all with the understanding that the BOD makes all final budgetary decisions.

4.8 Theme leaders

The role of the Theme leaders is to support integration of HQP projects and connection of research teams to accomplish network objectives and outputs as defined in the ToR that were approved by the BOD in May 2020 (appendix H). Each Theme is led by two experienced academics, and they are supported by the Director of Operations. The Theme leaders and all Co-Investigators meet annually with the respective meetings alternating at roughly six-month intervals.

4.9 Project Co-Investigators (Co-I's)

Project Co-Investigators are responsible for reporting on the scientific progress and financial matters of individual projects under their supervision (Co-Investigator Biannual Report form; Appendix J) and, if necessary, requesting any deviations with respect to the proposal projects (Appendix K). If additional funding is requested, e.g., flex funding (See details in Section 10.3, application form is Appendix J), they are required to include details of the expenditure in their project progress reports and financial statements. These reporting requirements gather information on project progress and concerns, status of outputs such as publications, data, source code, conference attendance and communication activities, as well as any in-kind or additional funding support provided to the Network.

4.10 Network Data Scientist (NDS)

N. Brown assumed the position of NDS in September 2019. They hold a BSc in Environmental Geoscience with a minor in Mathematics (University of Victoria) and an MSc in Geography with a specialization in Data Science (Carleton University). Their master's thesis was focused on permafrost modelling and was awarded the W. Garfield Weston Award for Northern Research. Brown previously worked as a project geologist in the N.W.T. and consequently is familiar with the practical details of northern fieldwork, while bringing existing professional relationships with many network partners. The NDS is overseen by the SD and progress is reported to the SC. Brown co-ordinated a successful application to Compute Canada's Research Platforms and Portals competition (valued at $10,389) to provide resources for PermafrostNet HQP, developed a data policy for the network, and prepared and led the 2020 Permafrost Data Workshop. The NDS is additionally responsible for acting as a technical liaison with CCADI to support data interoperability, developing tools and resources to support data handling and modelling for NSERC PermafrostNet HQP, managing the computing resources allocated by Compute Canada and offering day-to-day support for HQP on data handling, computer simulation and software development.

The network created a short-term software development intern position to assist with some of the initial ramp-up of data handling infrastructure. The software development intern position reported to the NDS and began in April 2020. A. Gao was hired for this

position following the completion of a BSc in computer science (Carleton University). Gao collaborated on designing a data cleaning tool and improving the data viewer portal on the permafrost data science platform. Funding for the software development intern position ended in December 2020. Gao has since been hired by CCADI, an NSERC PermafrostNet partner, as part of their software development team.

5.0 Network decision-making process

5.1 Roles and responsibilities

The decision-making process has followed the proposal plans quite closely. There are well-defined policies and procedures in place, as well as additional governance structures to assist in running the network efficiently and equitably as outlined in the previous section.

The BOD oversees all activities and budgetary decisions of the network, with overall responsibility for management, direction and fiduciary accountability, including approving annual budgets submitted to NSERC. The BOD appointed a BEC (see Section 4.7) to meet and make decisions on a biweekly basis, accelerating and adding traceability to the decision-making process. The DO has established a comprehensive set of Standard Operating Procedures (SOPs; Appendix N) that have been approved by the BOD. These SOPs cover funding, reporting of project progress, deviations to research, engagement, changes to the network partner organizations, conflicts of interest, letters of support, governance and other aspects of network management. These SOPs are working documents that are updated and improved to reflect changing needs and circumstances of the network, with revisions approved by the BOD. The system for reporting project progress and deviations is outlined in Section 4.9. The process for Co-I's requesting project deviations is well defined with guidance and forms provided to the Co-Investigators to simplify the process and explain and document the steps for review and approval by the DO, SD, SC, and BOD.

5.2 Communications and decision-making

The network decision-making process has been progressing well, while remaining agile and adaptable to the unprecedented changes to working patterns and limitations caused by the COVID-19 pandemic (discussed more in Sections 3 and 6). Between the hiring of the initial network staff in September 2019 and the public health mandated closure of Carleton University offices in March 2020, meetings and communications had been undertaken using a hybrid model of in-person and virtual tools. Fortunately, early preparations for the use of communication tools (video conferencing, website, cloud-based file storage, Teams) to enable effective connections between the geographically disparate members of the network enabled the network staff and members to transition to a work-from-home model within one day. These initial systems have been expanded and now support a wide range of meetings and communications for the network, enabling effective collaboration and decision-making. The Network's Teams currently hosts 21 channels and more than 200 members, facilitating meetings between members of each Theme, governance bodies and the organization of training and annual general meetings, among other uses.

The decision-making that takes place in the governance bodies is carefully documented in anonymized Freedom of Information and Protection of Privacy Act (FIPPA) compliant meeting minutes, reviewed by participants, and approved prior to being made available

to members of the network to ensure transparency through a password protected area of the network website and Teams. Dedicated areas of the network website offer secure storage and shared documents for the BOD, committees and members of the network. Each decision-making body's schedule for circulation of meeting agendas, minutes and notes are defined in their relevant ToR to enable sufficient time to review documents and the decisions that will be required of them during meetings. The presentation of information and recording of proceedings undergo iterative changes under the guidance of the BEC to continually improve functioning of the administration and governance bodies. Additionally, the BOD receives, in advance, comprehensive information about agenda items, including BEC meeting notes, progress reports, meeting minutes and recommendations from the other governance bodies, including KMCC, EDIC, and the Strategy committee, to maximize the opportunity for an informed and engaged discussion prior to making the decisions required.

5.3 Involvement of the Scientific Committee

The SC meets approximately one month before the BOD to review progress and make recommendations to the BOD (via the SC Chair supported by the meeting minutes and any associated documents). The SC has provided recommendations through the course of the network. Notably, they ensured continuity and maintenance of research objectives following the retirement/move abroad of three Theme leaders by reviewing project deviations and appointing new project supervisors and Theme leaders (see Section 1.3). The SC also ensured that research priorities were adaptable in the face of COVID-19 challenges by recommending the establishment of a flex fund and associated procedures. In October 2020, they recommended a process for adjusting or cancelling HQP projects facing recruitment or financial limitations. Another significant decision included supporting the promotion of Prof. O. Sonnentag from a collaborator to a network Co-Investigator (NSERC approval in June 2020). All the recommendations from the SC have been approved by the BOD and the committee has worked well towards a shared vision and goals for the network.

6.0 Main management issues and their solutions

- ❑ *Interpersonal issues*
- ❑ ***Staffing issues (including students)***
- ❑ ***Funding problems***
- ❑ ***Involvement of partners***
- ❑ ***Communication problems***
- ❑ *Intellectual property issues*
- ❑ *Other (specify):* ***project progress reporting***
- ❑ *No problems occurred during this instalment of the grant*

Provide a more detailed description of the management issues and/or problems identified above. Specify whether or not any assistance was requested and received from NSERC, and describe the steps taken to resolve each issue or problem.

6.1 Theme and project supervision

As discussed in Section 1.3, two investigators have left the network due to job changes or retirement while a further collaborator (Prof. M. Allard) retired. The network was able to fill the roles and responsibilities of the departed investigators internally, as already illustrated by the replacement of Theme leadership. Furthermore, the network has taken

steps to enable collaborating researchers at partner universities to supervise projects as Co-Investigators (Prof. O. Sonnentag).

6.2 Recruitment of HQP

NSERC PermafrostNet has faced challenges arising from the COVID-19 pandemic which have delayed recruitment of graduate students, due in part to travel difficulties (see Section 3). Recruitment of high-potential graduate trainees requires a significant investment of time and effort from network members. Raising the profile of the network through clear and consistent branding, media features (see Section 9) and establishment of communications channels, as well as continued engagement with network members, partners and stakeholders, has facilitated recruitment of 30 graduate students and four postdoctoral research fellows (PDFs) by January 2022. Further promotion of the network at scientific and industry conferences has been hampered by their cancellation or switch to a virtual format since 2020. However, the large community of trainee permafrost researchers now affiliated with the network and their enthusiastic involvement in Theme meetings, on the Teams channels, in the EDIC, at the AGMs and in training activities, is testament to the impact the network is making on training the next generation of permafrost researchers.

6.3 University project funding

The number of student projects in the network is ambitious. To stay in line with available NSERC grant funding, the in-kind commitments toward student stipends made by some of our partner universities were allocated as part of the overall budget in the proposal for NSERC PermafrostNet. In turn, the amount of stipend funding from the NSERC funds to be allocated to the Co-Investigators from those universities was reduced. In Year 1 of the network, we learned that this was not the original expectation of the Co-I's and partner institutions and would lead to inequities within the network. To alleviate this, it was decided that all Co-Investigators would receive the same annual NSERC PermafrostNet stipend allocations for PDF, PhD and MSc projects as detailed in the proposal. With this change, the original budget would face a potential shortfall of the equivalent of five PhD students over the five years of funding. The BOD decided that this would be addressed with a combination of additional external funding and the reduction of some projects, specifically PhD projects that may not be able to recruit on time. Each university's promised stipend (of differing amounts) has been provided, to the best of our knowledge, on top of those made available by the network.

On January 31, 2020, Co-Investigators were informed of the impacts of project stipend contributions on the recruitment of PhDs (see Section 10.3). In October 2020, the SC discussed the evolving research program and outlined the process for adjusting the funding of PhDs in the network. The SC requested project deviation requests be submitted by March 2021, which were reviewed by the SC in April 2021 for any students proposed to start in Fall 2021 (SC minutes 9.a.i. from 27 October 2020). The deviation requests included outlines of how the milestones would be achieved and how the proposed work will contribute to network outputs before the end of 2024. HQP projects, without either a confirmed student or a plan for changes available in March 2021, were not given a budget allocation for network Year 3. The BOD subsequently approved the deviation requests and the Year 3 budget in May 2021. In the October 2021 Theme Leaders meeting, the revised budget and cancelled PhD projects (due to no recruited students; see Appendix Table 1 for list) were discussed, along with the impact on adjustments to the research program. The SC unanimously approved a motion towards

achieving the main goals, outputs and outcomes set out in the network proposal while being fiscally prudent and adjusting for the ongoing impacts of the COVID-19 pandemic (22 October 2021, agenda item 9.b.ix.). The new research and budgetary approach for the network, in light of these changes, was subsequently approved by the BOD during their November 2021 meeting.

6.4 Involvement of partners

Contributions from partners, both cash and in-kind, have been less than anticipated due to factors outside the network's control, (e.g., cash contribution from the Canada Nunavut Geoscience Office (CNGO) discussed in Section 10.3) and fieldwork restrictions due to COVID-19 (see Section 3) that have delayed the ability of partners to contribute to research activities.

6.5 Project progress reporting

The network has faced minor difficulties in achieving timely reporting for the purposes of planning and network management by funded researchers. Budgetary planning and documentation to the SC and BOD draw upon project plans outlined in the proposal, but also on reporting of project progress. Insufficient information can cause issues in releasing funds to network investigators and adherence to financial policies in relation to NSERC financial administration rules and the Transfer Agreements (see appendix P for an example agreement) signed between Carleton University and the Co-Investigators' receiving universities. To address this, the network has co-ordinated with the NSERC representative (L. Wood) to ensure biannual progress reporting is submitted according to the set timelines.

6.6 Communication

Restrictions on travel and in-person meetings have had a significant impact on the ability to conduct face-to-face communications, hold meetings and attend events that would foster collaboration, knowledge sharing, training, relationship building, networking, outreach and dissemination of results (see Section 3). Numerous steps have been taken to recreate the vitality of in-person meetings with virtual tools. As an example, at the virtual joint CPA and NSERC PermafrostNet 2021 AGM, a poster session was held using the SpatialChat platform which enables posters to be displayed, or "pinned" to a browser window while "proximity" video chats allow individuals/groups of people to interact via video and audio within a virtual "room" created in the browser in a manner similar to a traditional poster session where participants join in spontaneous interactions to discuss the science being presented.

7.0 Training of Highly Qualified Personnel (HQP)

7.1 HQP terminology and numbers

Following the 2020 AGM, one of the network's northern partners brought to our attention that the term HQP, as used by the network, NSERC and other organizations can be understood as disrespectful to those who did not attend university but may hold equally valuable knowledge derived from other sources. This prompted discussion within the network, including by the EDIC and the SC. In response, NSERC PermafrostNet now reserves the term "HQP" solely for reporting to NSERC but otherwise uses descriptive

terms such as "students and postdoctoral fellows" (BOD decision, May 2021). The network HQP per Theme are listed in Table 2. Additionally, within this document we refer to "affiliate HQP" - HQP that are funded externally but have contributed to the network and participate in network activities such as theme meetings, AGMs, partner interactions and research projects.

Table 2: NSERC PermafrostNet HQP numbers by theme.

Type of HQP	Theme 1: Characterization of permafrost		Theme 2: Monitoring of permafrost change		Theme 3: Prediction of permafrost change		Theme 4: Hazards and impacts associated with permafrost thaw		Theme 5: Adaptation to permafrost thaw	
	Total	Completely supported by RN grant	Total	Completely supported by RN grant	Total	Completely supported by RN grant	Total	Completely supported by RN grant	Total	Completely supported by RN grant
M.Sc.	**2**	**0**	**1**	**1**	**4**	**3**	**4**	**1**	**5**	**3**
Ph.D.	**8**	**4**	**5**	**4**	**6**	**4**	**3**	**2**	**6**	**3**
PDF	**3**	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**0**

Table 2 does not include projects started, or scheduled to start, in 2022. A further two PDFs, one PhD and two MSc projects are commencing in 2022 (mentioned in Table 1). Details of all HQP and their projects are listed in Table 3 below, including start and end dates.

Table 3: NSERC PermafrostNet HQP project details

HQP	Project	Supervisor (Instit.)	Project Title	Period of project
THEME 1				
M. Paquette/ S. Gagnon[1]	T1-PDF1	D. Fortier (Montréal)	PINGO: Permafrost Information Network of Ground Observations	09/20 - 08/22
M. Roustaei[2]	T1-PDF2	D. Froese (Alberta)	Standardization of permafrost characteristics	01/22 - 12/23
T. Herring	T1-PDF3	A. Lewkowicz (Ottawa)	Canadian permafrost electrical resistivity survey next practices and database (CPERS)	04/21- 03/23
H. Fereydooni	T1-PhD2	S. Gruber (Carleton)	Characterizing the ice and water content of permafrost with dielectric methods	01/22 - 12/25
S. Z. Mohammadi[3]	T1-MSc1	J. Hayley (Calgary)	Strength and consolidation behaviour of permafrost sediments	06/20-05/23

[1] M. Paquette assumed a new position outside the network Feb 2022 and is replaced by S. Gagnon
[2] Employed as a research associate
[3] Student completing MSc as part of a PhD

K. Rgh	T1-PhD3	J. Hayley (Calgary)	Geomechanical properties of thawing permafrost	10/21 - 09/25
T. Rahman	T1-PhD4	P. Roy-Léveillée (Laval)	Permafrost and ground ice conditions in the Hudson Bay Lowlands	09/21 - 08/25
A. Chiasson	T1-PhD5	D. Froese (Alberta)	Permafrost conditions: Mackenzie Valley and glacial lakes Mackenzie and McConnell	09/20 - 08/24
J. Young[2]	T1-MSc2	D. Froese (Alberta)	Syngenetic permafrost of unglaciated Yukon	09/20 - 03/23
M. Gamshad	T1-PhD6	D. Fortier (Montréal)	Ground ice of the eastern Canadian Arctic polar deserts	01/20 - 12/23
THEME 2				
E. Street	T2-PhD2	T. Lantz (Victoria)	Inuvialuit and Gwich'in knowledge of permafrost systems	09/21 - 08/25
G. Francis	T2-PhD3	T. Lantz (Victoria)	Spatial monitoring permafrost change using Landsat	01/21 - 12/24
A. Plourde	T2-MSc1	B. Rabus (Simon Fraser)	Measuring surface displacement using winter SAR	01/22 - 12/23
U. Iqbal	T2-PhD4	B. Rabus (Simon Fraser)	Airborne InSAR to monitor permafrost thaw near linear infrastructure	09/20 - 08/24
F. Ghiami Shomami	T2-PhD5	S. Gruber (Carleton)	Interpreting ground temperature and subsidence for better quantifying permafrost change	09/20 - 08/24
THEME 3				
R. Lefebvre[4]	T3-MSc1	J. Melton (Victoria)	Simulating land cover change and its influence on permafrost with CLASS-CTEM	05/21 - 08/21 continuing 05/22 - 04/24
A. Mollasharifi-Targhi	T3-PhD1	J. Melton (Victoria)	Incorporation of excess ground ice and its impacts into CLASS-CTEM	09/20 - 08/24
M. Shaposhnikova	T3-MSc2	C. Duguay (Waterloo)	SAR-based water products to support simulation of lowland thermokarst	Completed 09/19-09/21
C. Gauthier	T3-MSc3	O. Sonnentag (Montréal), J. Melton (Victoria)	Fate of carbon in Canadian permafrost-affected soils	09/20 - 08/22

[4] Project started by summer undergraduate internship resuming as incoming MSc student.

B. Zhang	T3-PhD3	B. Rabus (Simon Fraser)	Mapping and parameterizing permafrost terrain types	09/20 - 08/24
H. Macdonell	T3-PhD4	S. Gruber (Carleton)	Quantifying confidence in simulations of permafrost change (started as MSc project)	09/21 - 08/25
G. Jonat	T3-PhD5	S. Gruber (Carleton)	Simulation-based climate services for permafrost environments	09/20 - 08/24
THEME 4				
K. Diederichs	T4-MSc3	T. Lantz (Victoria)	Spatial prediction of thaw slumps	09/22 – 08/24
E. Stewart-Jones	T4-PhD1	S. Gruber (Carleton)	Understanding and prediction of thaw-induced mass movement in steep mountains (started as MSc project)	09/20 - 08/22
A. Clark	T4-PhD4	B. Moorman (Calgary)	Early warning detection of slope failure to enable hazard forecasting	05/21 - 04/25
E. Hille[5]	T4-PhD5	M. Lafrenière (Queens)	Understanding and prediction of thaw-driven flash flooding and water quality change	09/19 - 08/24
D. Chiasson	T4-MSc5	P. Roy-Léveillée (Laval)	Permafrost recovery in drained lakes and ponds	05/21 - 04/23
J. Holloway[6]	T4-PDF1	P. Roy-Léveillée (Laval)	Stakeholder perspectives on permafrost hazard research and next practice	02/22 - Summer 2024
THEME 5				
S. Majidi	T5-PhD1	S. Kenny (Carleton)	Risk management of linear infrastructure in remote permafrost terrain: Churchill Railway	09/21 - 08/25
R. Landriau[7]	T5-PhD3	C. Burn (Carleton)	Timing of sump stability, western Arctic coast	09/21 - 08/25
A. Kirkwood	T5-PhD4	P. Roy-Léveillée (Laval / Laurentian)	Land use planning and mass-wasting hazards near Fort Severn AND water quality change	01/20 - 12/23
P. Jardine	T5-MSc3	C. Burn (Carleton)	Highway embankments and snow	09/20 - 08/22

[5] Started part time September 2019, full time since September 2020
[6] Project starting as 50% FTE with transition to 100% in Fall 2022
[7] Project converted to a MSc

			accumulation/manipulation, Blackstone Uplands	
P. Sharifi	T5-MSc4	R. Beddoe (RMC)	Digital image correlation for ground deformation at sensitive infrastructure	09/20 - 08/22
A. Moqadam	T5-MSc5	S. Kenny (Carleton)	Sustainable culvert design over degrading permafrost, Hudson Bay railway	09/22 - 08/24
A. Schetselaar	T5-MSc6	C. Burn (Carleton)	Asset management of linear infrastructure in southern and central Yukon	09/21 - 09/23

7.2 Affiliated HQP

- MSc student H. Travers-Smith (University of Victoria) Theme 2
- MSc student J. Humphries (Carleton University) Theme 5
- MSc student H. Ackerman (University of Ottawa) Theme 1
- MSc student B. Kameledenova (RMC) Theme 5
- MSc student A. Alvarez (University of Alberta) Theme 1
- MSc student C. Deslauries (University Laval) Theme 4
- MSc student A. Pekinasova (University of Calgary) Theme 4
- MSc student D. Ouellette (University of Calgary) Theme 4
- MSC student N. Arpin (Queens University) Theme 3
- PhD student F. Brieger (Carleton University) Theme 2
- PhD student A. Castagner (Carleton University) Theme 1
- PhD student E. Stockton (Carleton University) Theme 5
- PhD student C. Ross (RMC) Theme 5
- PhD student E. Nakhostin (Carleton University) Theme 5
- PhD student J. Eppler (SFU) Theme 3
- PhD student J. Haas (SFU) Theme 3
- Post-doctoral fellow Dr. G. Meyer (ECCC) Theme 3
- Post-doctoral fellow Dr. S. Gagnon (University of Montreal) Theme 5
- Post-doctoral fellow Dr. L. Huang (UC Boulder) Theme 2
- Post-doctoral fellow Dr. E. Devoie (McGill University and Carleton University) Theme 1

7.3 Cross-network and partner involvement in training

The network plan for HQP training aims to maximize the research impact, professional development, career readiness and longer-term employability of its trainees. This has been complemented by activities for knowledge and technology transfer. Network HQP have forged valuable connections through the large network of universities and partnering organizations within Canada and internationally. Involvement with the network has given trainees improved access to specialized training in areas such as data management and high-performance computing, career development, community engagement and science communication.

Training at the 2020 and 2021 AGMs included sessions specifically for the HQP to gain useful skills and knowledge, (e.g. 2020 HQP Flash presentations and the "Future of Permafrost Science & the Next Generation" panel, 2021 poster and mentoring sessions). Also at the AGMs, the network organized two EDI sessions in 2020 and a community

engagement and mentoring session in 2021 to foster a respectful, diverse, equitable and inclusive training environment.

A more comprehensive training experience within the network is created through a mentoring environment that connects trainees to multiple mentors. This approach ensures trainees interact with a diverse range of mentors in a variety of forums, large and small, from one-to-one mentoring to presentations to the entire network, to support their career and personal development. Their mentoring environment includes a supervisor, supervisory committee members, Theme Leaders, other network investigators, collaborators and partners, as well as their peers, who can provide diverse perspectives and advice. These interactions are co-ordinated by the network, e.g., theme and cross-theme meetings where Co-Investigators, trainees, affiliated students and guests interact, but also occur organically, e.g. the student-organized, student-only session at the 2020 AGM. In addition to this, many of the trainees have time allocated to work in another lab or with another organization during their studies.

Over the course of the network, online sessions have provided opportunities for trainees to connect, network and share progress and challenges with their research programs in a safe and non-judgmental space. These sessions began as informal "water-cooler" style video conference meetings and have adapted to changing circumstances as the network progressed, with more formal network seminars now co-ordinated by one of the Theme 3 graduate students in collaboration with the DO. The first seminar provided an opportunity for HQP M. Shaposhnikova (Theme 3) to share findings of her completed research project in December 2021.

A key element of training at the post-graduate level in permafrost research fields involves experiential learning through fieldwork (albeit hampered by pandemic-related restrictions; see Section 3). This training occurs when trainees spend time with their supervisors, partners and peers carrying out work in the field, where the theoretical knowledge is applied to the many varied conditions and logistics of actual practical investigations. This also takes place in front of the computer when interacting with real-world data sets and simulation tools (often with the assistance/tutelage of the NDS). By providing a large network and interconnected projects, we have provided opportunities for computer-based trainees to get a taste of fieldwork and for fieldwork-focused students to learn about data analysis. For example, in summer 2021, PDF Dr. T. Herring was able to visit the Canadian Arctic, meet northern partners and take part in fieldwork that contributes to their work on the CPERS database. However, generally, student and trainee access to specialized in-person training has been more limited than proposed. Planned field safety training had to be delayed due to the gathering restrictions imposed in the wake of the COVID-19 pandemic. However, they were able to virtually attend the Northern Transportation Adaptation Initiative annual meeting in 2021 and have received training on high-performance computing and software carpentry through two workshops. The first of these was the Permafrost Data workshop, which had 16 HQP participants. It included presentations and discussions with experts in permafrost data management, data interoperability and data management more broadly. The second activity was the permafrost data hackathon held on August 19, 2020 and organized by the NDS. The hackathon was designed to collaboratively help the 14 HQP participants gain skills in publishing permafrost data, data wrangling and coding. The event included breakout groups and a roundtable on best practices for data management and publication. Further to the workshops, our NDS has worked one-on-one with HQP on an as-needed basis to assist with software version control, programming and data management (publication, metadata, and best practices).

Network-level training in communications was provided by the NSERC-funded Science Communication Toolbox for Researchers course. The course provided the 39 participating network members with evidence-based science communication tools and training to help them effectively share their knowledge, communicate their research and convey information about the broader issues posed by permafrost to a variety of non-expert audiences. The course consisted of seven online workshops (Science Communication 101, Social Media 101, Public Engagement 101, Visual Science Communication, Community Engagement 101, Wikipedia Editing and Science Policy 101) between January and March 2021. This training consisted of synchronous and experiential learning activities tailored to permafrost, climate and Arctic subjects led by a diverse group of experts, including F. Qaiser (Evidence 4 Democracy, Chief Science Advisor's Youth Council), Dr. A. Wilcox (Environment and Climate Change Canada), J. Krolik (Art the Science), Dr. M. Falardeau-Côté (Université Laval), Dr. A. Menzies (Guelph University), Dr. G. A. MacMillan (CINE Centre for Indigenous Peoples' Nutrition and Environment), J. Ajayi (Northern Futures Planning) and our DO. The course was structured to raise awareness of EDI issues with a focus on the shared history of Indigenous and non-Indigenous peoples in Canada, examples of successful under-represented researchers, initiatives to address inequality, best practices in working with Indigenous communities, and carrying out respectful and effective community and public engagement. As examples, the Science Communication 101 workshop covered inclusive science communication practices, the Wikipedia editing workshop covered gender and racial bias in Wikipedia and shared initiatives to address the lack of representation by women and Black, Indigenous, and People of Colour (BIPOC), and the Community Engagement workshop covered the historical context, e.g. treaties and land claims, colonization and reconciliation, followed by guidance on ways of respecting Indigenous knowledge and the Ten Calls to Action for Natural Scientists Working in Canada.

8.0 Collaborations with partners, including international collaborations

8.1 Domestic activities

Partner involvement in the planning, execution and governance of research activities is integral to bi-directional knowledge transfer at the core of the network. Partner involvement in network governance through network decision-making bodies has been described in Section 4, while Section 2 discussed some partner interactions at the project level. Here we describe in more detail overarching and project-specific interactions between the network and its partners. Appendix Table 2 lists the organizations involved in collaborative interactions with NSERC PermafrostNet. In addition to supporting organizations, we have other important partners who do fit the criteria or could not easily follow the procedures of NSERC. Here we adopt the same approach as in our proposal by also referring to these organizations as partners.

Theme 1 has had several notable network partner interactions. Dr. M. Paquette (HQP) and the NDS have close contact with research consortia (Centre d'Etudes Nordiques' Nordicana D) as well as the GSC, Northwest Territories Geological Survey (NTGS) and YGS as part of PINGO design and implementation. Newly recruited HQP M. Roustaei is benefiting from samples received from network partner SRK Consulting. Dr. T. Herring (HQP) has consulted with the GSC and Prof. F. Calmels (Collaborator; Yukon University) to discuss ongoing research and provide feedback on a manuscript submitted to Permafrost and Periglacial Processes. HQP H. Fereydooni is collaborating with NTGS on ring-electrode sensors, testing spectral induced polarization (SIP) data near Yellowknife,

and is in ongoing discussion with NRCan/GSC and NTGS about co-locating field-SIP with investigations along the planned Grays Bay – Yellowknife all-weather-road corridor. Additionally, GSC personnel (Dr. P. Morse; Collaborator) are involved in a directed studies course for the student. In the HBL region, network partner Arctic Gateway sponsored the initial field survey of HQP T. Rahman. Other Theme 1 HQP (A. Chiasson and J. Young) have been in frequent collaboration with NTGS personnel, including joint fieldwork, leading to co-authorship on RCOP posters and upcoming manuscripts.

Connected with Theme 1 activities, research collaborations have been further developed with the HTGS, Infrastructure, and Highways, to carry out Airborne Electromagnetic (AEM) surveys of the central Mackenzie Valley Highway right-of-way and Inuvik – Tuktoyaktuk corridors. This project is supported by network partner Transport Canada with a $1.6-million contribution toward the $3.2-million project. The project will test the use of airborne geophysical methods to map permafrost thickness, taliks and ground hazards along these transportation corridors. This is the first use of AEM tools to characterize permafrost in northern Canada. The research is led by Co-I Prof. Froese (University of Alberta), along with Profs. L. Heagy (UBC) and M. Unsworth (University of Alberta). This project will support three new PhD students and contribute directly to Theme 1 activities.

Theme 2 has close interactions with CCMEO where Dr. R. Fraser (Collaborator) sits on the PhD committee of HQP G. Francis. They collaborate to explore the use of machine learning to map upland terrain impacted by the rapid ice wedge ponding. Collaborator Prof. F. Calmels is also involved in this Theme, assisting HQP U. Iqbal in identification of field sites for airborne InSAR analysis. NTGS Collaborator K. Karunaratne is a member of HQP F. Ghiami-Shomami's PhD committee. Ghiami-Shomami is also part of a sub-working group on permafrost data within the Northern Data Working Group of the Canadian Centre for Climate Services, ECCC (Supporting Organization). ECCC is closely linked to Theme 3 activities due to its strong modelling program. The project of R. Lefebvre (HQP) was greatly advanced by the in-kind contributions of Dr. G. Meyer (ECCC PDF, affiliate HQP), which advanced the incorporation of high-latitude vegetation into the CLASSIC model (See Sections 1.4 and 2). Several Theme 3 HQP join in three-times weekly ECCC-led CLASSIC development meetings (R. Lefebvre, A. Mollasharifi-Targhi, C. Gauthier) where they interact with ECCC research scientists and support staff. Other Theme 3 HQP partner interactions include M. Shaposhnikova (HQP) conducting a field campaign in April 2021 that included measurements of snow and ice properties with partner Yukon University personnel (C. Koot, L.-P. Roy, and N. Vogt); HQPs H. Macdonell and G. Jonat conducted summer 2021 fieldwork around Yellowknife and Kelvin Camp (and Inuvik for Jonat) in collaboration with NTGS. One field day was spent with personnel from the N.W.T. Association of Communities, and Dr. S. Kokelj (NTGS Collaborator) is part of H. Macdonell's PhD committee while G. Jonat's includes collaborators Dr. A. Cannon (ECCC) and Prof. F. Calmels. HQPs H. Macdonell and G. Jonat are also supporting the Northern Data Working Group of the Canadian Centre for Climate Services (ECCC).

The Theme 4 PhD project of HQP E. Stewart-Jones is developing simulation-based data products using observation data from PINGO and next practices with respect to predicting permafrost thermal characteristics and change in the mountains of Western Canada. In the summer of 2021, fieldwork was carried out in Tombstone Territorial Park, the traditional territory of the Tr'ondëk Hwëch'in (TH) First Nations (Supporting Organization), where field sites were established and temperature sensors installed in collaboration with A. McCulley of the TH Government, and D. Cronmiller and J. Humphries of the YGS. Theme 4 HQP Clark has been working with the GSC (Supporting

Organization) and the Hamlet of Tuktoyaktuk on local coastal erosion identification and monitoring. HQP and Collaborator E. Hille have collected community partner feedback from the Aurora Research Institute (ARI; Collaborator) and the NTGS. Their project goal and key objectives were developed in response to the feedback received. Close linkages with ARI were maintained by hiring an ARI research technician to support the 2020 and 2021 fieldwork. With support from ARI and with their hosting, a local Inuvialuit research assistant has been hired to support the data compilation and analysis components of the project. E. Hille has also been collaborating with Dr. S. Kokelj (NTGS), who has provided scientific expertise in the study design and continues to support the data analysis, as well as in-kind support, in the form of sample analyses through Taiga Environmental Laboratory. In April 2021, E. Hille met with the Inuvik Hunters and Trappers Committee to present the project goal and objectives. The project of Theme 4 HQP D. Chiasson is co-funded by a Polar Knowledge project developed and conducted in collaboration with Vuntut Gwitchin First Nations. Local community members went with D. Chiasson into the field to collect samples and progress is reported back to the community via a Facebook page and community meetings.

Theme 5 also has strong connections to partners. HQP S. Majidi has participated in discussions with the Arctic Gateway Group, which operates the Port of Churchill and the HBR, leading to a non-disclosure research agreement between Carleton University and HBR, a necessary step for their PhD project to proceed. Arctic Gateway has also been collaborating with HQP P. Sharifi on their project devoted to digital image correlation for ground deformation at sensitive infrastructure. HQP R. Landriau's project is in partnership with the Inuvialuit Land Administration and NTGS and communication lines between the HQP's research team and both organizations have been established to communicate the research plan. HQP A. Kirkwood's project was aided by Ontario Ministry of Natural Resources and Forestry (OMNRF) contributions to peat sample collection; Arctic Gateway helped with transport for northern Manitoba sample collection. Kirkwood is also presently in communication with Weenusk community members to plan summer 2022 fieldwork. Transport Canada and the Transportation Engineering Branch of the Yukon Government sponsored the fieldwork campaign of HQPs P. Jardine and A. Schetselaar. The fieldwork of HQP Jardine was also supported by the First Nation of Na-Cho Nyak Dun (FNNND).

Connected with Theme 4 and 5 activities mentioned earlier, research collaboration with the Arctic Gateway Group has been a catalyst to pursue complementary opportunities external to NSERC PermafrostNet. A $4.4-million proposal ("Permarail: A Transdisciplinary Approach to Increasing Railway Resilience to Permafrost Terrain Changes in a Warming Climate") was funded by the National Trade Corridors Fund, sponsored by Transport Canada. Permarail brings together a transdisciplinary team of researchers and practitioners with the long-term goal of improving infrastructure performance, resilience and integrity to permafrost terrain along the HBR corridor. The research team includes Co-I's (Profs. J. Hayley (PI), P. Roy-Léveillée, R. Beddoe and S. Kenny) and Dr. A. Take (Queen's University). The Arctic Gateway Group is providing direct and in-kind support to the proposal.

Further expanding the impact and outcomes of the network, there are several research activities that seek to enhance the current partnership between Carleton University members of NSERC PermafrostNet and the FNNND and the Yukon government (e.g., YGS). A research project using remote sensing technologies to investigate the effects of permafrost degradation on the natural and built environment is being conducted by affiliated PhD student F. Brieger (Department of Geography and Environmental Studies, DGES at Carleton University) with Prof. M. Richardson (DGES) and NSERC PermafrostNet

investigators Profs. S. Kenny and C. Burn. F. Brieger is supported by the NSERC CREATE Uninhabited aircraft systems Training, Innovation and Leadership Initiative (UTILI) program valued at $1.65 million which is led by Prof. J. Laliberté in the Department of Mechanical and Aerospace Engineering at Carleton University with Profs. Richardson and S. Kenny as co-applicants. In addition, Profs. C. Burn, Richardson and S. Kenny are collaborators on a proposal submitted to Infrastructure Canada Research and Knowledge Initiative (RKI) by the FNNND. The proposal seeks to develop significant technological capacity and expertise within FNNND to quantify, monitor, and respond to permafrost thaw-related geohazards and infrastructure threats using RPAS and geophysical surveying.

Network collaboration with its Partners and Supporting Organizations extends beyond the research projects funded by the network. The network's activities have precipitated deep conversations around the state of Canada's permafrost community in organizing to develop a national vision and strategy to boost Canada's ability to adapt to permafrost thaw and to inform its climate change mitigation from a uniquely northern perspective. To achieve the network's goal of informing forward-looking decision-making in the Canadian Arctic, succession planning for NSERC PermafrostNet was initiated within the network among relevant governance bodies and key stakeholders. These discussions led to the formation of a Strategy Committee of the NSERC PermafrostNet BOD. This committee is tasked with "supporting the NSERC PermafrostNet Board of Directors in leading or catalyzing an open and inclusive strategic thinking exercise for the future of Canadian permafrost research." The initial committee includes network investigators Prof. S. Gruber and J. Hayley, along with K. Karunaratne (NTGS/CPA; Collaborator), Dr. S. Marshall (ECCC; Supporting Organization), and D. Moore (Government of Northwest Territories; Supporting Organization), as well as ex-officio BOD members Drs. J. King (BOD Chair) and T. MacLean (DO). The intentions and process have been communicated to the permafrost community and an initial survey of network participants and partners has been undertaken, in part through a strategy session at the 2021 network AGM. Conversations about this strategic thinking exercise included other research networks, for example, ArcticNet – NSERC PermafrostNet is a co-sponsor of the assessment on The Future of Arctic and Northern Research in Canada recently accepted by the Council of Canadian Academies.

8.2 Partner in-kind and cash contribution forms

Table 4: In-kind contributions from NSERC PermafrostNet partners (non-University)

BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$275,000	$96,000
2) Donation of equipment, software	$50,000	
4) Fieldwork logistics	$125,000	$43,750
5) Provision of services	$350,000	$122,500
Total of all in-kind contributions	$750,000	$262,250
BGC Engineering Inc. (BGC)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)

In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$15,000	$3,450
Total of all in-kind contributions	$15,000	$3,450
Churchill Northern Studies Centre (CNSC)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$15,000	
2) Donation of equipment, software		$70
4) Fieldwork logistics	$17,500	
In-kind contributions to indirect costs of research		
1) Use of organization's facilities		$441
Total of all in-kind contributions	$32,500	$511
Environment and Climate Change Canada (ECCC) - Atmospheric Science and Technology Directorate (ASTD)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff		$3,600
5) Provision of services	$250,000	$46,400
Total of all in-kind contributions	$250,000	$50,000
Government of Northwest Territories – Department of Infrastructure (DOI)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$234,00	$11,760
4) Fieldwork logistics	$50,000	
In-kind contributions to indirect costs of research		
2) Salaries of managerial and administrative staff	$60,000	
Total of all in-kind contributions	$344,000	$11,760
Government of Nunavut - Climate Change Secretariat (CCS)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to indirect costs of research		
3) Other: participation in network teleconferences and workshops	$50,000	$8,500
Total of all in-kind contributions	$50,000	$8,500

Inuvialuit Game Council (IGC)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to indirect costs of research		
2) Salaries of managerial and administrative staff	$50,000	$23,650
Total of all in-kind contributions	$50,000	$23,650
MDA Geospatial Services Inc. (MDA)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
3) Donation of material	$120,000	$120,000
Total of all in-kind contributions	$120,000	$120,000
Ministère des Transports du Québec (MTQ)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$23,200	$5,600
5) Provision of services	$125,000	$125,000
Total of all in-kind contributions	$148,200	$131,400
Natural Resources Canada (NRCan) - Canada Centre for Mapping and Earth Observation (CCMEO)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$25,000	$20,000
5) Provision of services	$25,000	
Total of all in-kind contributions	$50,000	$20,000
Natural Resources Canada (NRCan) - Geological Survey of Canada	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$210,000	$16,625
Total of all in-kind contributions	$210,000	$16,625
SRK Consulting	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to indirect costs of research		
1) Salaries of managerial and administrative staff	$13,750	$6,650

Total of all in-kind contributions	$25,000	$6,650
Standards Council of Canada (SCC)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$30,000	$13,500
3) Other (specify): Travel to network meetings	$10,000	
Total of all in-kind contributions	$40,000	$13,500
Transport Canada (TC)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to indirect costs of research		
2) Salaries of managerial and administrative staff		$22,776
3) Other (specify): Dissemination and meeting participation		$6,288
Total of all in-kind contributions	$30,000	$29,064
Tr'ondëk Hwëch'in Government (THG)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$0	$880
Total of all in-kind contributions	$0	$880
Yukon Geological Survey (YGS)	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		
1) Salaries for scientific and technical staff	$152,825	$389,175
4) Fieldwork logistics	$32,975	$6,889
5) Provision of services		$38,395
Total of all in-kind contributions	$185,800	$434,459

Table 5: In-kind contributions from NSERC PermafrostNet partner universities

Carleton University	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$264,230	$215,961
In-kind contributions to direct costs of research		

1) Salaries for scientific and technical staff		$34,407
2) Donation of equipment, software		
3) Donation of material		
4) Fieldwork logistics		
5) Provision of services	$140,000	$84,000
6) Other (specify): _____		
In-kind contributions to indirect costs of research		
1) Use of organization's facilities	$40,050	$24,030
2) Salaries of managerial and administrative staff	$42,000	$13,200
3) Other (specify): furniture and equipment	$165,000	$103,000
Total of all in-kind contributions	$551,280	$440,191
University of Alberta	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$20,000	$20,000
Total of all in-kind contributions	$20,000	$20,000
University of Victoria	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$10,000	$10,000
Total of all in-kind contributions	$10,000	$10,000
Laurentian University of Sudbury	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$20,000	$0
Total of all in-kind contributions	$20,000	$0
Royal Military College of Canada	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$20,000	$4,000
Total of all in-kind contributions	$20,000	$4,000
University of Montreal	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$20,000	$0
Total of all in-kind contributions	$20,000	$0
University of Laval	Total Pledged over 5 years	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research		

1) Salaries for scientific and technical staff	$52,416	$10,822
4) Fieldwork logistics	$20,000	$5,000
6) Other (specify): Scholarship support/Student stipends	$28,600	$5,486
Total of all in-kind contributions	$101,016	$21,308

8.3 International activities

International activities have been difficult due to COVID-19's impact on travel, which has been partly compensated by a switch to virtual formats and steps taken to ensure the network benefits from interaction with the international permafrost community. As an example, Prof. T. Schuur (Northern Arizona University; Permafrost Carbon Network lead investigator) is a member of the SC to ensure the network has international perspective in overseeing the research program. Additionally, network researchers collaborate with international permafrost initiatives and organizations, including Nunataryuk, the Permafrost Carbon Network (PCN) and the International Permafrost Association (IPA). Dr. T. Herring (HQP) and Prof. A. Lewkowicz are members of an IPA Action Group on ERT processing and database with Herring leading one of the working parties (see Section 1.4).

International meetings and workshops were some of the most severely affected activities during the first half of the network due primarily to COVID travel restrictions, which led to the cancellation of the planned summer school with Nunataryuk in Abisko, Sweden (over two successive years) and the International Conference on Permafrost in Lanzhou, China in 2020. However, the 2020 network virtual AGM hosted a session titled *Making new connections: International Partners* featuring presentations and networking with the International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT; Dr. M. Johansson), IPA (Dr. G. Vieira), Nunataryuk (Dr. H. Lantuit), the PCN (Dr. C. Schaedel), the Permafrost Climate Change Initiative (CCI+) (Dr. A. Bartsch), GlobPermafrost of the European Space Agency (ESA; Dr. S. Westermann), the Swiss Permafrost Monitoring Network (PERMOS; Dr. J. Nötzli) and the Terrestrial Multidisciplinary distributed Observatories for the Study of Arctic Connections (T-MOSAiC; Dr. J. Boike).

The NDS also attended and presented at the International Arctic Science Committee (IASC) Arctic Science Summit week conference to represent the network and its role as a CCADI partner (Session 68: *Progress Towards Realizing Data Sharing for the Arctic Region and Beyond* where he was a co-presenter on *Building Globally Interoperable Data Infrastructure: contributions from the Arctic Data community* and lead author on *Towards a collective vision for interoperable Canadian permafrost data management*). Further outreach focused on data saw two sessions at the 2020 NSERC PermafrostNet Permafrost Data Workshop *(Lessons from the international community parts I and II*) dedicated to invited speakers from the international permafrost community to share a global perspective on permafrost data management. Experts from Switzerland/PERMOS (Dr. J. Noetzli), USA/IPA (Prof. D. Streletskiy) and China (Dr. X. Pan) presented on behalf of their organizations and participated in the broader workshop. These invited speakers also had prominent roles in other sessions.

Several projects involve targeted international collaboration to strategically access key skills. For example, Dr. D. Stillman from the Southwest Research Institute (SWRI) in Boulder, Colorado, U.S.A. is co-supervisor of Theme 2 HQP H. Fereydooni and will host them at SWRI in late 2022 on making existing measurement techniques more fully available to permafrost research. The research group of the PI worked with Drs. N. Tubini and R. Rigon to develop an accurate and efficient model of excess ice loss during permafrost thaw that will be used by HQPs G. Jonat (Theme 3) and F. Ghiami-Shomami (Theme 2).

9.0 Dissemination of network results and knowledge & technology transfer

The network has adopted the approach to knowledge and technology transfer outlined in its proposal and is closely integrated with the governance and management of the research program to ensure members and users are involved in a bi-directional and cyclical process of information transfer. By closely aligning training, research and knowledge mobilization, as well as the organization of projects around themes, it ensures the outputs of the research reach stakeholders and serve the needs of the trainees. This is achieved by formal reporting to governance bodies, consultation with network members, and their involvement in decision-making and network initiatives. There has been considerable work undertaken to prepare communications infrastructure in the first half of the network. It was expected that the most substantive dissemination and knowledge mobilization activities would be concentrated in the final year of the network.

9.1 Host institution support

Carleton University has provided considerable support in terms of expertise and finances to ensure a well-planned communication and knowledge mobilization approach. The KMCC has been chaired by communication professionals from Carleton University (J. Carl and K. Elliott). Together with the KMCCoor and the rest of the KMCC, they created a logic model, strategic five-year plan and an annual plan for knowledge mobilization and communication. These documents provided a broad, yet detailed analysis of stakeholder needs and effective communication approaches to plan the dissemination of research findings. In addition, Carleton University promoted the launch of the network by announcing the funding, posting a research news item, a newsroom feature and producing other printed and digital materials that were used to raise awareness of the work of the network. Carleton University also facilitated a *Re$earch Infosource* announcement and article in 2019. In winter 2020, the NDS explained the role of data science in addressing permafrost thaw in a feature in Carleton University's *Raven* magazine titled, "Unfrozen, how digging and data can help mitigate permafrost thaw". The network was then highlighted once again in the Fall 2021 issue of the *Carleton University Research Review*.

Carleton University provided the network with offices and shared areas in the Advanced Research and Innovation in Smart Environments (ARISE) building - a space for working jointly with partners, hosting meetings, holding videoconferences and a gallery for exhibiting ongoing work. Preparations were completed to move into the space in January 2020; however, the team pivoted to working from home during the pandemic. The space is designed for interactions with research partners, collaborators, Co-Investigators and HQP and it is anticipated that, should restrictions be lifted, it will be occupied in the second half of the network.

9.2 Digital communications and materials

To ensure professional and consistent branding of network activities, a set of bilingual logos and color schemes were developed in consultation with the KMCC, governance bodies and stakeholders. To support the logo and members' use of templates (posters, PowerPoints etc) branding guidelines were developed alongside boilerplate and tagline text to ensure consistent messaging of the network's mission and recognition of funders. Supporting materials continue to be developed such as Zoom backgrounds and templates for knowledge dissemination on different platforms. These materials have been supported with other guides on document management, using collaborative digital tools, a variety of administrative and communication databases and a social media strategy.

To ensure scholars, stakeholders and members of civil society discover the network within Canada and abroad, the network website was established in 2019 - www.permafrostnet.ca. Careful consideration was taken in hosting of the website to ensure it was based in Canada and powered entirely by renewable energy to be in line with the principles and mission of the network. The site has undergone continual expansion and improvement to serve the needs of network members and stakeholders and provide transparent communication. The site features details of the network, aims, research projects, members, news, events, training, publications, graduate positions, resources and access to private areas for network members and governance bodies. The website contains bilingual content and includes an overview video, animations, social media streams, galleries, calendars, embedded maps, outreach meeting scheduling for stakeholders, newsletter subscriptions, survey forms, password protected areas, etc. In addition to the website, a variety of communication channels have been established, including Teams, a Newsletter (at the end of 2021, the bilingual newsletter has published six issues and has 270 subscribers), and various social media (Twitter, Facebook, LinkedIn, Flickr, YouTube, Instagram). To facilitate the uptake and use of social media channels, the KMCCoor provided the core team (SD, DO S. McKey, NDS) with social media training in November 2019. The network's Teams site, with 208 members and guests, is hosted by Carleton University and has 21 channels (10 private) supporting administration, training, collaboration between investigators, themes, governance bodies. This platform enables network members to promote events, distribute notices, hold meetings and organize. The LinkedIn page is currently the most wide-reaching platform for disseminating information with 1,023 followers. Comprehensive guides to production and maintenance of the website, newsletter and social media hosting have been created to enable new staff or network members to contribute or take on responsibility for these tasks if required.

9.3 Knowledge mobilization events and presentations

Alongside digital communication and engagement, the network has focused dissemination and bi-directional knowledge transfer efforts to events, both network hosted and external. Prior to pandemic restrictions, the network was able to host stands at the Northern Lights conference (February 2020, Ottawa, Ontario), Third Canadian Polar Data Workshop (February 2020 Banff, Alberta) and the Land Claims Agreement Coalition conference (LCAC) in partnership with CPA (February 2020, Gatineau, Quebec), to raise awareness of the work of the network, share knowledge, develop a better understanding of the needs of stakeholders and develop new partnerships. As the network faced limitations on in-person events after February 2020, we undertook

more online engagement such as a virtual booth at Arctic Change 2020 (December 2020).

Dissemination of results at this stage of the network has been largely achieved through presentations internally to other network members, partners and stakeholders. Research findings have been presented at the CPA AGMs (held in partnership with the NSERC PermafrostNet AGMs), the 2021 Northern Transportation Adaptation Initiative (NTAI) meeting, the joint 2021 RCOP and 19th International Conference on Cold Regions Engineering (ICCRE). Theme 5 HQP P. Jardine presented their work on the "Effects of Snowpack Compaction on the Ground Thermal Regime of Northern Road Embankments" at the NTAI meeting. Many of the network members presented their findings at the joint RCOP and ICCRE meeting in October 2021 (see Table 6.).

The NDS N. Brown organized a data workshop session at the 2021 RCOP which had transitioned to an online format. The session was co-led by Dr. M. Jones (University of California Santa Barbara & Arctic Data Centre) and Dr. P. Pulsifer (Carleton University & CCADI). Workshop attendees included participants from Canada, the U.S.A. and Switzerland. A summary report of the session is available. The workshop identified barriers and actionable solutions to the continued development of permafrost data systems (databases, web portals, APIs) with a focus on interoperability through informal, structured discussion.

9.4 Knowledge mobilization training

An additional network-level activity was the creation of the Science Communication Toolbox for Researchers which provided network researchers and trainees with evidence-based science communication training (discussed in Section 7.2) The NSERC Science Communication Skills grant provided $20,000 to support program design and delivery, including project management, evaluation and production of bilingual legacy resources. Furthermore, the project developed a science communication training program that can be replicated for other researchers, networks and post-secondary institutions.

9.5 Partner contributions to knowledge mobilization

The network has worked with partners to promote permafrost research through means such as Transport Canada's Northern Transportation Adaptation Initiative (NTAI). The network has also been sharing updates on the progress of the research projects with international audiences through the annual International Permafrost Association (IPA) newsletter Frozen Ground. The Tr'ondëk Hwëch'in Government has been providing guidance on community engagement and collection of Traditional Knowledge to HQP for their projects, while the Inuvialuit Game Council (IGC) have been providing support in developing appropriate communications and approaches for the region through participation in the EDIC (M. Kudlak). SRK Consulting has been providing advice on communications and dissemination products for industry and their clients' needs through participation in the KMCC (E. Marquez). The most extensive knowledge translation and mobilisation partnership activities have been with the CPA, co-hosting annual meetings, sharing a booth at the LCAC and cross-posting social media and other communications items. As the network progresses, it will be able to draw upon project outputs and relationships with other partners such as regional governments, FCM, CIRNAC, CCCS, CCMEO, NRC, SCC and BGK to translate and mobilize knowledge. As pandemic restrictions ease, the network has begun to plan for in-person events; however, the

situation continues to be unpredictable. For instance, Co-Investigator R. Beddoe was invited to make an in-person keynote presentation about the network at the University of Guelph Annual Environmental Sciences Symposium in March 2022 on the theme "Breaking the Ice." However, a couple of weeks prior to the event the organizers reverted back to a virtual delivery. Despite these ongoing challenges, we hope there will be a return to in-person events this year.

9.6 Publications

Table 6: NSERC PermafrostNet contributions

Accepted/ Published	Contribution
Refereed Journal Articles	1. Ground subsidence and heave over permafrost: hourly time series reveal interannual, seasonal and shorter-term movement caused by freezing, thawing and water movement. The Cryosphere, Gruber, S., 30-Apr-20. 2. The ERA5-Land soil temperature bias in permafrost regions. The Cryosphere, Cao, B., Gruber, S., Zheng, D., and Li, X., 12-Aug-20. 3. On success in applied environmental research - what is it, how can it be achieved, and how does one know when it has been achieved? Environmental Reviews, Cooke, S., et al, 26-Aug-20. 4. A method for solving heat transfer with phase change in ice or soil that allows for large time steps while guaranteeing energy conservation. The Cryosphere, Tubini, N., Gruber, S., and Rigon, R. 04-Jun-21. 5. Meyer, G., Humphreys, E. R., Melton, J. R., Cannon, A. J., and Lafleur, P. M.: Simulating shrubs and their energy and carbon dioxide fluxes in Canada's Low Arctic with the Canadian Land Surface Scheme Including biogeochemical Cycles (CLASSIC), Biogeosciences, 18, 3263–3283, 2021. 6. Clark, Andrew, Moorman, Brian, Whalen, Dustin and Fraser, Paul. "Arctic coastal erosion: UAV-SfM data collection strategies for planimetric and volumetric measurements." Arctic Science 7. (2021): 605-633. 7. Hille, Erika. "Using River Geochemistry to Monitor the Hydrology of Arctic Watersheds." *Nature Reviews Earth & Environment*, vol. 3, no. 1, 2022, p. 5. *Crossref*, https://doi.org/10.1038/s43017-021-00257-6.
Non-refereed journal articles	8. Permafrost thaw and northern development. Nature Climate Change, O'Neill, H.B., Burn, C.R., Allard, M. Arenson, L.U., Bunn, M.I., Connon, R.F., Kokelj, S.A., Kokelj, S.V., Leblanc, A-M., Morse, P.D., and Smith, S.L. 29-Jul-20.
Conference presentation (invited)	9. Performance of climate projections used for engineering design in Yukon and adjacent Northwest Territories, 1991-2020, Invited Speaker, Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering And The Regional Conference On Permafrost, 24-29 October 2021, Boulder, CO. Astrid Schetselaar.

Conference presentation (submitted)	10. Recent acceleration of thaw-driven mass-wasting in the central Mackenzie Mountain foothills is intensified by decadal-scale forest fire conditioning. Arcticnet Annual Scientific Meeting, Halifax 2019, Young, J.M., Alvarez, A., Van Der Sluijs, J., Macphee, A., Stocker, B.J., Kokelj, S., Margold, M. And Froese, D. 11. Semantic segmentation of land use / land cover (LU/LC) types using F-CNNS on multi-sensor (radar-ir-optical) image data. 41st Annual IEEE Geoscience and Remote Sensing Society Symposium, Ahmed, U., Velasco, A. and Rabus, B. 15-Jul-21. 12. Off-Nadir Photogrammetry for Airborne SAR Motion Compensation: A First Step. 41st Annual IEEE Geoscience and Remote Sensing Society Symposium, Ahmed, U., Rabus, B. and Kubanski, M., 14-Jul-21. 13. Long-Term (2000-2017) Response of Lake-Bottom Temperatures and Talik Configuration to Changes In Climate at Two Adjacent Tundra Lakes, Western Arctic Coast, Canada. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Anderson, T.S., Jardine, P.A., Burn, C.R., 10-Mar-21. 14. Effects of Snowpack Compaction on the Ground Thermal Regime of Northern Road Embankments. Northern Transportation Adaptation Initiative (NTAI) Annual Network Meeting 2021, February 23rd - 26th, 2021, Jardine , P. 15. Mercury, Methylmercury, And Microbial Communities in a Degrading Palsa of The Hudson Bay Lowlands, Far North Ontario. 2021 Regional Conference on Permafrost and 19th International Conference on Cold Regions Engineering, Boulder, CO, 11-16 July, 2021, Kirkwood A, Roy-Leveille P, Branfireun B, Pakalen M, Mclaughlin J, Basiliko N. 11-16 July, 2021. 16. Pulsifer, P., Hayes, A., Alix, G., Anker, H., Arthurs, D., Brown, N., Christoffersen, S., Chu, B., Godin, E., Herbert, C., Igbeinkutu, E., Ingram, R., Kreps, P., Ratsimbazafy, T., Sankar, R.D., Sellars, S., Vey, G and Wilkes, G. (2021). Building Globally Interoperable Data Infrastructure: contributions from the Arctic Data community. Presented at Arctic Science Summit Week 2021 (March 19-26, 2021). 17. Towards a collective vision for interoperable Canadian permafrost data management. Brown, N. Gruber, S., Rudy A., O'Neil B., Smith, S. and Lipovsky P. (2021). 19-26 March 2021. Arctic Science Summit Week. 18. Lewkowicz, Antoni. *Towards a revised version of the Glossary of Permafrost and Related Ground Ice Terms*. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. 19. Permafrost warming and thaw in the discontinuous zone tracked using electrical resistivity tomography, Alaska Highway corridor, Canada. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions

	Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Lewkowicz, A. 20. Standardized processing of geoelectrical data for permafrost applications: Initial findings from a new IPA action group. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Herring, T. 21. Developing a user-friendly forward modelling and inversion tool to inform electrical resistivity tomography studies of permafrost. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Herring, T. 22. Initial investigations of degrading peat plateaus in the central Mackenzie Valley, Northwest Territories Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Chiasson, A. 23. Slope failure at the base of permafrost increasing frequency and magnitude of thaw-driven mass-wasting across discontinuous permafrost terrain in the central Mackenzie Valley foothills, N.W.T. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Young, J. 24. Permafrost core characterization using gamma ray attenuation and industrial computed tomography scanning. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Froese, D. 25. Mercury, methylmercury, and microbial communities in a degrading palsa of the Hudson Bay Lowlands, Far North Ontario. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Kirkwood, A. 26. Monitoring ground temperatures on portage sites along the Tibbitt-Contwoyto winter road to assess road resiliency. Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO. Beddoe, R.
Technical Reports	27. Permafrost Data Workshop Final Report. Brown, N., Gruber, S., Pulsifer, P., Stewart-Jones, E., 27-29 May 2020. 28. Brown, N., Macdonell, H., Stewart-Jones, E., Gruber, S. (2021) Permafrost Data Systems: RCOP 2021 Data Workshop Report. NSERC PermafrostNet: Ottawa, Canada. DOI: 10.22215/pn/10121001.
Other	29. Maria Shaposhnikova (2021). Temporal Deep Learning Approach to Bedfast and Floating Thermokarst Lake Ice

	Mapping using SAR imagery: Old Crow Flats, Yukon, Canada. UWSpace. http://hdl.handle.net/10012/17414
Submitted / in review	
	30. Vertical distribution of excess ice in icy sediments and its statistical estimation from geotechnical data (Tuktoyaktuk Coastlands and Anderson Plain, Northwest Territories). Arctic Science. Castagner, A., Brenning, A., Gruber, S., Kokelj, S.V. 31. A Repository of 100+ years of measured soil freezing characteristic curves. Earth System Science Data Discussions, Devoie, É.D., McKenzie, J.M., Gruber, S. 32. Herring, T. and Lewkowicz, A.G. A systematic evaluation of electrical resistivity tomography for permafrost interface detection using forward modelling. Permafrost and Periglacial Processes.

10.0 Financial information

As detailed in Tables 7 and 8, NSERC PermafrostNet expenditures have followed the planned budget as closely as possible, taking into consideration pandemic-related impacts on fieldwork and delays in recruitment (see Sections 3 and 6.2), Co-Investigator changes and cancelled projects (discussed in Section 1.3), and a reassessment of how university contributions were included in the budgeting (see Section 6.3). Each expenditure has been carefully allocated to support network goals and objectives, with oversight and approval by the SC, BEC, BOD and Carleton University's Research Financial Services.

The network has received a total of $3,006,429 in cash contributions. This consists of $2,591,488 from the NSERC Permafrost Partnership Network for Canada grant, $200,961 from Carleton University, $20,000, $10,000 and $4,000 from the University of Alberta, the University of Victoria and the RMC, respectively for Indigenous engagement, $159,980 from the NSERC COVID-19 supplement and $20,000 from the NSERC Science Communication skills grant. Partners have also attested to non-cash in-kind contributions totalling $1,781,578, further detailed in Section 8.2 Tables 4 and 5. The network expenditure over the reporting period totals $1,131,09, detailed in Tables 7 and 8.

As of 31, December 2021 a total of $1,309,230 of funds has been transferred to the Co-Investigators for student stipends, salaries, domestic conference travel, equipment, user fees, flex fund expenditures and COVID-19 supplementary funds. In year 1 funding was transferred to investigators in anticipation of recruitment of HQP. Following this initial disbursement, subsequent funding was issued upon confirmation of recruitment, 50% spending of previous transfers and, where required, submission of biannual reporting. Over half of the transferred funds ($701,199) have been used as of the 31st of December 2021. Over half (57%) of the total network expenses have so far been on salaries and benefits to trainees. Though the proportion is currently lower than planned for the entire duration of the network (69.36% in the proposal) we expect this to notably rise as more projects get underway and stipends and salaries are paid out to trainees that have been recruited. The network has a commitment to supporting as many students and post-doctoral fellows as possible and ensuring they receive funding for the duration of their projects. Therefore, the BOD has carefully considered the financial commitments to the

planned and underway projects, and at least $2,382,190 will be required to ensure the project stipends, conference travel, user fees, fieldwork and collaborations are funded for each project.

As can be expected, the formal budgets approved by the BOD differ from the proposal as the network has adapted to the operating environment, as outlined above, and as research and priority deviations have been requested by investigators and approved by the SC and BOD. At the November 6, 2019 BOD meeting, the network year-end was officially moved from June 30 to March 31, to permit time to compile reports and follow the proper governance channels for review of the reports (item 9.b.i). The financial reporting below reflects this network year schedule; Year 1 (30 June 2019 - 31 March 2020), Year 2 (1 April 2020 - 31 March 2021) and a partial Year 3 which is 'actual expenditures to date' and covers the reporting period up to 31 December 2021.

The financial benefit of adopting a network-based approach to research has been demonstrated through the co-investigator reporting of substantial additional contributions to network research projects. At the end of December 2021, a total of $665,502 in additional support has been provided, ranging from $100 emergency bursaries to a $105,000 Alexander Graham Bell Canada Graduate Scholarship.

As has been detailed in this report, there has been a significant impact on activities due to the COVID-19 pandemic. In December 2020, the network received a supplement from NSERC ($159,980) that provided partial support for trainees and research support personnel to offset salary costs due to the negative impact of COVID-19 on research project progress. This support was applied toward HQP, and administrative salaries paid from April 1, 2020 to March 31, 2021. To receive the additional funding, Co-Investigators were required to provide accounting for the student salaries paid over this period and submit a report verifying their student(s) were impacted by the pandemic and will require additional time to complete their projects and therefore additional funding.

The network also received $20,000 from the NSERC Science Communication skills grant to deliver the Science Communication Toolbox for Researchers (Section 7.2). $6,000 of this grant supported the KMCCoor to administer the grant, develop and deliver the course, provide technical support during workshops and develop accompanying resources.

10.1 Research

NSERC PermafrostNet's research costs are detailed in Table 7. This includes stipends, user fees, conference, fieldwork, collaboration, and publication costs. The budget and expenses for Year 1 (30 June 2019 - 31 March 2020) represent nine months. The budgetary figures for year 1 and 2 are listed as approved by the Board of Directors.

Table 7: NSERC PermafrostNet research budget

Budget Item	Budget Year 1 $	Actual expenditures Year 1 $	Balance Remaining Year 1 $	Budget Year 2 $	Actual expenditures Year 2 $	Balance Remaining Year 2 $	Actual expenditures to date $	Planned expenditures for the next 30 months $
a) Students	257,600	35,075	222,525	575,525	138,410	437,115	360,671	1,409,575

b) Postdoctoral Fellows	99,180	1,272	97,908	132,240	111,081	21,159	281,005	396,720
c) Technical/ Professional Assistants	0	0	0	0	0	0	0	291,692
d) Other (specify)	0	0	0	0	0	0	0	0
a) Purchase or Rental of equipment	35,000	0	35,000	29,000	5,632	23,368	7,060	81,290
b) Operation and Maintenance Costs	0	0	0	0	0	0	0	0
c) User fees	25,000	0	25,000	10,000	0	0	0	120,625
a) Materials and Supplies	8,800	0	8,800	6,800	0	6,800	0	52,750
a) Conferences	42,000	3,243	38,757	84,000	6,250	77,750	9,493	449,307
b) Fieldwork	40,000	0	40,000	40,000	1,064	38,936	23,534	330,266
c) Collaboration / Consultation and summer school	25,000	11,548	13,452	28,000	6,528	21,472	25,636	132,581
a) Publication Costs	0	0	0	0	0	0	0	138,000
b) Other								
Field safety training	9,500	1,373	8,127	10,000	0	10,000	1,373	15,577
Permafrost workshop travel	0	5,736	-5,736	0	0	0	0	0
Reallocation to flex fund	0	0	0	120,750	19,150*	101,600	31,340*	0
Third Canadian Polar Data workshop	0	0	0	0	15,000	-15,000	0	0

* Flex funding disbursed

10.2 Administration

NSERC PermafrostNet's administrative costs are detailed in Table 8. This includes salaries for the DO, NDS, KMCCoor and AA. It also includes expenses for annual meetings and associated costs for meetings of the BOD and SC. Additional expenses for communication, dissemination and knowledge mobilization are included as well.

Table 8: NSERC PermafrostNet administrative budget

Budget Item	Budget Year 1 $	Actual expenditures Year 1 $	Balance Remaining Year 1 $	Budget Year 2 $	Actual expenditures Year 2 $	Balance Remaining Year 2 $	Actual expenditures to date $	Planned expenditures for the next 30 months $
Salaries and Benefits˜	143,000	139,706	3,294	143,000	46,814	96,186	293,584	330,267
Equipment or Facility	4,100	5,562	-1,462	0	544	-544	6,372	0
Materials and Supplies	6,200	1,790	4,410	6,200	10,674	-4,474	17,491	17,009
Travel	0	0	0	0	0	0	0	0
Dissemination Costs (Communication, translation, and knowledge mobilization)	25,000	5,122	19,878	25,000	4,634	20,366	13,962	94,038
Other								
AGM	44,677	10,503	34,174	35,000	7,329	27,671	30,357	166,595
Board meeting	10,172	3,366	6,806	8,190	0	8,190	5,107	49,763
Indigenous engagement	19,500	3,225	16,275	0	0	0	3,225	80,781^
Other meetings	0	616	-616	0	7,669	-7,669	8,285	0
International activities	0	0	0	0	0	0	0	39,200
Northern workshops	0	0	0	0	0	0	0	60,000
Capstone activity	0	0	0	0	0	0	0	109,700

˜The salary budgets for the DO, NDS and KMCCoor were presented to the BOD as "Admin Centre salaries". The planned expenditure for the NDS and DO are presented here in tables 7c and 8 respectively.
^ Lower planned expenditure than originally proposed due to decreased contributions from partners.

10.3 Budget Justification

There are areas where the proposal budget and research plan require deviations in response to external events, new research, or the recruitment and retention of HQP. The network has employed a thorough procedure for oversight of project deviations and associated budgetary variances. After discussing with the Theme Lead, Co-Investigators submit a "Deviations from proposal projects" form (appendix K). The DO processes the forms and forwards them to the SD. If deviations are without budgetary consequence and do not impact project milestones, the SD can approve the deviations. All deviations with potential impacts on budget or project milestones are discussed by the SC, with recommendations forwarded to the BOD for any subsequent approval.

Student stipends and post-doctoral salaries: As has been outlined in this report, a variety of factors have impacted recruitment of HQP, and hence expenditure of stipend funds.

At the mid-point of the five-year network, of the $701,199 spent by Co-Investigators $641,676 of the funds have been used for student stipends and post-doctoral salaries. The network originally proposed to have a total of 40 HQP projects underway or completed at the 30-month stage and on the 31st of December 2021 there were 29 projects underway or completed. The lower-than-expected expenditure on student stipends is due to the delays in recruitment (see Section 3), with those projects that have had delayed recruitment delayed by an average of 12.8 months. This delay is only an estimation, as there have been a variety of changes to the overall network timeline as projects have been cancelled, changed and amalgamated into new projects, are still recruiting, or in some instances were able to start earlier than expected e.g. T4-PhD5.

Other salaries: The original proposal allocated $108,000 per annum for the NDS and $104,400 per annum for the DO, including benefits, with a part-time KMCCoor ($13,846 per annum in Years 1-4, $60,000 full time in Year 5). The NDS and DO were hired at a reduced rate (NDS $76,220 per annum plus benefits and DO $82,400 per annum plus benefits). Given the centrality of communications and knowledge mobilization in a network, and the importance of having professional and efficient communications established swiftly, hiring a KMCCoor with expanded responsibilities and a stronger leadership role (with more hours- 80% FTE) in the first year was seen as beneficial. In May 2020, the BOD approved the extension of the KMCCoor position at 80% FTE until the end of March 2021. The Administrative Centre salary expenses were further adjusted over the reporting period due to a variety of factors, including a leave of absence for the KMCCoor during the initial pandemic lockdown in 2020 to provide childcare under the Declared Emergency Leave provisions (working 23 hours per month for three months), parental leave for the NDS (working 20% FTE in January and February 2021, 80% FTE March - August 2021 and on leave 10 August - 10 December 2021), use of parts of the NSERC COVID-19 supplement and the NSERC Science Communication skills grant for administrative salaries.

Travel: There was an in-person AGM held in Ottawa in November 2019 (Cost $19,365 versus a budget of $44,677) and a Theme 1 meeting to discuss the evaluation of ground ice maps and database development, also in Ottawa as planned (Jan/Feb 2020). The original proposal planned a launch AGM in Quebec City in 2019, then AGMs in Yellowknife (2020) and Victoria (2021). However, as discussed in Sections 3 and 6.2,

the delayed recruitment of HQP and COVID-19 pandemic severely curtailed the travel, fieldwork, in-person collaborative meetings and conference attendance of all the network members after March 2020. Many of the Canadian territories prohibited travel into their regions during the 2020 field season and international travel was similarly off limits. Annual meetings and collaborative meetings were moved online, reducing expenses. Both the 2020 (cost $7,329 versus a budget of $15,000) and 2021 AGMs (cost $12,525 versus a budget of $15,000) were held virtually and resulted in lower costs due to the lack of travel. Funds for fieldwork, collaboration and travel have been provided to investigators where there is need, or expected future need, to enable a swift resumption of activities as pandemic restrictions lift. It is expected that the funds allocated to domestic conference travel ($3,000 per annum per HQP) and collaborations will be required in the following years of the network as the network plans for a return to an in-person annual meeting and specialized fieldwork training activities as early as 2022.

User fees: User fees include analytical costs, core scanning, geochemistry and characterization, shipping of frozen samples from the field, specialized analyses, maintenance costs and consumables (detailed in Table 1.6 of the proposal budget justification). In November 2019, the Board approved the Scientific Committee recommendation for user fees to be paid out on a usage basis, evaluated by the Scientific Director and Scientific Committee. To ensure a prudent distribution of funds, investigators were requested to confirm their need for the funding allocated in the proposal prior to disbursement. Due to the delayed fieldwork, user fees were not required or requested by investigators until mid-2021.

Equipment: A significant proportion of the equipment fees were allocated to computers for the HQP and data scientist ($54,250 of $92,850). These funds were transferred to investigators, along with stipends once investigators had recruited HQP. Therefore, the delayed recruitment of students has reduced the expenditure so far.

Materials and supplies: Similarly, to the equipment expenditure, the material and supply requirements of the themes have been greatly reduced by delayed recruitment of HQP for the projects and the lack of laboratory and fieldwork due to work from home policies and travel restrictions.

Contributions by partners: A more equitable accounting of stipend contributions from universities to network projects caused an increased proportion of network spending on HQP stipends, leading to a potential budget shortfall of $584,000 (see Section 6.3). Additionally, the cash contribution committed by Canada Nunavut Geoscience Office (CNGO) of $250,000 can no longer be fulfilled due to a cut in their funding of approximately 80%.

Reassignment to Flex Funding: In response to changing project needs resulting from the pandemic, in May 2020 the BOD approved a SC proposal for reassignment of funds to a flexible fund ("Flex Fund") that could be used towards expenses not explicitly outlined in the proposal. The SC recommended making available $45,000 as a partial reallocation from the Year 1 underspend, and $75,000 from HQP stipends to other uses in support of HQP projects and the overall objectives of the network. This reallocation was based on the assumption that some projects postponed due to slow recruitment will not materialize. Therefore, the funds were reallocated to a short-term flex fund overseen by a committee following a clearly defined process (see Appendix M). NSERC agreed with the BOD's approval of creating the Flex Fund from the existing budget to support additional HQP and research activities related to PermafrostNet's objectives and

deliverables. The fund was set up to run until the end of March 2021, which was then extended to the end of March 2022 by the BOD in May 2021. It was overseen by a four-person subcommittee of the SC (A. Lewkowicz, J. Hayley, C. Dow, S. Gruber). The flex funding distributed was $19,150 (Year 2) and $12,190 (Year 3) as of 31 December 2021.

References

Ahmed, U., Velasco, A. and Rabus. B. "Semantic segmentation of land use / land cover (LU/LC) types using F-CNNS on multi-sensor (radar-ir-optical) image data." *41st Annual IEEE Geoscience And Remote Sensing Society Symposium*, 15 Jul. Virtual event, 2021.

Ahmed, Usman Iqbal, Bernhard Rabus, and Mike Kubanski. "Off-Nadir Photogrammetry for Airborne SAR Motion Compensation: A First Step." *41st Annual IEEE Geoscience And Remote Sensing Society Symposium*, 14 Jul. Virtual event, 2021. https://doi.org/10.1109/IGARSS47720.2021.9553861

Andersen, Trevor S., et al. "Long-Term (2000–2017) Response of Lake-Bottom Temperatures and Talik Configuration to Changes in Climate at Two Adjacent Tundra Lakes, Western Arctic Coast, Canada." Permafrost 2021, 2021. Crossref, https://doi.org/10.1061/9780784483589.001.

Beddoe, R. "Monitoring ground temperatures on portage sites along the Tibbitt-Contwoyto winter road to assess road resiliency." *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO.

Brown, Nicholas, et al. "Permafrost Data Workshop 2020: Final Report." *NSERC PermafrostNet*, 2020. *Crossref*, https://doi.org/10.22215/pn/10120001.

Brown, N. Gruber, S., Rudy A., O'Neil B., Smith, S. and Lipovsky P. "Towards a collective vision for interoperable Canadian permafrost data management." *Arctic Science Summit Week*. 19-26 March, 2021. Online event. Brown et al 2021a

Brown, N., Macdonell, H., Stewart-Jones, E., Gruber, S. "Permafrost Data Systems: RCOP 2021 Data Workshop Report." *NSERC PermafrostNet*, 2021, Ottawa, Canada. DOI: 10.22215/pn/10121001. Brown et al 2021b

Cao, Bin, et al. "The ERA5-Land Soil Temperature Bias in Permafrost Regions." *The Cryosphere*, vol. 14, no. 8, 2020, pp. 2581–95. *Crossref*, https://doi.org/10.5194/tc-14-2581-2020.

Castagner, Ariane, et al. "Vertical Distribution of Excess Ice in Icy Sediments and Its Statistical Estimation from Geotechnical Data (Tuktoyaktuk Coastlands, Northwest Territories)." *Arctic Science*, 2021. *Crossref*, https://doi.org/10.5194/egusphere-egu21-14048.

Cooke, Steven J., et al. "On 'Success' in Applied Environmental Research — What Is It, How Can It Be Achieved, and How Does One Know When It Has Been Achieved?" *Environmental Reviews*, vol. 28, no. 4, 2020, pp. 357–72. *Crossref*, https://doi.org/10.1139/er-2020-0045.

Chiasson, A. "Initial investigations of degrading peat plateaus in the central Mackenzie Valley, Northwest Territories" *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO.

Clark, Andrew, et al. "Arctic Coastal Erosion: UAV-SfM Data Collection Strategies for Planimetric and Volumetric Measurements." *Arctic Science*, vol. 7, no. 3, 2021, pp. 605–33. *Crossref*, https://doi.org/10.1139/as-2020-0021.

Clark, A; Moorman, B; Whelan, D. "UAV-SfM and geographic object-based image analysis for multi-temporal volumetric erosion of Arctic coasts." *Geomorphology*, forthcoming. Clark, Moorman and Whelan in press a.

Clark, A; Moorman, B; Whelan, D., "Multiscale object-based classification and feature extraction along Arctic coasts." *Remote Sensing*, forthcoming. Clark, Moorman and Whelan in press b

Devoie, Élise G., et al. "A Repository of 100+ Years of Measured Soil Freezing Characteristic Curves." *Earth System Science Data Discussions*, 2022. *Crossref*, https://doi.org/10.5194/essd-2022-61.

Froese, D. "Permafrost core characterization using gamma ray attenuation and industrial computed tomography scanning." *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO.

Gruber, Stephan. "Ground Subsidence and Heave over Permafrost: Hourly Time Series Reveal Interannual, Seasonal and Shorter-Term Movement Caused by Freezing, Thawing and Water Movement." *The Cryosphere*, vol. 14, no. 4, 2020, pp. 1437–47. *Crossref*, https://doi.org/10.5194/tc-14-1437-2020.

Herring, T. and Lewkowicz, A.G. "A systematic evaluation of electrical resistivity tomography for permafrost interface detection using forward modelling." *Permafrost and Periglacial Processes*, forthcoming.

Herring, T. "Developing a user-friendly forward modelling and inversion tool to inform electrical resistivity tomography studies of permafrost." *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO. Herring 2021a

Herring, T. "Standardized processing of geoelectrical data for permafrost applications: Initial findings from a new IPA action group." *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO. Herring 2021b

Hille, Erika. "Using River Geochemistry to Monitor the Hydrology of Arctic Watersheds." *Nature Reviews Earth & Environment*, vol. 3, no. 1, 2022, p. 5. *Crossref*, https://doi.org/10.1038/s43017-021-00257-6.

Kirkwood A, Roy-Leveille P, Branfireun B, Pakalen M, Mclaughlin J, Basiliko N. "Mercury, Methylmercury, And Microbial Communities in A Degrading Palsa of the Hudson Bay Lowlands, Far North Ontario." *2021 Regional Conference On Permafrost And 19th International Conference On Cold Regions Engineering*, Boulder, CO, 11-16 July, 2021.

Kirkwood, A. "Mercury, methylmercury, and microbial communities in a degrading palsa of the Hudson Bay Lowlands, Far North Ontario." *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO.

Lewkowicz, A. "*Towards a revised version of the Glossary of Permafrost and Related Ground-Ice Terms." Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO. Lewkowicz 2021a

Lewkowicz, A. "Permafrost warming and thaw in the discontinuous zone tracked using electrical resistivity tomography, Alaska Highway corridor, Canada." *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO. Lewkowicz 2021b

Meyer, Gesa, et al. "Simulating Shrubs and Their Energy and Carbon Dioxide Fluxes in Canada's Low Arctic with the Canadian Land Surface Scheme Including Biogeochemical Cycles (CLASSIC)." *Biogeosciences*, vol. 18, no. 11, 2021, pp. 3263–83. *Crossref*, https://doi.org/10.5194/bg-18-3263-2021.

O'Neill, H. B., et al. "Permafrost Thaw and Northern Development." *Nature Climate Change*, vol. 10, no. 8, 2020, pp. 722–23. *Crossref*, https://doi.org/10.1038/s41558-020-0862-5.

Pulsifer, P., Hayes, A., Alix, G., Anker, H., Arthurs, D., Brown, N., Christoffersen, S., Chu, B., Godin, E., Herbert, C., Igbeinkutu, E., Ingram, R., Kreps, P., Ratsimbazafy, T., Sankar, R.D., Sellars, S., Vey, G and Wilkes, G. "Building Globally Interoperable Data Infrastructure: contributions from the Arctic Data community." *Arctic Science Summit Week*, March 19-26, 2021, Online event.

Pumple, J., Monteath, A., Alvarez, A., Froese, D. "Permafrost core characterization using gamma ray attenuation and industrial computed tomography scanning." *49th Annual Yellowknife Geoscience Forum,* 24-26 Nov. 2021, Virtual event.

Schetselaar A. "Performance of climate projections used for engineering design in Yukon and adjacent Northwest Territories, 1991-2020" Invited Speaker, *Cold Regions Engineering 2021: Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost*, 24-29 October 2021, Boulder, CO.

Schetselaar, A. "Increases in maintenance costs of highways due to climate change in Yukon." *CMOS Ottawa Centre Talks*, Video date: Jan 24, 2022.

Shaposhnikova, M. *Temporal Deep Learning Approach to Bedfast and Floating Thermokarst Lake Ice Mapping using SAR imagery: Old Crow Flats, Yukon, Canada. UWSpace*. 17 Sept. 2021. University of Waterloo, MSc thesis. UWSpace. http://hdl.handle.net/10012/17414

M. Shaposhnikova, C. R. Duguay and P. Roy-Léveillée. "Bedfast and floating ice dynamics of thermokarst lakes using a temporal deep learning mapping

approach: Case study of the Old Crow Flats, Yukon, Canada." *The Cryosphere*, forthcoming.

Burn, Christopher, et al. "Compendium of Permafrost Reports: Northern Transportation Adaptation Initiative (NTAI) 2011–2021." Carleton University, edited by Emma Stockton, 2021. Crossref, https://doi.org/10.52381/cpr.ntai.2021.

Travers-Smith, H. Z., et al. "Surface Water Dynamics and Rapid Lake Drainage in the Western Canadian Subarctic (1985–2020)." *Journal of Geophysical Research: Biogeosciences*, vol. 126, no. 12, 2021. *Crossref*, https://doi.org/10.1029/2021jg006445.

Tubini, Niccolò, et al. "A Method for Solving Heat Transfer with Phase Change in Ice or Soil That Allows for Large Time Steps While Guaranteeing Energy Conservation." *The Cryosphere*, vol. 15, no. 6, 2021, pp. 2541–68. *Crossref*, https://doi.org/10.5194/tc-15-2541-2021.

Young, J.M., Alvarez, A., Van Der Sluijs, J., Macphee, A., Stocker, B.J., Kokelj, S., Margold, M. and Froese, D. "Recent acceleration of thaw-driven mass-wasting in the central Mackenzie Mountain foothills is intensified by decadal-scale forest fire conditioning." *ArcticNet Annual Scientific Meeting*, Dec. 2-5, 2019, Halifax, Canada.

Young, J. "Slope failure at the base of permafrost increasing frequency and magnitude of thaw-driven mass-wasting across discontinuous permafrost terrain in the central Mackenzie Valley foothills, N.W.T." *Cold Regions Engineering 2021:*

Proceedings of the 19th International Conference on Cold Regions Engineering and the Regional Conference on Permafrost, 24-29 October 2021, Boulder, CO.

APPENDICES

APPENDIX A: NSERC PermafrostNet Strategic Network Agreement

PERMAFROSTNET STRATEGIC NETWORK AGREEMENT

PermafrostNet: NSERC Permafrost Partnership Network for Canada

This Network Agreement the (**"Agreement**") is made and entered into as of this 30 Day of June, 2019 (the "**Effective Date")**

By and Between:

CARLETON UNIVERSITY, (hereinafter referred to as "**Carleton**")

AND

BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development (FLNROD)

AND

BGC Engineering Inc. (BGC)

AND

Churchill Northern Studies Centre (CNSC)

AND

Environment and Climate Change Canada, Atmospheric Science and Technology Directorate (ASTD)

AND

Environment and Climate Change Canada, Canadian Centre for Climate Services (CCCS)

AND

Fort Severn First Nation

AND

Federation of Canadian Municipalities (FCM)

AND

Government of Nunavut: Climate Change Secretariat

AND

Government of the Northwest Territories; Department of Environment and Natural Resources (ENR)

AND

Gwich'in Renewable Resources Board (GRRB)

AND

Inuvialuit Game Council (IGC)

AND

MDA Geospatial Services Inc. (MDA)

AND

Ministère des Transports du Québec (MTQ), Direction générale des projets et de l'exploitation aéroportuaires

AND

National Research Council (NRC)

AND

Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada (NRCan)

AND

Government of Northwest Territories, Department of Infrastructure (DOI)

AND

Government of the Northwest Territories; Department of Industry, Tourism and Investment; Northwest Territories Geological Survey (NTGS)

AND

Ontario Ministry of Natural Resources and Forestry (MNRF)

AND

SRK Consulting (U.S.), Inc. (SRK)

AND

Standards Council of Canada (SCC)

AND

Tr'ondëk Hwëch'in Government (THG)

AND

Her Majesty the Queen in right of Canada, as represented by the Minister of Transport ("Transport Canada")

AND

Yukon Government: Department of Environment (YG-DE)

AND

Yukon Government: Transportation Engineering Branch (TEB)

AND

Yukon Government: Yukon Geological Survey (YGS)

AND

Yukon Government: Yukon Parks

AND

Laurentian University of Sudbury

AND

Queen's University at Kingston

AND

Royal Military College of Canada

AND

Simon Fraser University

AND

The Governors of the University of Alberta

AND

The Governors of the University of Calgary

AND

Université de Montréal

AND

University of Ottawa

AND

University of Victoria

AND

University of Waterloo (individually a "**Party**" and collectively, "**Parties**")

RECITALS

WHEREAS Carleton, as the Lead Institution and in collaboration with the University Network Partners (as defined in Section 2. u.) and with the Network Supporting Organizations (as defined hereinafter in Section 2. m.), has submitted a proposal to the Natural Sciences and Engineering Research Council's ("**NSERC**") Strategic Partnership Grants for Networks program entitled **"PermafrostNet: NSERC Permafrost Partnership Network for Canada"** (the "**Application**");

WHEREAS NSERC has selected the Application to receive funding under the Strategic Partnership Grants for Networks Program, grant number NETGP 523228-18 and has approved the establishment of PermafrostNet as proposed in the Application (the "**Network**").

WHEREAS a group of Network Supporting Organizations have agreed to partner on the network, oftentimes including a financial contribution to the Network in the form of cash or in-kind as set out in Appendix B hereto, in return for the rights provided for by this Agreement;

WHEREAS Carleton will act as the manager of the Network and will, on behalf of the Parties, receive and administer in good faith the NSERC funding and all payments contributed to the Network, as set out in the Application and the NSERC Grant, and will enter into separate Network Funds Transfer Agreements (Appendix F) with the University Network Partners to transfer funding for specific Network Research;

NOW, THEREFORE, in consideration of the premises and the mutual covenants that follow, the Parties agree as follows:

1. APPENDICES

1.1 The following Appendices attached hereto form an integral part of this Agreement:

Appendix A: NSERC Strategic Network Grant Application.
Appendix B: University Network Partners and Network Supporting Organization Commitments.
Appendix C: Network Investigator's Acknowledgement.
Appendix C-1: University of Alberta Network Investigator's Acknowledgement
Appendix D: Notices – Partners contact names and addresses.
Appendix E: Network Governance Documents.
Appendix F: Template for Network Funds Transfer Agreement.
Appendix G: New partner accession Agreement

2. DEFINITIONS

2.1 In addition to any words defined elsewhere in this Agreement, the following terms shall havethe following meanings in this Agreement:

a. **"Arising Intellectual Property"** or **"Arising IP"** means all new Intellectual Property conceived, discovered or developed by one or some Party(ies) after the Effective Date as part of the Network Research, including any improvement, enhancement or modification to Background IP.

b. **"Background Intellectual Property"** or **"Background IP"** means individually and collectively, all Intellectual Property developed, produced or obtained by a Party outside of the Network Research Project, including any enhancements or modifications thereto, which were conceived, created or developed prior to, or independent of, any Network Research Project.

c. **"Board of Directors"** (BOD) means any board of directors who have overall responsibility for the management, direction and accountability of Network activities as further detailed in the Network Governance Documents in **Appendix E**.

d. **"Intellectual Property"** means any element of intellectual property including works, discoveries or inventions (whether patentable or not), patents, copyrights, trademarks, computer programs, or technical information and data, that are first conceived, discovered or developed by a Party or jointly by more than one Party.

e. **"Lead Institution"** means Carleton University.

f. **"Mandate"** means the written agreement executed by all undivided joint owners of the given Joint Arising IP identified in such written agreement, including the terms and conditions of the mandate that they give to the Lead Party designated in this same agreement.

g. **"Network"** has the meaning ascribed to it in the recitals hereof.

h. **"Network Collaborators"** means the personnel identified on the Application as "Collaborators" on the NSERC Strategic Network Grant Application attached as **Appendix A**.

i. **"Network Director"** means the Lead Applicant of the Application, or such other faculty member of an Institution designated by the Board and named in the Network Governance Documents in the **Appendix E** who shall be responsible for the general supervision of Network activities.

j. **"Network Funds"** means all funds received and managed by the Network, including the NSERC funds and funds provided by Network University Partners and Supporting Organizations in support of the activities of the Network.

k. **"Network Investigator"** means a person who is employed or otherwise given academic status by an Institution and is eligible to receive NSERC funds; is responsible for carrying out Network Research with Network Funds and has signed the acknowledgement attached as **Appendix C**.

l. **"Director of Operations"** means the administrative manager of the Network named in the Network Governance Documents in the **Appendix E** who shall normally be employed or otherwise engaged by the Lead Institution.

m. **"Network Supporting Organization"** means the supporting organizations participating in the Network, as listed as in **Appendix B1.1** on this Agreement.

Network Supporting Organizations will also include any new organizations approved by the Board of Directors that may participate in the Network under an amended Agreement.

n. **"Network Research"** means research projects carried out under the supervision of at least one Network Investigator and to which the Board of Directors has allocated funding from the Network Funds.

o. **"Participant(s)"** means a student, academic appointee, or any other individual employed by or otherwise associated with a Party, who participates in a Network Research Project.

p. **"Partner", "Partners" "Parties"** and **"Party"** means the University Network Partners and the Network Supporting Organizations collectively or individually.

q. **"Scientific Committee"** means the committee responsible for ongoing review of the Network Research, recommending the allocation of Network Funds to the Board of Directors for approval, promoting collaboration among the research themes and projects, and any other duties as the Board of Directors may determine.

r. **"Term"** means the term and duration of this Agreement as set out in Section 10.

s. **"Termination"** means the termination of the Network Agreement, the termination of the participation of a Party, and/or the dissolution of the Network.

t. **"Theme Leaders"** means the Network Investigators appointed by the Network Director.

u. **"University Network Partners"** mean the universities participating in the Network, currently being Carleton, Laurentian University of Sudbury, Queen's University, Royal Military College of Canada, Simon Fraser University, Université de Montréal, University of Alberta, University of Calgary, University of Ottawa, University of Victoria and University of Waterloo. University Network Partners will also include any new universities approved by the Board of Directors that may participate in the Network under an amended Agreement.

2.2 Number and Time. The singular includes the plural and vice versa. All references to "days" are calendar days.

3. PURPOSE

3.1 The Parties intend to contribute, each in its area of expertise, to the development and advancement of the knowledge and expertise under the Network entitled, "PermafrostNet: NSERC Permafrost Partnership Network for Canada" as described in Appendix A, Strategic Network Grant Application. The Network Research undertaken hereunder will contribute to a fundamental and applied knowledge base in the areas of interest as defined in Appendix A, Strategic Network Grant Application and all Parties and participants will endeavor to maximize outcomes for the benefit of Canada.

4. FRAMEWORK

4.1 Each Party agrees to act at all times in such a way as to give full effect to the provisions of this Agreement.

4.2 Each Party represents that to the best of its knowledge, it is under no obligation,

contractual or otherwise, that is conflicting or inconsistent in any respect with the terms of this Agreement, or that would impede the diligent and complete fulfillment of its obligations hereunder.

4.3 The Parties agree that Network Supporting Organizations and University Network Partners may join the Network provided that:

4.3.1 With the Board of Directors' documented approval, Lead Institution would be entitled to amend the Agreement on behalf of the Partners in order to add a new Network Supporting Organization or a new University Network Partner (as applicable) as a Party to this Agreement.

4.3.2 The Network Supporting Organization and/or University Network Partner (as applicable) agrees to be bound by all terms and conditions of this Agreement; and

4.3.3 The Amendment to the Agreement has been executed by BOD.

5. NETWORK GOVERNANCE

The Parties agree that the administrative structure of the Network shall be composed of seven (7) main components: 1) the Board of Directors (BOD); 2) the Scientific Committee (SC); 3) the Knowledge Mobilization and Communications Committee (KMCCom); 4) the Equity, Diversity and Inclusion Committee (EDIC); 5) the Network Director (also known as Principal Investigator and Chair of the SC); 6) the Director of Operations; and 7) the Theme Leaders. The responsibilities of each component are outlined in Appendix E of this Agreement.

6. COMMITMENT OF THE PARTIES

6.1 Each Party agrees to participate in the Network in accordance with the commitments and procedures stipulated herein and to act with due professionalism and diligence in order to facilitate the progress and achievement of the objectives of the Network.

6.2 Each Partyshall ensure that, if applicable, (i) appropriate certification or institutional approval is obtained for their Network Research in the scope of projects that involves human subjects, or requires the use of animals or biohazards; (ii) any research they conduct under this Agreement is assessed and approved in accordance with the Canadian Impact Assessment Act prior to commencing the research; and (iii) any research they conduct under this Agreement is conducted in accordance with the Standards of the Canadian Council on Animal Care (CCAC).

6.3 Each Party agrees to contribute to the Network the elements identified in Appendix A and Appendix B in accordance with the terms and conditions of this Agreement.

6.4 Financial Obligations. Each University Network Partner shall:

6.4.1 Hold Network Funds in trust to be used exclusively for the purposes of Network Research and other related Network activities;

6.4.2 Ensure that Network Funds are used only for conducting Network Research and are not used for the benefit of any research or project outside the Network;

6.4.3 For the duration of the Agreement and for a period of seven (7) years from the termination of the Network, keep proper accounts, records and supporting documentation for the receipt and expenditure of the Network Funds;

6.4.4 Ensure that adequate financial controls consistent with NSERC's rules, regulations and guidelines and any rules established by the Board of Directors are maintained with respect to Network Funds;

6.4.5 Provide financial reports for Network Funds received and administered by the Institution to the Director of Operations and the Lead Institution when requested by the Director of Operations;

6.4.6 Provide such other financial information and documentation as may be required by the Director of Operations or the Lead Institution to administer Network activities and meet obligations to NSERC; and

6.4.7 Notify the Network Director and the Lead Institution if any of the Institution's Network Investigators become ineligible to hold NSERC funding.

6.5 Other Requirements. Each University Network Partner shall:

6.5.1 Obtain in writing an acknowledgement in the form set out as Appendix C from each of their respective Network Investigators;

6.5.2 When working with Network Collaborators, ensure that all such Network Collaborators abide by all relevant provisions of this Agreement, including without limitation confidential transfer of information, publication and disclosure requirements, relevant to the portion of the Network Research to be completed by Network Collaborator;

6.5.3 Ensure its Network Investigator abides by the Tri-Agency Framework: Responsible Conduct of Research governing the use of grant funds;

6.5.4 Ensure that its Network Investigators obtain appropriate certification or approval regarding use of humans, animals and biohazards in the conduct of Network Research in accordance with the requirements of NSERC;

6.5.5 Ensure that research involving human subjects meet the requirements of the TCPS 2 Tri-Council Policy Statement; Ethical Conduct for Research Involving Humans;

6.5.6 Ensure that research requiring the use of animals be conducted in accordance with the policies and guidelines of the Canadian Council on Animal Care: Guide to the Care and Use of Experimental Animals;

6.5.7 Ensure that research involving biohazards be conducted in accordance with the requirements of The Government of Canada's Canadian Biosafety Standard (CBS), 2nd Edition, 2015; and

6.5.8 Ensure that Network Research containing Confidential Information of any other Party is treated as confidential in accordance with Section 7 herein.

6.6 Obligations of the Lead Institution. The Lead Institution shall:

6.6.1 Allocate budgets on an annual basis, based on recommendations of the Board of Directors and use reasonable efforts to ensure that Network Funds related to student involvement are protected;

6.6.2 Administer and, subject to the receipt of sufficient funds from NSERC and Parties, distribute Network Funds to other University Network Partners upon execution of a Internal Transfer of Funds Agreement in the form set out as Appendix F in accordance with the applicable policies and procedures of the Lead Institution and the directions of the Board of Directors;

6.6.3 Provide accounting and financial reporting to NSERC and provide two offices in the Advanced Research and Innovation in Smart Environments (ARISE) Building for the duration of the Network; and

6.6.4 In consultation with the Network Director, generally coordinate all communications with NSERC in respect of Network Activities.

6.7 Network Supporting Organizations Obligations

6.7.1 Each Network Supporting Organization will provide to the Lead Institution for the Network, the support as shown in **Appendix B,** and included in the Application submitted on February 18, 2019 (**Appendix A**) as the support from that Network Supporting Organization, which will be paid or made available to the Network Research in accordance with the provisions of **Appendix B**.

6.8 Network Investigators

6.8.1 All Network Research shall be conducted under the technical direction of a Network Investigator. Each Network Investigator shall:

6.8.1.1 Abide by all applicable provisions of this Agreement;

6.8.1.2 Submit reports on progress of their Network Research, in a format as specified by the Board of Directors;

6.8.1.3 Provide notice of and information about Arising Intellectual Property created by the Network Investigator, students and/or other researchers working on Network Research under the supervision of the Network Investigator, to his or her institution;

6.8.1.4 Sit on Network committees as outlined in Appendix E of this Agreement and participate in other Network activities as required by the Board of Directors; and

6.8.1.5 Notify his or her Institution and the Network Director immediately if the Network Investigator becomes ineligible to hold NSERC funds.

7. CONFIDENTIALITY

7.1 Each Party (the "**Provider**") may disclose information it considers confidential to another Party or the other Parties (the "**Recipient(s)**") to facilitate Network Research. **"Confidential Information"** means without limitation, all scientific, technical, business, financial, legal, marketing or strategic information and data (i) that is non-public, protected, confidential, privileged or proprietary in nature; (ii) that may have actual or potential economic value, in part, from not being known; (iii) however fixed, stored, expressed or embodied (and includes, without limitation, samples, prototypes, specimens and derivatives); (iv) disclosed during discussions, telephone calls, meetings, tests, demonstrations, correspondence or otherwise; (v) that is consistently treated as confidential; or any part or portion thereof, related to the Network Research project pursuant to this Agreement, that is specifically marked confidential or identified as confidential at the time of disclosure. Confidential Information does not include information that: (i) is already known to the Party to which it is disclosed; (ii) is developed by personnel of the receiving Party who it can be demonstrated did not have access to the Confidential

Information; (iii) is or becomes part of the public domain without breach of this Agreement; (iv) is obtained from a third party that has no obligation to keep such information confidential; or (v) is required to be disclosed pursuant to judicial or administrative order. Where, at the time of disclosure, the information is clearly so marked, or by its own nature or by the circumstances surrounding its disclosure ought, in good faith, to be treated as confidential, the receiving **Party (Recipient)** shall safeguard the Information and not disclose the information to anyone **without a "need to know"** within the Recipient's organization.

Any Confidential information disclosed orally shall be reduced to written version that is marked as above and given to the Recipient within fifteen (15) days of disclosure.

7.2 The Recipient shall protect, keep and treat as confidential any Confidential Information, unless such disclosure is authorized by the Provider in writing, or unless disclosure is required by law including but not limited to applicable statute, regulation or other enactment or by lawful order, including a subpoena, of a court or administrative or regulatory authority having jurisdiction, provided Recipient provides Provider with immediate notice of such requirement upon Recipient's receipt of notice of the same. Confidential Information shall be kept confidential and protected by the Recipient with at least the same degree of care as it uses to protect its own confidential information, but not less than a reasonable degree of care.

7.3 Unless written permission is obtained from the Provider, the Recipient shall not use any Confidential Information in the performance of Network Research where such use would knowingly compromise exploitation of any resulting Arising IP. Confidential Information may be disclosed within Recipient's organization and to the Scientific Committee, as required to perform Network Research.

7.4 Obligations of confidentiality and restrictions relating to publication or disclosure of Confidential Information shall not apply to, and no Party to this Agreement shall be liable for a disclosure to another Party or to a third Party of, Confidential Information that:

7.4.1 Is already known to the Recipient to which it is disclosed prior to disclosure by the Provider without breach of the provisions of this Agreement;

7.4.2 Is or becomes part of the public domain without breach of this Agreement;

7.4.3 Is lawfully obtained from third parties that have no confidentiality obligations to the disclosing Party;

7.4.4 Is independently developed by one Party without reference to Confidential Information provided by the other Party.

7.5 Notwithstanding any other provision of this Agreement each Party may make public at any time and without prior approval of any other Party, the following information regarding this Agreement: the project title, names of the applicants and individuals who are Network Investigators, amount awarded, duration, institute or faculty or department involved, the field of research, and summary of the research proposal prepared by the applicant for public release, and cost estimates for the Party's involvement in the Network.

7.6 As directed by the Provider, Confidential Information shall, upon request or Termination of this Agreement, be returned to the Provider or destroyed by the Recipient. Recipient shall not keep copies of Confidential Information, unless authorized in writing by owners of the Confidential Information or required to do so by law.

7.7 Unless otherwise decided by the concerned Provider(s), and subject to the exemptions and exceptions provided for in this Agreement, all obligations of confidentiality and

restrictions on the use of Confidential Information cease to apply five (5) years after the expiration of this Agreement.

8. PUBLICATION AND DATA RELEASE

8.1 The Parties recognize the importance of publishing and sharing Network Research Project results, data or code in a free and open manner, in adherence with the Tri-Agency Open Access Policy. Furthermore, all Parties agree that this Project should adhere to the principles of a 'Community Resource Project', defined as a research project specifically devised and implemented to create a set of data or other material whose primary utility will be as a resource for the broader community.

8.2 At the same time, this partnership involves Indigenous community partners and, therefore, all research undertaken in partnership with Indigenous communities must adhere to the First Nations Principles of Ownership, Control, Access and Possession (OCAP) and/or the National Inuit Strategy on Research (NISR).

8.3 All Parties agree to sharing data, code, or applicable outputs in a timely fashion through an open access license, unless the sharing of said results would contravene the principles stated in Section 8.2.

8.4 Any Party that plans to publish any of their Network Research Project results, data, code or Arising IP shall first send a copy of any Proposed Publication to the other Parties with whom they collaborated to create the said results, data, code or Arising IP (the "Reviewers") at least thirty (30) days prior to the submission of such Proposed Publication. The Reviewers shall have thirty (30) days after receipt of the Proposed Publication (the "Review Period"), to object to such Proposed Publication if it includes or discloses their Confidential Information or patentable subject matter, requiring protection. If the Proposed Publication contains Confidential Information provided by a particular Reviewer, the concerned Reviewer may request that the Party who wishes to publish remove all concerned Confidential Information from the Proposed Publication except Network results and data. If the Proposed Publication contains patentable material, any Reviewer may request that such Proposed Publication be postponed for a maximum of ninety (90) days after the end of the Review Period (the "Patent Delay") in order for the Reviewer to file a patent application on each patentable subject matter.

8.5 Notwithstanding anything otherwise contained in this Agreement, the Parties acknowledge that, in accordance with NSERC policies, the defense of a student's thesis shall not be delayed or postponed.

8.6 All publications shall acknowledge the author's participation in the Network and the support of the NSERC Grant, using either the full name of the network, 'PermafrostNet: NSERC Permafrost Partnership Network for Canada' or the acronym, 'NSERC PermafrostNet', and, shall also acknowledge applicable Network Supporting Organization support where appropriate.

8.7 Notwithstanding the other provisions of this Agreement, students involved in the Network Research shall retain copyright in respect of their master's theses or doctoral theses.

9. INTELLECTUAL PROPERTY

9.1 All Arising Intellectual Property shall be governed by the institutional/organizational

policies of the creator of such Intellectual Property.

9.2 With the exception of copyrights, the Parties agree to grant to each other, a non-transferable, non-exclusive, royalty-free, fully paid-up, world-wide perpetual license to use, reproduce or implement any Arising Intellectual Property for non-commercial purposes only. No rights to sub-license are granted and nothing in this Agreement shall be construed as granting a license to any existing Intellectual Property or rights.

9.3 For clarity, authors and/or their employers (as per Section 9.1) shall maintain exclusive ownership of any and all rights, including moral rights, associated with any copyrighted works which they may produce in the performance of the project.

9.4 The ownership of Arising Intellectual Property shall be determined by applicable Canadian law and shall vest in the Party(ies)or the Network Investigator(s) according to the policies of the respective Parties. Where more than one Party is involved in the development of Arising Intellectual Property, joint ownership of Arising Intellectual Property will be decided on the basis of inventive contribution of each Party to the Arising Intellectual Property.

9.5 Pursuant to the mandate of the Strategic Partnership Grants for Networks Program, every reasonable effort must be made to have the results of Network Research exploited in Canada for the benefit of Canadians. Accordingly, the Parties shall act in accordance with the NSERC Policy on Intellectual Property.

10. DURATION, DEFAULT AND TERMINATION

10.1 Notwithstanding the signature date, this Agreement shall come into force on the Effective Date, and shall end five (5) years later, or on dissolution of the Network, whichever comes first, except for provisions in Sections 7, 8, 9,10,11,12, and 18, which shall survive termination end.

10.2 A Party shall be in default when it does not comply with any of its obligations pursuant to any applicable law or to the Agreement (the “Defaulting Party”). If a Party is in default, any other Party shall have the right to send to all Parties, including the Defaulting Party, a written notice that shall include a description of the default and the period within which the Defaulting Party must remedy its default, which shall not be less than thirty (30) days. If the Defaulting Party has not remedied this default within the remedy period mentioned in the notice to the satisfaction of the other Parties, its participation in the Network shall be terminated as of the date of the expiration of the remedy period. This termination shall not affect the validity or enforceability of this Agreement for the remaining Parties.

10.3 If the Board of Directors determines that a Network Investigator has failed to comply with the duties and responsibilities set out in this Agreement, it shall notify in writing the Network Investigator and his or her University Network Partner of the particulars. The Network Investigator shall have thirty (30) days from receipt of the written notice within which to remedy the failure, failing which the Board of Directors may terminate his or her status as a Network Investigator and access to Network Funds. Notwithstanding such termination, the Network Investigator shall cooperate to ensure an orderly transfer of responsibilities and phase-out of activities and shall continue to be bound by the provisions of this Agreement, the governing intellectual property, publication, confidentiality and any other provisions which are necessary to fulfill the Mandate of the Network.

10.4 Each Party shall have the right, at its sole discretion, to terminate their participation in the Network and this Agreement by giving four (4) months prior written notice thereof to the Lead Institution. Termination by one Party shall not affect the validity or enforceability of this Agreement for the remaining Parties.

10.5 All Parties may agree to terminate this Agreement or dissolve the Network on or before the end of the term mentioned in Section 10.1 above, by mutual written consent.

10.6 Termination of the Agreement with respect to a Party shall have the following consequences:

10.6.1 Each Party must pay all amounts it may owe to any other Party under this Agreement up to the date of Termination in respect of all commitments that cannot be cancelled or reimburse the amounts received pursuant to this Agreement and that it did not spend, as foreseen in Appendix A and B. For greater certainty, each Party shall have no obligation without any penalty or recourse of any kind to the other Parties, to provide any cash and/or in-kind contribution described in Appendix A and B after the date of Termination of its participation in the Network and this Agreement;

10.6.2 Each Party must pay all amounts it may owe to third parties pursuant to this Agreement in respect of commitments that cannot be cancelled. In that case, the amounts due are to be reviewed by the members of the Board of Directors and shall be deemed to be reasonable if approved by it. If there is a dispute with respect to any amounts owing hereunder, the amounts in dispute are to be reviewed by the Board of Directors and the decision of the Board of Directors concerning such amounts in dispute shall be binding and final;

10.6.3 Each Party must comply with any other obligations it undertook, prior to Termination, hereunder or pursuant to this Agreement;

10.6.4 Each Party shall provide a full and complete report on all aspects of its Network Research up to the effective date of Termination to the Network Director;

10.6.5 Any Party who has terminated their participation in the Network during the Agreement term, but wishes to renew their membership during this same term, may be obligated to pay some or all of the missed cash contributions they had committed as of the Effective Date prior to re-entering the Network as a Partner.

10.7 Termination shall be effective upon the following dates:

10.7.1 On the last day of the notice period provided pursuant to Section 10.2, Section 10.3, Section 10.4 whichever is applicable; or

10.7.2 On the effective date of Termination agreed to by all Parties, pursuant to Section 10.5.

11. DISCLAIMER OF WARRANTY

11.1 Each Party acknowledges that it shall use any and all Network Research results, data or Arising IP that it may receive pursuant to this Agreement with caution and prudence, since all of their characteristics are not known. Each Party who creates Arising IP disclaims all liability for any damages however arising from another Party's use of the Arising IP. Each Party further acknowledges that Network Research results, data, Arising IP, Confidential Information or other tangible or intangible materials are provided

without warranty of merchantability or fitness for a particular purpose or any other warranty of any sort, express or implied, and that the provider makes no representations that the use of the same will not infringe any patent or other proprietary right.

12. LIABILITY AND INDEMNIFICATION

12.1 Subject to Section 12.3, each Party (the "Responsible Party") shall be liable and shall indemnify and save harmless each other Party (the "Indemnified Party") for any and all damages, liabilities, claims, losses or costs sustained by the Indemnified Party (the "Damages") caused by wilful misconduct, fraud, gross negligence or recklessness of the Responsible Party, including the persons or property for whom the Responsible Party is legally responsible at law pursuant to its default to comply with its obligations under the terms of this Agreement or under the law, unless the Damages are caused by the fault of the Indemnified Party, including any person or property for whom the Indemnified Party is legally responsible at law, or by a breach by the Indemnified Party of its obligations hereunder or of its legal obligations. Any Party requiring indemnification shall give a prompt notice of the concerned claim to the Responsible Party, and provide all reasonable assistance in order for the Responsible Party to produce a defence or settle the claim.

12.2 Each Party declares that it has adequate liability insurance or shall maintain a self-insurance program of minimum two (2) million dollars to cover any liabilities incurred or attributed to its officers, employees, and agents while acting within the scope of their employment with that Party, but not applicable to any liabilities arising from, or related to any infringement of any third party's intellectual property.

12.3 In no event shall any Party be liable to the other for indirect, incidental, consequential, special, punitive, or exemplary damages in any action arising out of or relating to this Agreement, or the breach of any terms thereof, under any theory of law or equity even if that Party has been advised of the possibility of such damages. This limitation precludes the recovery of loss of use, lost income, lost or anticipated profits, lost revenue or business, and the cost of procuring substitute goods and services. Further, in no event shall any Party be entitled to injunctive relief, except with respect to Intellectual Property and Confidential Information. This limitation shall not apply to wilful misconduct, fraud, gross negligence, or recklessness.

13. DISPUTE RESOLUTION

13.1 Disputes that cannot be resolved within thirty (30) days through consultation and discussion between the Parties shall be escalated to the Network Director. If the Network Director is unable to resolve the dispute within sixty (60) days, it shall be escalated to the Board of Directors for resolution.

13.2 Disputes that cannot be resolved by the Board of Directors pursuant to section 13.1 shall be submitted to a mutually acceptable mediator chosen by those Parties who are involved in the dispute.

13.3 Disputes which are not resolved by mediation in accordance with section 13.2 within ninety (90) days shall be submitted to arbitration. The Parties who are involved in the dispute shall each appoint an arbitrator to adjudicate the issue. The arbitrators shall appoint one additional arbitrator, and these arbitrators shall constitute a panel. The arbitration shall be held in a place mutually agreed on by the Parties involved in the

dispute. If such parties cannot agree on a place for the arbitration, the arbitration shall be held in a major Canadian city that is relatively equidistant from the Parties involved in the dispute. The panel shall be required to adjudicate the dispute within thirty (30) days of it being submitted for arbitration.

13.4 The decision of the panel shall be binding on the Parties involved in the dispute. The Parties shall each bear their own expenses and shall share the cost of the panel equally unless otherwise awarded by the panel.

14. ENTIRE AGREEMENT

14.1 The terms and conditions set forth in this Agreement, together with the Recitals and the Appendices listed in Section 1 form the complete agreement between the Parties and shall be binding upon the Parties.

15. RELATIONSHIP TO OTHERS

15.1 Nothing in this Agreement shall be construed so as to create a legal relationship of partnership, agency or employment among any of the Parties. Each Party is an independent contractor and is not authorized or empowered to act as agent for any other Party for any purpose, except as explicitly set forth herein.

16. NOTICES

16.1 Required notices under this Agreement shall be given by prepaid post, email or courier to the relevant Party's administrative contact as set out in Appendix D to this Agreement. Notices sent by prepaid post or courier shall be deemed received on the fifth business day following dispatch. Notices sent by email shall be deemed received on the business day following dispatch.

17. USE OF NAMES

17.1 Parties agree to the use of the name or identifying mark of a Party in the interest of promoting NSERC PermafrostNet, on the website and promotional collateral, for the good of all parties.

17.2 Subject to the provisions of Section 17.1 hereinabove, the name or identifying mark of a Party or of its employee or student shall not be used in any other publicity without the prior written approval of an authorized representative of that Party. Subject to the provisions of Section 7.5 hereinabove, no Party may use the name or marks of another Party, a Network Investigator or a student in conjunction with the use of exploitation of the Arising IP, including without limitation the development, production or marketing of products.

18. ASSIGNMENT, SUBCONTRACTING AND AMENDMENT

18.1 No amendment or variation of this Agreement will operate to change or vary the terms, obligations, or conditions hereof except upon written agreement by all Parties signed by authorized representatives of each Party.

18.2 No part of this Agreement may be assigned or subcontracted by any Party without the written consent of all others signed by authorized representatives of each Party, which

shall not be unreasonably withheld.

18.3 This Agreement shall inure to the benefit of and be binding upon the Parties and their respective administrators, and permitted assigns.

18.4 In the event that a third Party is approved by the Board of Directors to join the Network (the "New Partner"), the Lead Institution shall execute a New Partner Accession Agreement in the form of that provided in Appendix G with the New Partner. A copy of the New Partner Accession Agreement shall be promptly forwarded by the Lead Institution to each Partner for their records as well as amended Appendix D.

19. GOVERNING LAW

19.1 This Agreement will be governed by and interpreted in accordance with the laws in force in the Province of Ontario for enforcement thereof.

20. FORCE MAJEURE

20.1 Where a Party is delayed in performing or observing a covenant or obligation hereunder which is to be performed or observed by a specific date or within a particular time by reason of excusable delay, the date or period of time by or within which such Party is to perform or observe such covenant or obligation shall be extended by a period of time equal to the duration of the delay. As used herein, "excusable delay" means any delay in the performance or observance by any Party or any obligation of such Party hereunder which occurs as a consequence of or is attributable to any circumstance which is beyond the reasonable control of such Party and which is not caused by any default or act of omission of such Party and is not avoidable by the exercise of reasonable effort or foresight by such Party.

21. NO IMPLIED WAIVER

21.1 No failure to enforce any provision of this Agreement shall be construed as a waiver of such provision or a waiver of the right to enforce each and every provision of this Agreement. Waiver of any breach shall not be deemed to be a waiver of any future breach, even if similar in nature.

22. SEVERABILITY

22.1 If and insofar as any part or provision of this Agreement is or becomes invalid or unenforceable, the Parties shall use reasonable effort to reform the portions of this Agreement declared invalid to realize the intent of the Parties as fully practicable and the application of such valid term or provision to circumstances other than those to which it is held invalid or unenforceable shall not be affected thereby. Each of the remaining terms and provisions of this Agreement shall remain in full force and effect.

23. COUNTERPARTS

23.1 This Agreement may be signed in counterparts, and each counterpart may be delivered by signed PDF by email. Each counterpart shall constitute an original, and when taken together, shall constitute one and the same instrument.

IN WITNESS WHEREOF, the duly authorized officers of the Parties hereto have signed this Agreement as of the Effective Date.

CARLETON UNIVERSITY

Rafik Goubran

Digitally signed by Rafik Goubran
DN: CaCA, OU=VP (Research & International), O=Carleton University, CN=Rafik Goubran, E=Rafik.Goubran@Carleton.ca
Reason: I am approving this document
Location: Ottawa
Date: 2021.05.06 16:28:38-04'00'
Foxit PhantomPDF Version: 10.1.3

Name: Rafik Goubran

Title: Vice-President (Research and International)

Date: 06 May 2021

CARLETON UNIVERSITY

Digitally signed by Chris Lannon
Date: 2021.05.06 15:56:06 -04'00'

Name: Chris Lannon

Title: Director, Industry and Partnership Services

Date: _____

APPENDIX A

STRATEGIC PARTNERSHIP GRANTS FOR NETWORK APPLICATION

Appendix A.1 NSERC Permafrost Partnership Network for Canada Application (https://www.permafrostnet.ca/resources/members-area/)

Appendix A.2 Notice of Award (https://www.permafrostnet.ca/resources/members-area/)

Appendix A.3 Terms and Conditions of Award (https://www.permafrostnet.ca/resources/members-area/)

APPENDIX B

NETWORK SUPPORTING ORGANIZATIONS COMMITMENTS

Appendix B1.1 Network Supporting Organizations Contributions

The Network Supporting Organizations intend to provide cash contribution and/or in-kind support to the Network, in the amounts as set out in Schedule A and as further summarized below:

Network Supporting Organizations	Contributions
	In-kind
BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development (FLNROD)	$750,000
BGC Engineering Inc. (BGC)	$15,000
Churchill Northern Studies Centre (CNSC)	$32,500
ECCC, Atmospheric Science and Technology Directorate (ASTD)	$250,000
Federation of Canadian Municipalities (FCM)	
Fort Severn First Nation	
Government of the Northwest Territories; Environment and Natural Resources (ENR)	
Government of Nunavut: Climate Change Secretariat	$50,000
Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada (NRCan)	$385,000 in-kind
Inuvialuit Game Council (IGC)	$50,000
MDA Geospatial Services Inc. (MDA)	$120,000
Ministère des Transports du Québec (MTQ), Direction générale des projets et de l'exploitation aéroportuaires	$148,200
National Research Council (NRC)	
Northwest Territories Department of Infrastructure (DOI)	$344,000
Northwest Territories Geological Survey (NTGS)	$728,750
Ontario Ministry of Natural Resources and Forestry (MNRF)	$150,000
SRK Consulting (U.S.), Inc. (SRK)	$25,000
Standards Council of Canada (SCC)	$40,000
Transport Canada (TC)	$30,000
Tr'ondëk Hwëch'in Government (THG)	
Yukon Government: Department of Environment (YG-DE)	
Yukon Government: Transportation Engineering Branch (TEB)	$50,000
Yukon Government: Yukon Geological Survey (YGS)	$185,800
Yukon Parks	
Total	**$3,354,250**
Ontario Ministry of Natural Resources and Forestry (MNRF)*	$20,000
Grand Total	**$3,374,250**

*Note: the cash contribution from MNRF will be disbursed through Laurentian University of Sudbury and accounted for with in-kind contribution reporting

Appendix B1.2 University Network Partners Support

University Network Partners	Contributions
	Cash
Carleton University (Administrative Salaries)	$244,230.00
Indigenous Engagement Commitments	
Carleton University	$20,000.00
The Governors of the University of Alberta	$20,000.00
University of Victoria	$10,000.00
Laurentian University of Sudbury	$20,000.00
Royal Military College of Canada	$20,000.00
Université de Montréal	$20,000.00
Total	**$354,230.00**

Appendix B.2 Invoice Schedule

The Lead Institution shall invoice, each year, all Partners as per cash contribution table here above, in accordance with the below schedule, or as one payment in year two, as per University Network Partner's directive:

Year 1: Agreement Execution
Year 2: July 1, 2020
Year 3: July 1, 2021
Year 4: July 1, 2022
Year 5: July 1, 2023

		2019	2020	2021	2022	2023
Carleton University	$264,230	-	-	-	-	-
The Governors of the University of Alberta	$20,000	$4,000	$4,000	$4,000	$4,000	$4,000
University of Victoria	$10,000	$2,000	$2,000	$2,000	$2,000	$2,000
Laurentian University of Sudbury	$20,000	$4,000	$4,000	$4,000	$4,000	$4,000
Royal Military College of Canada	$20,000	$4,000	$4,000	$4,000	$4,000	$4,000
Université de Montréal	$20,000	$4,000	$4,000	$4,000	$4,000	$4,000

APPENDIX C

NETWORK INVESTIGATOR'S ACKNOWLEDGEMENT

I, _____, am a Network Investigator involved in the ***NSERC Permafrost Partnership Network for Canada*** (the "Network") established under a Research Network Agreement (the "Network Agreement") among the University Network Partners and the Network Supporting Organizations. I acknowledge that I participate as an Employee of _____ (my "Institution") and that my signature to this document indicates that I understand the terms of my activities in connection with the Network.

I acknowledge and agree that all Arising IP shall be owned by the Institution and/or its participants who created the Arising IP, in accordance with the policies and procedures of the Institution and any applicable collective or other employment agreements in respect of that Institution's participants in the Network.

I further agree that as a Network Investigator, I will:

a. Give credit to the Network, NSERC, Partner Organizations and collaborating researchers, in publications and publicity relating to my Network Research (as defined in the Network Agreement). My public relations communications relating to Network activities will be consistent with NSERC's General Guidelines for the Public Announcement of Major NSERC Awards.

b. Abide by the provisions of the Network Agreement with respect to intellectual property and the public disclosure of research results. I will disclose all Arising IP (as defined in the Network Agreement) to my Institution's technology transfer office in a timely manner. I will inform all participants in my Network Research, whether or not paid from Network funds, of all of the foregoing obligations.

c. Abide by the confidential transfer of information (as per Section 7) and publication (as per Section 8), intellectual property (as per Section 9) and disclosure requirements of the Network Agreement.

d. Inform students and other members of my research team of the Council's regulations governing the use of grant funds and of transfer of information and materials, publication, intellectual property and disclosure obligations created by the Network Agreement, including the specific provisions applicable to theses (as per Section 8.5).

e. Abide by the Tri-Council Policy Statement on Integrity in Research and regulations governing the use of grant funds and in the conduct of research.

f. Abide by my Institution's or NSERC's, whichever is more stringent, policies and guidelines with respect to conflict of interest and conflict of commitment.

g. Obtain appropriate certification and/or approval regarding the use of humans, animals and/or biohazards in the conduct of Network Research in accordance with the requirements of my Institution and NSERC.

h. If applicable, comply with all applicable legislation with respect to the products of my Network Research and to evaluation of their environmental and human health impact.

i. Advise my Institution and the Network Director if I become ineligible to hold NSERC funding.

j. Endeavour to attain milestones and goals set out in the Network Research.

k. Prepare timely research progress reports for submission to the Network's Board of Directors and/or Network Director as and when requested.

l. Make reasonable efforts to attend along with my students who are supported by Network funds or involved in my Network Research, any annual Network scientific meeting and/or workshops.

_____

Name:

_____

Title:

_____

Signature:

Date: _____

APPENDIX C-1

UNIVERSITY OF ALBERTA NETWORK INVESTIGATOR'S ACKNOWLEDGEMENT

I acknowledge to the Governors of the University of Alberta (the "U of A") that:

1. I have read the NSERC Permafrost Partnership Network for Canada Strategic Network Agreement (the "Network Agreement") and accordingly am aware of the terms and conditions pursuant to which the U of A will participate in the NSERC PermafrostNet Network (the "Network") and the Network Research as defined in the Network Agreement (the "University Obligations").
2. Section 6.5.1 of the Network Agreement requires the U of A to obtain from me an acknowledgement substantially in this form as a condition of the U of A assigning me to, or permitting me to participate in, the Network Research.
3. I am aware that in accordance with the terms and conditions applicable to my appointment as an academic/non-academic staff member/status as a registered student [circle one] of the U of A my participation in the Network Research must be in accordance with the University Obligations.
4. I am aware that:
    a. In order to permit the U of A to comply with the provisions of Section 6.5.1 of the Network Agreement the U of A must obtain ownership of all Arising IP (as defined in the Network Agreement) and I assign to the U of A my right, title and interest in all Arising IP for the purpose of permitting the U of A to comply with the University Obligations;
    b. "Arising IP" means, individually and collectively, all new Intellectual Property developed by a Party after the Effective Date as part of Network Research, including any improvement, enhancement or modification to Background IP.
    c. "Intellectual Property" means inventions, patents, copyrights, trademarks, computer programs, or technical information that are first produced or obtained by a Party.
    d. The provisions of Section 8.7 of the Network Agreement provide that students involved in the Network Research shall retain copyright in respect to their master's theses or doctoral theses and therefore I do not assign to the U of A my right, title and interest in such copyright.
5. I am executing and delivering this Acknowledgement on a voluntary basis after having been given an opportunity to review and discuss the Acknowledgement both on my own and with others of my choosing. The U of A has advised me because the Network Agreement requires that my copyright in Arising IP be assigned by me to the U of A, the U of A is not requiring, and will not require, me to participate in the Network Research. However, the U of A has also stated that upon my delivery of this Acknowledgement as to the matters included in paragraph 4, it will permit me to participate in the Network Research.

6. The U of A has advised me that, subject to the qualification contained in paragraph 5, it believes the Network Agreement including the provisions relating to ownership of Arising IP, is in the best overall interests of the U of A and each U of A research team member who is an inventor of Arising IP.

Dated the __ day of _____, _____.

_____	_____
Witness	Research Participant
[Print Name of Witness]	[Print Staff Member's Name]

APPENDIX D

NOTICES PARTNERS CONTACT NAMES AND ADDRESSES

Appendix D.1 For Network Agreement Contractual Matters:

Carleton University	Laurentian University of Sudbury
Asli Eran Research Contracts and Agreements Officer Industry and Partnership Services 4200 ARISE Building 613.520.2600 Ext. 4144 asli.eran@carleton.ca	Lise Carrière Research Contracts Officer Office Research Services 935 Ramsey Lake Road Sudbury ON P3E 2C6 705.675.1151 Ext. 2429 lncarriere@laurentian.ca
Royal Military College of Canada	**Simon Fraser University**
Kenneth Rochon Research Administration Comptroller's Office P.O. Box 17000 – Stn Forces Kingston ON K7K 7B4 613.541.6000 Ext. 6372 ken.rochon@rmc.ca	Aniko Takacs-Cox Director, Research Services 2 Discovery, Room 215 8888 University Drive Burnaby BC V5A 1S6 778.782.5457 ata26@sfu.cacc Research Contract Coordinator research_contract@sfu.ca
Université de Montréal	**University of Alberta**
Julia Guy Conseillère à la recherche Bureau de recherche institutionnelle P.O. Box 6128, Centre ville Montreal QC H3C 3J7 514.343.6111 poste 50715 julia.guy@umontreal.ca cc : Martine Haviernick Directrice-Contrats et partenariats par interim 514-343-6111 ext 36883 martine.haviernick@umontral.ca	Julaine Herst Assistant Director, Agreements 1-560 Enterprise Square 12030 Jasper Avenue Edmonton, AB T5J 4P6 Phone: 780-492-7885 julaine.herst@ualberta.ca
University of Calgary	**University of Ottawa**
Attn: Legal & IP, Research Services Office 2500 University Drive, NW Calgary AB T2N 1N4 403.220.6354 legaladm@ucalgary.ca	Director University of Ottawa Innovation Support Services 800 King Edward (3042) Ottawa ON K1N 6N5 613.562.5399 iss@uottawa.ca Anne Coughlan acoughla@uottawa.ca

University of Victoria	University of Waterloo
Office of Research Services PO Box 1700 STN CSC Victoria BC V8W2Y2 250-472-4362 contract@uvic.ca	Sarindra Andiranasolo, M.Sc. Grants and Contracts Manager EC5 3043 A 200 University Avenue West Waterloo, ON, Canada N2L 3G1 519-888-4567 Ext. 39104 sandrianasolo@uwaterloo.ca

BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development (FLNROD)	BGC Engineering Inc. (BGC)
Alexandre (Alex) Bevington Research Hydrologist, Omineca Region 499 George St., 5th Floor Prince George BC V2L 1R5 250.561.3460 Alexandre.Bevington@gov.bc.ca	Lukas Arenson Senior Geotechnical Engineer Suite 500 – 980 Howe Street Vancouver, BC Canada V6Z 0C8 604.684.5900 Ext. 41116 larenson@bgcengineering.ca
Churchill Northern Studies Centre (CNSC)	Environment and Climate Change Canada, Atmospheric Science and Technology Directorate (ASTD)
Graham Neale Executive Director 1 Launch Road Box 610 Churchill MB. R0B 0E0 204.675.2307 ed@churchillscience.ca	Anne Walker Manager, Climate Research Division Science and Technology Branch 4905 Dufferin Street Toronto ON M3H 5T4 416.739.4357 anne.walker@canada.ca
Environment and Climate Change Canada, Canadian Centre for Climate Services (CCCS)	Federation of Canadian Municipalities (FCM)
Lo Chiang Cheng Executive Director 200 Blvd. Sacre-Coeur Gatineau QC K1H 0H3 819.938.3886 lo.cheng@canada.ca	Sara Jane O'Neill Federation of Canadian Municipalities 24 Clarence Street Ottawa ON. K1N 5P3 343.925.6474 sjoneill@fcm.ca

Fort Severn First Nation	Government of Nunavut: Climate Change Secretariat
Paul Burke Chief P.O. Box 149 Fort Severn ON P0V 1W0 807.478.2572 paulburkefso@gmail.com	Sara Holzman Acting Director P.O. Box 1000, Stn. 1360 Iqaluit NU. X0A 0H0 867.975.7733 sholzman@gov.nu.ca

Government of Northwest Territories; Environment and Natural Resources (ENR)	Gwich'in Renewable Resources Board (GRRB)
Bruce Hanna Advisor, Regional Science Programs P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9232 Ext. 53055 Bruce_Hanna@gov.nt.ca	Amy Amos Executive Director P.O Box 2240 Inuvik NT X0E 0T0 867.777.6600 Ext. 2 aamos@grrb.nt.ca
Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)	Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)
Yu Zhang Research Scientist, Canada Centre for Mapping and Earth Observation 560 Rochester Street Ottawa ON K1S 5K2 613.759.6024 yu.zhang@canada.ca Robert Fraser Research Scientist, Canada Centre for Mapping and Earth Observation robert.fraser@canada.ca	Linda Ham Chief Geologist, Canada-Nunavut Geoscience Office 1106 Inuksagait Plaza P.O. Box 2319 Iqaluit NU X0A 0H0 867.975.4412 linda.ham@canada.ca
Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)	Inuvialuit Game Council (IGC)
Catherine Ste-Marie Manager, Geological Survey of Canada 601 Booth Street Ottawa ON K1A 0E8 613.790.6857 catherine.ste-marie4@canada.ca	Davonna Kasook P.O. Box 2120 Inuvik NT X0E 0T0 867.777.2828 igc-rp@jointsec.nt.ca
MDA Geospatial Services Inc. (MDA)	Ministère des Transports du Québec Direction de la coordination de la recherche et de l'innovation
Heidi Harms Manager, Contracts/Subcontracts 13800 Commerce Parkway Richmond BC V6V 2J3 604.231.2968 heidi.harms@mda.space	Papa Demba Seye Coordonnateur 800, Place d'Youville, 15e étage Québec QC G1R 3P4 418.643.0800, poste 24140 Papa-demba.seye@transports.gouv.qc.ca
National Research Council (NRC)	Government of Northwest Territories, Department of Infrastructure (DOI)
Cameron McCartney Senior Innovation Coordinator 613.993.9775 cameron.mccartney@nrc-cnrc.gc.ca Anne Barker Arctic Program Lead 1200 Montreal Road	Jeffrey Dawe Departmental Capital Planner, Infrastructure 4th Floor, New Government Building P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9081 jeffrey_dawe@gov.nt.ca

Ottawa ON K1A 0R6 613.990.2511 anne.barker@nrc-cnrc.gc.ca	Nicole Hannah Nicole_Hannah@gov.nt.ca 867.767.9045 Ext. 32005

Northwest Territories Geological Survey (NTGS)	Ontario Ministry of Natural Resources and Forestry (MNRF)
Steve Kokelj Permafrost Scientist P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9211 Ext. 63214 Steve_Kokelj@gov.nt.ca Kumari Karunaratne Manager, Geoscience Information Servicies P.O. Box 1320 Yellowknife, NT 867.767.9211 Ext. 63213 Kumari_Karunaratne@gov.nt.ca	Jim McLauglin Forest Soils Research Scientist Ontario Forest Research Institute 1235 Queen Street, East Sault Ste. Marie ON. P6A 2E5 705.946.7418 jim.mclauglin@ontario.ca
SRK Consulting (U.S.) Inc. (SRK)	Standards Council of Canada (SCC)
Christopher Stevens Senior Geocryologist 110901 Business Blvd., Suite 110 P.O. Box 770401 Eagle River, AK USA 99577 907.301.8718 cstevens@srk.com	Brady Allin Manager, Infrastructure and Climate Change Program 600 – 55 Metcalfe Street Ottawa ON Canada K1P 6L5 613.238.3222 Ext. 314 brady.allin@scc.ca
Tr'ondëk Hwëch'in Government (THG)	Transport Canada (TC)
Alice McCulley Fish and Wildlife Projects Coordinator P.O. Box 599 Dawson YT Y0B 1G0 867.993.7100 Ext. 240 alice.mcculley@trondek.ca Kirsten Scott Manager, Lands and Resources Branch P.O. Box 599 Dawson YT Y0B 1G0 867.993.7100 Ext. 105 Kirsten.Scott@trondek.ca	Jenna Craig Senior Advisor, Northern Transportation Adaptation Initiative 330 Sparks Street, 26th Floor (ACS) Place de Ville, Tower C Ottawa ON K1A 0N5 613.993.3455 Jenna.Craig@tc.gc.ca Catherine Kim Manager, Northern Transportation Adaptation Initiative 330 Sparks Street, 26th Floor (ACS) Place de Ville, Tower C Ottawa ON K1A 0N5 613.991.0867 catherine.kim@tc.gc.ca

Yukon Government: Department of Environment (YG-DE)	Yukon Government: Transportation Engineering Branch (TEB)
Maxine White Adaptation Analyst 10 Burns Road Whitehorse YT Y1A 4Y9 867.667.7971 Maxine.White@gov.yk.ca	Muhammad Idrees Manager, Geotechnical Program 461 Range Road Whitehorse YT Y1A 3A4 867.667.8820 Muhammad.Idrees@gov.yk.ca

Yukon Government: Yukon Geological Survey (YGS)	Yukon Government: Yukon Parks
Carolyn Relf Director P.O. Box 2703 (K-14) Whitehorse YT Y1A 2C6 867.667.8892 carolyn.relf@gov.yk.ca	Jean Langlois Manager, Park Planning P.O. Box 2703, V-4 Whitehorse YT Y1A 2C6 867.456.6761 jean.langlois@yukon.ca Mike Etches Director mike.etches@yukon.ca

Appendix D.2 For Scientific Matters:

Carleton University	Carleton University
Stephan Gruber stephan.gruber@carleton.ca	Christopher Burn christopher.burn@carleton.ca
Carleton University	Laurentian University of Sudbury
Shawn Kenny shawn.kenny@carleton.ca	Pascale Roy-Léveillée proyleveillee@laurentian.ca
Royal Military College of Canada	Simon Fraser University
Ryley Beddoe Ryley.Beddoe@rmc.ca	Bernhard Rabus btrabus@sfu.ca
Université de Montréal	Université de Montréal
Daniel Fortier daniel.fortier@umontreal.ca	Oliver Sonnentag oliver.sonnentag@umontreal.ca
University of Alberta	University of Calgary
Duane Froese duane.froese@ualberta.ca	Jocelyn Hayley JHayley@ucalgary.ca
University of Calgary	University of Ottawa
Brian Moorman moorman@ucalgary.ca	Antoni Lewkowicz alewkowi@uOttawa.ca

University of Victoria	University of Victoria
Trevor Lantz tlantz@uvic.ca	Joe Melton joe.melton@canada.ca
University of Waterloo	
Claude Duguay cduguay@uwaterloo.ca	

BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development (FLNROD)	BGC Engineering Inc. (BGC)
Alexandre (Alex) Bevington Research Hydrologist, Omineca Region 499 George St., 5th Floor Prince George BC V2L 1R5 250.561.3460 Alexandre.Bevington@gov.bc.ca	Lukas Arenson Senior Geotechnical Engineer Suite 500 – 980 Howe Street Vancouver, BC Canada V6Z 0C8 604.684.5900 Ext. 41116 larenson@bgcengineering.ca
Churchill Northern Studies Centre (CNSC)	Environment and Climate Chanage Canada, Atmospherice Science and Technology Directorate (ASTD)
Neale Graham Executive Director ed@churchillscience.ca LeeAnn Fishback Scientific Coordinator 1 Launch Road Box 610 Churchill MB. R0B 0E0 204.675.2307 fishback@churchillscience.ca	Anne Walker Manager, Climate Research Division Science and Technology Branch 4905 Dufferin Street Toronto ON M3H 5T4 416.739.4357 anne.walker@canada.ca
Environment and Climate Change Canada, Canadian Centre for Climate Services (CCCS)	Federation of Canadian Municipalities (FCM)
Lo Chiang Cheng Executive Director 200 Blvd. Sacre-Coeur Gatineau QC K1H 0H3 819.938.3886 lo.cheng@canada.ca	Sara Jane O'Neill Federation of Canadian Municipalities 24 Clarence Street Ottawa ON. K1N 5P3 343.925.6474 sjoneill@fcm.ca
Fort Severn First Nation	Government of Nunavut: Climate Change Secretariat
Paul Burke Chief P.O. Box 149 Fort Severn ON P0V 1W0 807.478.2572 paulburkefso@gmail.com	Sara Holzman Acting Director P.O. Box 1000, Stn. 1360 Iqaluit NU. X0A 0H0 867.975.7733 sholzman@gov.nu.ca

Government of Northwest Territories; Environment and Natural Resources (ENR)	Gwich'in Renewable Resources Board (GRRB)
Bruce Hanna Advisor, Regional Science Programs P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9232 Ext. 53055 Bruce_Hanna@gov.nt.ca	Sarah Lord Fisheries & Forestry Biologist P.O. Box 2240 Inuvik NT X0E 0T0 867.777.6600 Ext. 4 slord@grrb.nt.ca
Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)	Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)
Yu Zhang Research Scientist, Canada Centre for Mapping and Earth Observation 560 Rochester Street Ottawa ON K1S 5K2 613.759.6024 yu.zhang@canada.ca Robert Fraser Research Scientist, Canada Centre for Mapping and Earth Observation robert.fraser@canada.ca	Linda Ham Chief Geologist, Canada-Nunavut Geoscience Office 1106 Inuksagait Plaza P.O. Box 2319 Iqaluit NU. X0A 0H0 867.975.4412 linda.ham@canada.ca
Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)	Inuvialuit Game Council (IGC)
Steve Wolfe Research Scientist, Geological Survey of Canada 601 Booth Street Ottawa ON K1A 0E8 (613) 992-7670 stephen.wolfe@canada.ca Catherine Ste-Marie Manager, Geological Survey of Canada 613.790.6857 catherine.ste-marie4@canada.ca	Davonna Kasook P.O. Box 2120 Inuvik NT X0E 0T0 867.777.2828 igc-rp@jointsec.nt.ca

MDA Geospatial Services Inc. (MDA)	Ministère des Transports du Québec Direction générale des projets et de l'exploitation aéroportuaires
Ron Caves Director, R&D, Geospatial Services 1300 Commerce Parkway Richmond BC V6V 2J3 604.231.2323 Ron.Caves@ mda.space	Anick Guimond Coordonnatrice-Adaptation aux changements climatiques 26, rue Monseigneur Rhéaume Est, 2e étage Rouyn-Noranda QC J9X 3J5 819.763.4080, poste 46806 anick.guimond@transports.gouv.qc.ca
National Research Council (NRC)	Government of Northwest Territories, Department of Infrastructure (DOI)

Igor Egorov Research Officer 1200 Montreal Road Ottawa ON K1A 0R6 613.796.4284 Igor.Egorov@nrc-cnrc.gc.ca	Jeffrey Dawe Departmental Capital Planner, Infrastructure 4th Floor, New Government Building P.O. Box 1320 Yellowknife NT X1A 2L9 jeffrey_dawe@gov.nt.ca Nicole Hannah Nicole_Hannah@gov.nt.ca 867.767.9045 Ext. 32005
Northwest Territories Geological Survey (NTGS)	Ontario Ministry of Natural Resources and Forestry (MNRF)
Steve Kokelji Permafrost Scientist P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9211 Ext. 63214 Steve_Kokelj@gov.nt.ca Kumari Karunaratne Manager, Geoscience Information Servicies 4601-B 52 Avenue Yellowknife, NT X1A 2R3 867.767.9211 Ext. 63213 Kumari_Karunaratne@gov.nt.ca	Jim McLauglin Forest Soils Research Scientist Ontario Forest Research Institute 1235 Queen Street, East Sault Ste. Marie ON. P6A 2E5 705.946.7418 jim.mclauglin@ontario.ca

SRK Consulting (U.S.), Inc. (SRK)	Standards Council of Canada (SCC)
Christopher Stevens Senior Geocryologist 110901 Business Blvd., Suite 110 P.O. Box 770401 Eagle River, AK USA 99577 907.301.8718 cstevens@srk.com	Brady Allin Manager, Infrastructure and Climate Change Program 600 – 55 Metcalfe Street Ottawa ON Canada K1P 6L5 613.238.3222 Ext. 314 brady.allin@scc.ca
Tr'ondëk Hwëch'in Government (THG)	Transport Canada (TC)
Alice McCulley Fish and Wildlife Projects Coordinator P.O. Box 599 Dawson YT Y0B 1G0 867.993.7100 Ext. 240 alice.mcculley@trondek.ca Kirsten Scott Manager, Lands and Resources Branch P.O. Box 599 Dawson YT Y0B 1G0 867.993.7100 Ext. 105 Kirsten.Scott@trondek.ca	Jenna Craig Senior Advisor, Northern Transportation Adaptation Initiative 330 Sparks Street, 26th Floor (ACS) Place de Ville, Tower C Ottawa ON K1A 0N5 613.993.3455 Jenna.Craig@tc.gc.ca Catherine Kim Manager, Northern Transportation Adaptation Initiative 330 Sparks Street, 26th Floor (ACS) Place de Ville, Tower C Ottawa ON K1A 0N5 613.991.0867 catherine.kim@tc.gc.ca

Yukon Government: Department of Environment (YG-DE)	Yukon Government: Transportation Engineering Branch (TEB)
Maxine White Adaptation Analyst 10 Burns Road Whitehorse YT Y1A 4Y9 867.667.7971 Maxine.White@gov.yk.ca	Muhammad Idrees Manager, Geotechnical Program 461 Range Road Whitehorse YT Y1A 3A4 867.667.8820 Muhammad.Idrees@gov.yk.ca
Yukon Government: Yukon Geological Survey (YGS)	Yukon Parks
Panya Lipovsky Surficial Geologist P.O. Box 2703 (K-14) Whitehorse YT Y1A 2C6 867.667.8520 panya.lipovsky@gov.yk.ca	Jean Langlois Manager, Park Planning P.O. Box 2703, V-4 Whitehorse YT Y1A 2C6 867.456.6761 jean.langlois@yukon.ca Mike Etches Director Mike.etches@yukon.ca

Appendix D.3 For Funds Transfer Agreements:

Carleton University	Laurentian University of Sudbury
Tristan MacLean Director of Operations NSERC PermafrostNet B349 Loeb 1125 Colonel By Drive Ottawa ON K1S 5B6 613.520.2600 Ext. 2510 tristan.maclean@carleton.ca	Financial Services Attention: Carole Chaput Manager Research Accounting 10th Fl, Rm L-1012, R.D. Parker Bldg 935 Ramsey Lake Road Sudbury ON P3E 2C6 705.675.1151 ext 3037 CChaput@laurentian.ca

Royal Military College of Canada	Simon Fraser University
Payment to: Royal Military Colleges Foundation Attn: Nancy Marr P.O. Box 17000 – Stn Forces Kingston ON K7K 7B4 613.541.6000 nancy.marr@rmc.ca	Gabriella Por VP Research Office 2 Discovery, Room 230 8888 University Drive Burnaby BC V5A 1S6 778.782.9218 gabriella_por@sfu.ca
Université de Montréal	Université de Montréal
Meryem Gharbi Agente admin et recherche Bureau de recherche institutionnelle P.O. Box 6128, Centre ville Montreal QC H3C 3J7 514.242.6111 poste 38495 meryem.gharbi@umontreal.ca	Chef de section Fonds de recherche Direction des finances Expertise comptable et formation 514.343.6111, poste 4192

Pascal Fortin 514.343.6111 poste 8974 pascal.fortin.2@umontreal.ca	
University of Alberta	University of Calgary
Julaine Herst Assistant Director, Contracts & Agreements 222 Campus Tower Edmonton AB T6G 2E1 780.492.5787 julaine.herst@ualberta.ca	Danielle Demiantschuk Research Grants and Ptrshps Offcr 2500 University Drive, NW Calgary AB T2N 1N4 403.210.5459 danielle.demiantschu@ucalgary.ca
University of Ottawa	University of Victoria
Paul Bélanger Assistant Director University of Ottawa Research Management Services Tabaret Hall, room 159 550 Cumberland St. Ottawa ON K1N 6N5 613.562.5800 Ext. 1240 **paul.belanger@uottawa.ca**	Debra Anderson Manager Research Finances Office of Research Services University of Victoria Room B219, Michael Williams Building, 3800 Finnerty Rd. (Ring Road) Victoria BC V8P 5C2 orsfince@uvic.ca

University of Waterloo	
Cheques payable to University of Waterloo Central Finance East Campus 5, 4th Floor University of Waterloo 200 University Avenue West Waterloo, ON N2L 3G1 Please include the name of UW Co-Investigator "Dr. Claude Duguay" and Reference number "WO# 51521-10006". **sandrianasolo@uwaterloo.ca**	

Appendix D.4 For cash and in-kind contributions from Partners:

Carleton University	Laurentian University of Sudbury
Tristan MacLean Director of Operations NSERC PermafrostNet B349 Loeb, 1125 Colonel By Drive Ottawa ON K1S 5B6 613.520.2600 Ext. 2510 tristan.maclean@carleton.ca	Lise Carrière Research Contracts Officer Office Research Services 935 Ramsey Lake Road Sudbury ON P3E 2C6 705.675.1151 Ext. 2429 lncarriere@laurentian.ca
Royal Military College of Canada	Simon Fraser University

Kenneth Rochon Research Administration Comptroller's Office P.O. Box 17000 – Stn Forces Kingston ON K7K 7B4 613.541.6000 Ext. 6372 ken.rochon@rmc.ca	Gabriella Por VP Research Office 2 Discovery, Room 230 8888 University Drive Burnaby BC V5A 1S6 778.782.9218 gabriella_por@sfu.ca
Université de Montréal	University of Alberta
Pascal Fortin Chef de section - Administration des fonds Bureau de recherche institutionnelle P.O. Box 6128, Centre ville Montreal QC H3C 3J7 514.343.6111 poste 8974 pascal.fortin.2@umontreal.ca	Julaine Herst Assistant Director, Contracts & Agreements 222 Campus Tower Edmonton AB T6G 2E1 780.492.5787 julaine.herst@ualberta.ca
University of Calgary	University of Ottawa
Danielle Demiantschuk Research Grants and Ptrshps Offcr 2500 University Drive, NW Calgary AB T2N 1N4 403.210.5459 danielle.demiantschu@ucalgary.ca	Nizar Ben Sedrine Assistant Director Financial Resources Tabaret Hall, W030B 550 Cumberland St. Ottawa ON K1N 6N5 613.562.5800 Ext. 1512 nizar@uottawa.ca
University of Victoria	University of Waterloo
Melissa Joyce Manager, Research Accounting University of Victoria Michael Williams Building, Room B115 3800 Finnerty Road Victoria, B.C., V8P 5C2 Telephone: 250.472.4157 Fax: 250.472.4781 meljoyce@uvic.ca	Sarindra Andiranasolo, M.Sc. Grants and Contracts Manager EC5 3043 A 200 University Avenue West Waterloo, ON, Canada N2L 3G1 519.888.4567 Ext. 39104 **sandrianasolo@uwaterloo.ca**
BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development (FLNROD)	BGC Engineering Inc. (BGC)
Alexandre (Alex) Bevington Research Hydrologist, Omineca Region 499 George St., 5th Floor Prince George BC V2L 1R5 250.561.3460 Alexandre.Bevington@gov.bc.ca	Lukas Arenson Senior Geotechnical Engineer Suite 500 – 980 Howe Street Vancouver, BC Canada V6Z 0C8 604.684.5900 Ext. 41116 larenson@bgcengineering.ca
Churchill Northern Studies Centre (CNSC)	Environment and Climate Chanage Canada, Atmospheric Science and Technology Directorate (ASTD)
Graham Neale Executive Director 1 Launch Road Box 610 Churchill MB. R0B 0E0 204.675.2307 ed@churchillscience.ca	Anne Walker Manager, Climate Research Division Science and Technology Branch 4905 Dufferin Street Toronto ON M3H 5T4 416.739.4357 anne.walker@canada.ca

Environment and Climate Change Canada, Canadian Centre for Climate Services (CCCS)	Federation of Canadian Municipalities (FCM)
Lo Chiang Cheng Executive Director 200 Blvd. Sacre-Coeur Gatineau QC K1H 0H3 819.938.3886 lo.cheng@canada.ca	Sara Jane O'Neill Federation of Canadian Municipalities 24 Clarence Street Ottawa ON. K1N 5P3 343.925.6474 sjoneill@fcm.ca
Fort Severn First Nation	Government of Nunavut: Climate Change Secretariat
Paul Burke Chief P.O. Box 149 Fort Severn ON. P0V 1W0 807.478.2572 paulburkefso@gmail.com	Sara Holzman Acting Director P.O. Box 1000, Stn. 1360 Iquluit NU. X0A 0H0 867.975.7733 sholzman@gov.nu.ca

Government of Northwest Territories; Environment and Natural Resources (ENR)	Gwich'in Renewable Resources Board (GRRB)
Bruce Hanna Advisor, Regional Science Programs P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9232 Ext. 53055 Bruce_Hanna@gov.nt.ca	Amy Amos Executive Director P.O Box 2240 Inuvik NT X0E 0T0 867.777.6600 Ext. 2 aamos@grrb.nt.ca Sarah Lord Fisheries & Forestry Biologist P.O. Box 2240 Inuvik NT X0E 0T0 867.777.6600 Ext. 4 slord@grrb.nt.ca
Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)	Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)
Yu Zhang Research Scientist, Canada Centre for Mapping and Earth Observation 560 Rochester Street Ottawa ON K1S 5K2 613.759.6024 yu.zhang@canada.ca Robert Fraser Research Scientist, Canada Centre for Mapping and Earth Observation robert.fraser@canada.ca	Linda Ham Chief Geologist, Canada-Nunavut Geoscience Office 1106 Inuksagait Plaza P.O. Box 2319 Iqaluit NU. X0A 0H0 867.975.4412 linda.ham@canada.ca
Her Majesty the Queen in Right of Canada, as Represented by the Minister of Natural Resources (NRCan)	Inuvialuit Game Council (IGC)
Catherine Ste-Marie Manager, Geological Survey of Canada	Davonna Kasook P.O. Box 2120

601 Booth Street Ottawa ON K1A 0E8 613.790.6857 catherine.ste-marie4@canada.ca	Inuvik NT X0E 0T0 867.777.2828 igc-rp@jointsec.nt.ca
MDA Geospatial Services Inc. (MDA)	Ministère des Transports du Québec Direction générale des projets et de l'exploitation aéroportuaires
Heidi Harms Manager, Contracts/Subcontracts 13800 Commerce Parkway Richmond BC V6V 2J3 604.231.2968 heidi.harms@mda.space	Anick Guimond Coordinatrice – Changements climatiques (le Nord) 26, rue Monseigneur Rhéaume Est, 2e étage Rouyn-Noranda QC J9X 3J5 819.763.4080, poste 46806 anick.guimond@transports.gouv.qc.ca
National Research Council (NRC)	Government of Northwest Territories, Department of Infrastructure (DOI)
Cameron McCartney Senior Innovation Coordinator 613.993.9775 cameron.mccartney@nrc-cnrc.gc.ca Anne Barker Arctic Program Lead 1200 Montreal Road Ottawa ON K1A 0R6 613.796.2511 anne.barker@nrc-cnrc.gc.ca	Jeffrey Dawe Departmental Capital Planner, Infrastructure 4th Floor, New Government Building P.O. Box 1320 Yellowknife NT X1A 2L9 jeffrey_dawe@gov.nt.ca Nicole Hannah Nicole_Hannah@gov.nt.ca 867.767.9045 Ext. 32005
Northwest Territories Geological Survey (NTGS)	Ontario Ministry of Natural Resources and Forestry (MNRF)
Steve Kokelj Permafrost Scientist P.O. Box 1320 Yellowknife NT X1A 2L9 867.767.9211 Ext. 63214 Steve_Kokelj@gov.nt.ca Kumari Karunaratne Manager, Geoscience Information Servicies 4601-B 52 Avenue Yellowknife, NT X1A 2R3 867.767.9211 Ext. 63213 Kumari_Karunaratne@gov.nt.ca	Jim McLauglin Forest Soils Research Scientist Ontario Forest Research Institute 1235 Queen Street, East Sault Ste. Marie ON. P6A 2E5 705.946.7418 jim.mclauglin@ontario.ca
SRK Consulting (U.S.) Inc. (SRK)	Standards Council of Canada (SCC)
Christopher Stevens Senior Geocryologist 110901 Business Blvd., Suite 110 P.O. Box 770401 Eagle River, AK USA 99577 907.301.8718 cstevens@srk.com	Brady Allin Manager, Infrastructure and Climate Change Program 600 – 55 Metcalfe Street Ottawa ON Canada K1P 6L5 613.238.3222 Ext. 464 brady.allin@scc.ca
Tr'ondëk Hwëch'in Government (THG)	Transport Canada (TC)

Alice McCulley Fish and Wildlife Projects Coordinator P.O. Box 599 Dawson YT Y0B 1G0 867.993.7100 Ext. 240 alice.mcculley@trondek.ca Kirsten Scott Manager, Lands and Resources Branch P.O. Box 599 Dawson YT Y0B 1G0 867.993.7100 Ext. 105 Kirsten.Scott@trondek.ca	Jenna Craig Senior Advisor, Northern Transportation Adaptation Initiative 330 Sparks Street, 26th Floor (ACS) Place de Ville, Tower C Ottawa ON K1A 0N5 613.993.3455 Jenna.Craig@tc.gc.ca Catherine Kim Manager, Northern Transportation Adaptation Initiative 330 Sparks Street, 26th Floor (ACS) Place de Ville, Tower C Ottawa ON K1A 0N5 613.991.0867 catherine.kim@tc.gc.ca
Yukon Government: Department of Environment (YG-DE)	Yukon Government: Transportation Engineering Branch (TEB)
Maxine White Adaptation Analyst 10 Burns Road Whitehorse YT Y1A 4Y9 867.667.7971 Maxine.White@gov.yk.ca	Muhammad Idrees Manager, Geotechnical Program 461 Range Road Whitehorse YT Y1A 3A4 867.667.8820 Muhammad.Idrees@gov.yk.ca
Yukon Government: Yukon Geological Survey (YGS)	Yukon Government: Yukon Parks
Julie Minor Finance & Operations Manager P.O. Box 2703 (K-14) Whitehorse YT Y1A 2C6 867.667.8508 julie.minor@gov.yk.ca Carolyn Relf Director carolyn.relf@gov.yk.ca	Jean Langlois Manager, Park Planning P.O. Box 2703, V-4 Whitehorse YT Y1A 2C6 867.456.6761 jean.langlois@yukon.ca Mike Etches Director Mike.etches@yukon.ca

APPENDIX E

NETWORK GOVERNANCE DOCUMENTS

In Accordance with Section 5 of the Agreement, the administrative structure of the Network shall be composed of seven (7) main components: 1) the Board of Directors (BOD), 2) the Scientific Committee (SC), 3) the Knowledge Mobilization and Communications Committee (KMCCom), 4) the Equity, Diversity and Inclusion Committee (EDIC), 5) the Network Director (also known as Principal Investigator and Chair of the SC), 6) the Director of Operations, and 7) the Theme Leaders, and whose responsibilities are defined hereinafter.

Appendix E.1 Board of Directors

The Board of Directors (BOD) shall reflect the interests and concerns of the public, private and academic sectors involved in the Network and have overall responsibility for the management, direction and accountability of Network activities.

1.1 The BOD, with input from the Scientific Committee will provide:

1.1.1 Leadership by:

1.1.1.1 Overseeing management and decision making;

1.1.1.2 Implementing a framework and monitoring measures to advance equity, diversity and inclusion;

1.1.1.3 Maximizing the relevance of network research and its external support; and

1.1.1.4 Recruiting and approving new partners.

1.1.2 Scientific leadership through:

1.1.2.1 Monitoring of research progress on project milestones toward Network objectives;

1.1.2.2 Approval of annual research project plans;

1.1.2.3 Approval of additional projects or termination of projects within years;

1.1.2.4 Approval of additional Network Investigators as necessary;

1.1.2.5 Approval of research reports to NSERC, contributing partners and Research Network members; and

1.1.2.6 Allocation of funding to Network Research projects.

1.1.3 Financial accountability to NSERC and contributing Partners through:

1.1.3.1 Approval of annual Network budgets;

1.1.3.2 Approval of within-year reallocations between projects as requested by Network Researchers and/or the Scientific Committee; and

1.1.3.3 Approval of financial reports.

1.2 The Network Director shall be responsible for appointing the initial members of the BOD and its initial Chair. The Parties acknowledge that NSERC must approve the overall composition of the BOD and must be advised of the membership of the BOD and of any changes in membership during the term of the Grant.

1.3 The Chair must not be affiliated with any organization that can obtain direct funding from the Network.

1.4 For replacement of a Board member, a duly constituted Nominations Committee of not more than four (4) Board members, one of which must be the Network Director, shall submit the name of a candidate to the BOD for discussion and action. The Nomination Committee shall submit the proposed new Board member to NSERC for final approval.

1.5 The normal term of a Network Investigator on the BOD shall be one year and renewable. The term for the other members of the Board will be staggered two (2) and (3) year renewable terms. The terms are indicated in brackets in the table below.

1.6 The term of the Chair is multi-year, to be confirmed annually, up to five (5) years.

1.7 The membership of the BOD must reflect the interest and concerns of the public, private and academic sectors involved in the Network.

1.7.1 At the outset, the NSERC approved Board will consist of eleven (11) voting members and two (2) non-voting members.

1.7.2 Voting members include representatives from the partner organizations, the Chair of the Scientific Committee, one Network Investigator, and two external members.

1.7.3 Initial composition of the members of the BOD will be:

Board of Directors (BOD) Length of renewable term indicated by (X)	
Role	**Initial name, affiliation and mandate duration**
Chair - External Member	Janet King – Public Service and Procurement Canada (5)
Industry Partner Organization Representative	Lukas Arenson – BGC Engineering Inc. (2)
Provincial Government Representative	Anick Guimond – Ministère des Transport du Québec (2)
Nunavut Government Representative	Linda Ham – Canada-Nunavut Geoscience Centre (3)
Indigenous Partner Representative	Lawrence Ruben – Inuvialuit Game Council (3)
NWT Government Representative	David Moore – Govt. of NWT: Dept. of Infrastructure (2)
Federal Government Representative	Megan Nichols – Transport Canada (3)
Yukon Government Representative	Carolyn Relf – Yukon Govt.: Yukon Geological Survey (3)
Network Director	Stephan Gruber – Carleton University
Network Investigator	Duane Froese – University of Alberta (1)
External Member	Pending (2)
Non-Voting Member	Tristan MacLean (Director of Operations) - Carleton University
Non-Voting Member	Lynda Wood (NSERC Manager) – Natural Sciences and Engineering Research Council

1.7.4 The Director of Operations will attend the Board meetings as a non-voting member and for Board support.

1.7.5 An NSERC Manager will attend the Board meetings as a non-voting member.

1.8 Each voting member shall have one vote.

1.9 BOD members shall not receive remuneration for the performance of their duties. Expenses of members representing network supporting organizations are considered in-kind contribution; external members may claim appropriate expenses.

1.10 The BOD will hold at least two (2) meetings per year; one of which must be held in person and the other meeting held in person or by video- or teleconference.

1.11 Attendance at a meeting of the BOD, in person or by video- or teleconference, by more than one-half of the voting Directors shall constitute a quorum. There is no provision for voting by proxy.

Appendix E.2 Scientific Committee

The Scientific Committee (SC) shall support the Scientific Director in providing scientific leadership for enabling and sustaining excellence in network research and training. In addition the SC shall support the development of strategy and direction for keeping network research and training relevant to stakeholders, managing the research and training program synergistically, producing network-level outputs, and such other duties as the Board of Directors (BOD) may determine.

2.1 The Scientific Committee shall have the following responsibilities:

2.1.1 To review, challenge and recommend to the BOD through the SC Chair:

2.1.1.1 Research and financial reports from co-applicants;

2.1.1.2 External assessment of network project reports if necessary;

2.1.1.3 Annual research project plans, addition or termination of project;

2.1.1.4 Priorities for the Network Data Scientist and the data policy;

2.1.1.5 Annual allocation of funding to network research projects;

2.1.1.6 Addition or termination of network investigators or partners; and

2.1.1.7 Endorsements of external research proposals and/or liaison plans.

2.1.2 Synthesize results into a final report at the conclusion of the Network.

2.2 The Network Director, in consultation with the Network Investigators, shall be responsible for appointing the intial members of the Scientific Committee. The Parties acknowledge that NSERC must approve the overall composition of the SC. The BOD shall approve subsequent members of the SC and advise NSERC of the membership of the SC and of any changes in membership during the term of the Grant.

2.3 The normal term of a Network Investigator on the SC shall be one (1) year and renewable. The term for the other members of the SC will be staggered two (2) and (3) year renewable terms. The terms are indicated in brackets in the table below.

2.4 The membership of the SC shall represent the multi-sectoral and multidisciplinary Network.

2.4.1 At the outset, the NSERC approved SC will be composed of seven (7) voting members and two (2) non-voting members.

2.4.2 Voting members include three (3) Network Investigators, one (1) representative from a partner organization, one (1) member external to the Network from Canada and one (1) international member. Network Investigators will include the Network Director who shall act as Chair of the SC. While the Canadian Consortium for Arctic Data Interoperability (CCADI) is a stakeholder, one of their members was considered to be an external member of the SC. As Peter Pulsifer has been offered a position at Carleton University and is no longer external, he is now considered an additional member of the SC as CCADI liaison.

2.4.3 Initial composition of the Scientific Committee will be:

Scientific Committee (SC) Length of renewable term indicated by (X)	
Role	**Initial name, affiliation and mandate duration**
Chair – Principal Investigator	Stephan Gruber – Carleton University
External International	Ted Schuur – Northern Arizona University (3)
CCADI Liaison	Peter Pulsifer – Carleton University (2)
External National	Christine Dow – University of Waterloo (2)
Partner	Fabrice Calmels – Yukon Research Centre (3)
Network Investigator	Jocelyn Hayley – University of Calgary (1)
Network Investigator	Pascale Roy-Léveillée – Laurentian University of Sudbury (1)
Non-Voting Member	Director of Operations – Tristan MacLean – Carleton University
Non-Voting Member	NSERC Manager - Lynda Wood – Natural Sciences and Engineering Research Council of Canada

2.4.4 The Director of Operations will attend all SC meetings as an observer and for committee support.

2.4.5 An NSERC Manager will attend SC meetings as an observer.

2.5 Each voting member shall have one vote.

2.6 SC members shall not receive remuneration for the performance of their duties. Expenses of members representing network supporting organizations, are considered in-kind contribution; external members may claim appropriate expenses.

2.7 The SC will meet at least twice per year prior to each major BOD meeting to finalize their report to the Board and more frequently if required. Meetings may be held in person, or by video- or teleconference.

2.8 Attendance at a meeting of the SC, in person or by video- or teleconference, by more than one-half of the voting members shall constitute a quorum. There is no provision for voting by proxy.

Appendix E.3 Knowledge Mobilization and Communications Committee

The Knowledge Mobilization and Communications Committee (KMCCom) will ensure adequate two-way communication between network participants and partners at all stages of research design and implementation, and communication of results in a format well suited to the user groups' needs as defined in the proposal (Appendix A).

3.1 Reporting to the Director of Operations, the KMCCom will have the following duties:

3.1.1 Develop and execute a 5-year strategic knowledge mobilization and communications plan to outline objectives, audience groups, key messages and activities designed to promote the research results and the success of the network.

3.1.2 Develop the annual workplan.

3.1.3 Provide strategic communications advice and support to the members of the network.

3.1.4 Oversee the coordination of the planning, strategy, and execution of communications and knowledge mobilization efforts required to promote the work of the network.

3.1.5 Provide support to the Knowledge Moblization and Communications Coordinator (also known as Knowledge Broker).

3.1.6 Liaise with members by providing a standard for communications issues and questions.

3.1.7 Promote the work of the network and facilitate the mobilization of the knowledge and outcomes of the network's initiatives.

3.1.8 Prepare and submit the annual report to the Director of Operations for review. The reviewed report will be presented to the Board of Directors by the Knowledge Broker for information, discussion and approval.

3.2 The Network Director shall be responsible for appointing the intial members of the KMCCom. The Knowledge Broker, in consultation with the Chair of the Committee, will recruit subsequent members for the committee. The Board of Directors shall approve members of the KMCCom and the Director of Operations will advise NSERC of the membership of the KMCCom and of any changes in membership during the term of the Grant.

3.3 The term of the Chair and the Knowledge Broker shall be one (1) year and renewable. The term for the other members of the KMCCom will be staggered two (2) and (3) year renewable terms. The terms are indicated in brackets in the table below.

3.4 The membership of the KMCCom will be comprised of one partner, one industry partner, one Indigenous partner, one government partner, a knowledge broker and it will be chaired by a senior communications professional from the Office of the Vice-President (Research and International) at Carleton University.

3.4.1 At the outset, the KMCCom will be composed seven (7) voting members.

3.4.2 Voting members include at least one (1) network participant, one (1) industry partner, one (1) government partner, one (1) indigenous partner, a part time knowledge broker, and the Chair.

3.4.3 Initial composition of the KMCCom will be:

Knowledge Mobilization and Communications Committee (KMCCom) Length of renewable term indicated by (X)	
Role	**Initial name, affiliation and mandate duration**
Chair – Communications Officer	Kathryn Elliott – Carleton University (1)
Network Participant	LeeAnn Fishback – Churchill Northern Studies Centre (3)
Government	Peter Morse – NRCan (2)
Industry	Eduardo Marquez – SRK Consulting (U.S.), Inc.(2)
Indigenous organization or government	Kumari Karunaratne – Northwest Territories Geological Survery (3)
Knowledge Broker	Pending (1)
Government	Pending (3)
Indigenous partner	Pending (2)

3.4.4 The Knowledge Broker will attend all KMCCom meetings and provide committee support.

3.5 Each voting member shall have one vote.

3.6 KMCCom members shall not receive remuneration for the performance of their duties. Expenses of members representing network supporting organizations are considered in-kind contributions; external members may claim appropriate expenses.

3.7 The KMCCom will meet quarterly and more frequently if required. Meetings may be held by video- or teleconference, or in person in conjunction with the Annual General Meeting.

3.8 Attendance at a meeting of the KMCCom, in person or by video- or teleconference, by more than one-half of the voting members shall constitute a quorum. There is no provision for voting by proxy.

Appendix E.4 Equity, Diversity and Inclusion Committee

Network participants will be invited to form an Equity, Diversity and Inclusion Committee (EDIC).

4.1 The role of the committee will be to perform annual equity and diversity surveys and be a point of contact for concerns. The results of the survey will be reported to the BOD and SC via the Director of Operations. The committee will assist with devising appropriate strategies to address any identified challenges.

4.2 The EDIC, with the support of Equity Services at Carleton University and the Director of Operations will develop a framework for equity, diversity and inclusion in the network. The framework will guide the BOD in the finalization of a governance model, support the Director of Operations in designing the Standard Operating Procedures and outline:

4.2.1 A shared understanding of what is meant by equity, diversity and inclusion in the network;

4.2.2 A plan for how issues will be addressed;

4.2.3 Goals, tactics and measures;

4.2.4 An on-boarding process for any new members that might join; and

4.2.5 A strategy for communication of the framework to the network, especially to all committees.

4.3 The EDIC will self-report its members to the Director of Operations.

4.4 Priority to serve on the committee will be given to any network members who is part of an underrepresented group who expresses an interest in joining. Network members are invited to join the committee, rather than being appointed.

4.4.1 Initial composition of the EDIC will be:

Equity, Diversity and Inclusion Committee (EDIC)	
Role	**Initial name, affiliation and mandate duration**
Carleton Representative	Kate Swan – Carleton University
Chair - Network Participant	Kala Pendakur – Standards Council of Canada
Indigenous Partner Representative	Pending
Co-Investigator	Pascale Roy-Léveillée – Laurentian University of Sudbury
Director of Operations	Tristan MacLean – NSERC PermafrostNet

4.4.2 The Director of Operations will attend all EDIC meetings and provide committee support.

4.5 Each voting member shall have one vote.

4.6 EDIC members shall not receive remuneration for the performance of their duties. Expenses of members representing network supporting organizations are considered in-kind contributions; external members may claim appropriate expenses.

4.7 The EDIC will meet at least once annually, and more frequently if required. Meetings may be held by video- or teleconference, or in person in conjunction with the Annual General Meeting.

4.8 Attendance at a meeting of the EDIC, in person or by video- or teleconference, by more than one-half of the voting members shall constitute a quorum. There is no provision for voting by proxy.

Appendix E.5 Network Director

The Network Director, who will act as Chair of the Scientific Committee, shall report to the Board of Directors.

5.1 The Network Director shall have the following responsibilities:

5.1.1 Providing Scientific/management leadership and direction to the network;

5.1.2 Recruiting a Director of Operations;

5.1.3 Suggesting new projects, partners, of network participants to the Scientific Committee;

5.1.4 Promoting continuous, dynamic, and constructive interactions among the co-applicants, the partners, the theme leaders, the members of the Board and Committees;

5.1.5 Promoting and representing the Network to the scientific community, the private and public sectors and the general public;

5.1.6 Maintaining the focus of the activities of the network;

5.1.7 Producing and transmitting annual, mid-term, and final progress and/or financial reports to the co-applicants, the partners, the members of the Board and Committees, and NSERC.

Appendix E.6 The Director of Operations

The Director of Operations provides the leadership and direction of the Network's non-technical operations and ensures control and financial management on a day-to-day basis. The Director of Operations reports to the Network Director.

6.1 The Director of Operations shall be responsible for:

6.1.1 Organizing and coordinating meetings of the BOD and of the Committees, with assistance from the Knowledge Mobilization and Communications Coordinator as assigned, and implementing their decisions;

6.1.2 Managing the disbursement of Network funds by Carleton University to the University Network Partners based on operating plans and budgets approved by the Board;

6.1.3 Partner relations, as the interface between the Network Supporting Organizations and the University Network Partners;

6.1.4 Creating an environment that enhances the collective training experiences of the Highly Qualified Personnel (HQP) involved in the network;

6.1.5 Compliance with the Network's policies, guidelines and regulations;

6.1.6 Development and execution of an effective communications plan. Publicizing and promoting the successes of The Network to the scientific community, policy makers and the general public;

6.1.7 Overseeing the preparation of progress and financial reports in accordance with NSERC requirements;

6.1.8 Overseeing organization and coordination of the Annual General Meeting of the

Network;

6.1.9 Overseeing the flux of administrative data and information across the entire Network; and

6.1.10 Organizing special information sessions for HQP career development and facilitating HQP networking events to ensure trainees have ample opportunities to engage and interact with each other as of means of building the critical connections and relationships needed for effective and ongoing teamwork.

Appendix E.7 The Theme Leaders

The Theme Leaders will support the the integration of HQP projects and connection of research teams towards the accomplishment of common objectives.

7.1 The Theme Leaders shall be responsible for:

7.1.1 Coordinating the activities amongst the various research groups within the Theme;

7.1.2 Working with the Network Director to ensure that activities across all the Themes remain coordinated; and

7.1.3 Supporting the Network Director with the scientific management of the Network.

Appendix E.8 Annual General Meeting

The Network will hold an Annual General Meeting. It is the intent that this event will align with other prominent partner organization events whenever possible to increase the effectiveness of communication and reduce costs and carbon emissions. Alternating between northern and southern locations will provide opportunities to partner and interact with as many partners and participants as possible as well as to build connections with the permafrost community at large and with personnel at partner organizations.

Appendix E.9 Partner and Highly Qualified Personnel Engagement

A number of joint meetings are foreseen as outlined in the support letters from collaborating national and international initiatives. As with the Annual General Meetings, to increase the effectiveness of communication and reduce costs and carbon emissions, the locations for joint meetings will alternate and will include video- or teleconference meetings and northern, southern and international locations, as approved by the Board of Directors.

APPENDIX F

Appendix F.1 Allocation of Network Funds to University Network Partners

The Network funds for each year will be allocated to each University Network Partner based on number of students and salaries indicated in the NSERC proposal as required and approved by the Board annually, and subject to the spending reported in the Statement of Account.

In the event that less than half of the previously transferred funds had not been spent at the end of March, a second Statement of Account from the University Network Partner will be required, at such a time when more than 50% of the previous transfer(s) had been spent. Once the 50% spending threshold has been established, the next year's funds will be transferred.

Appendix F.2 Template for Network FUNDS TRANSFER AGREEMENT

Transfer of Funds Agreement Between Carleton University "Primary Institution" and University of X "Collaborating Institution"	
Date:	
Principal Investigator (Carleton University):	Stephen Gruber
Co-Investigator (Collaborating Institution):	
Funding Agency:	NSERC
Funding Agency Reference Number:	NETGP-523228-18
Carleton University Fund Number:	319653
Project Title:	NSERC Permafrost Partnership Network for Canada
Grant Period:	June 30, 2019 – June 29, 2024
Sub-Grant Period:	April 1, XXXX - March 31, XXXX
Amount:	
Use of Funds:	

General Terms and Conditions:

By signing and returning this Agreement to the Primary Institution, the Collaborating Institution agrees to abide by the conditions herein:

2.1 This award shall be administered in accordance with the policies and procedures of the Tri-Agency, including but not limited to, the *Agreement on the Administration of Agency Grants and Awards by Research Institutions "The Agreement"* (http://www.science.gc.ca/default.asp?lang=En&n=56B87BE5-1) to which the recipient institution is a signatory, and the *Tri-Agency Financial Administration Guide* which may be found on their website at https://www.nserc-crsng.gc.ca/InterAgency-Interorganismes/TAFA-AFTO/guide-guide_eng.asp

2.2 The Collaborating Institution may not disburse any funds until all applicable compliance certificates (e.g., human, animal, and/or biohazard) have been obtained. Collaborating

Institution must ensure that applicable certificates are maintained, in accordance with the provisions of *The Agreement*, for the duration of the grant period.

2.3 Prior approval from the Primary Institution is required to make any significant changes to the project plans. All expenses incurred must be eligible according to agency guidelines and related to the objectives for which the project was awarded funding. Carleton University accepts no responsibility or obligation for funds expended in excess of the amount quoted above or funds expended before or after the Grant Period.

2.4 Each party shall be responsible for its negligent acts or omissions and the negligent acts or omissions of its employees, officers, or directors, to the extent allowed by law.

2.5 Any equipment purchased with the sub-granted funds remains the property of the Collaborating Institution, and not the individual researcher. Equipment may be purchased using funds allocated in the budget as equipment. Equipment may not be purchased using funds allocated for HQP or Postdoc salaries.

2.6 The Collaborating Institution may not issue a sub-grant of this award.

An accountable advance payment will be issued to the Collaborating Institution upon receipt of the fully executed Agreement.

FUND TRANSFER INSTRUCTIONS to be provided by the Collaborating Institution

An annual Statement of Account (Form 300), reporting on the period ending March 31st, must be returned by April 30th of each year to the attention of:

Erin Feltmate
Research Financial Services
Erin.Feltmate@carleton.ca

301 Robertson Hall
Carleton University
1125 Colonel By Drive, Ottawa, ON, K1S 5B

A brief annual narrative report form (template will be provided) on each research project, including a description of HQP, research progress, results, deliverables, future HQP requirements, and any concerns, (and potentially other touch points for the purposes of reporting to the Network's Board of Directors), must be submitted twice annually (by email) by March 31st and September 30th of each year to the attention of:

Tristan MacLean
Director of Operations
tristan.maclean@carleton.ca

Carleton University
1125 Colonel By Drive, Ottawa, ON, K1S 5B

Future institutional transfers will occur annually, or bi-annually, based on the Board of Director's approved budget for that fiscal year and may be adjusted based on progress, amount spent from previous transfers, and any changes to the scientific direction recommended by the Board.

Future payments may be withheld if the above-mentioned Form 300 or narrative report are not

received in a timely manner, or the balance reported on the Form 300 is more than 50% of previous transfers. In the latter case, a second Form 300 may be requested at a later date to justify the transfer of funds.

Unspent funds may be carried over from one year to the next until the end of the Grant Period, subject to confirmation of budget plans with the Principal Investigator. Any unspent balance remaining at the end of the Grant Period must be returned to the University with the final Form 300 Statement of Account.

The Collaborating Institution agrees to keep complete and accurate records on the use of Agency funding, including verifiable audit trails with complete supporting documentation for each transaction, for at least seven years and make the records available to the University, upon reasonable notice.

This Agreement may be executed in any number of counterparts by the parties hereto in separate counterparts, each of which when so executed shall be deemed to be an original and all of which taken together shall constitute one and the same agreement. Delivery by facsimile or by electronic transmission in portable document format (PDF) of an executed counterpart of this Agreement is as effective as delivery of an originally executed counterpart of this Agreement.

Agreed and accepted:

Carleton University _____ Andrea Lawrance _____ Date Director,CORIS	By Authorized Official of **Collaborating Institution**: _____ Name _____ Date _____ Title

By Principal Investigator OR Co-Investigator of Carleton University: _____ Stephen Gruber _____ Date Professor, Department of Geography and Environmental Studies	By Principal Investigator OR Co-Investigator of **Collaborating Institution**: _____ Name _____ Date _____ Title

APPENDIX G

NEW PARTNER ACCESSION AGREEMENT

BETWEEN

CARLETON UNIVERSITY, a Canadian university with principal offices at 1125 Colonel By Drive, Ottawa, Ontario, K1S 5B6, and herein acting and represented by its duly authorized representatives, (the "Lead Institution")

AND

(NAME), (description of the organization) with its head office at (address), and herein acting and represented by its duly authorised representative(s) (hereinafter referred to as the "**New Partner**")

WHEREAS Carleton, as the Lead Institution and in collaboration with the University Network Partners (as defined in Section 2. u.) and with the Network Supporting Organizations (as defined hereinafter in Section 2. m.), has submitted a proposal to the Natural Sciences and Engineering Research Council's ("**NSERC**") Strategic Partnership Grants for Networks program entitled **"NSERC PermafrostNet: NSERC Permafrost Partnership Network for Canada"** (the "**Application**")

WHEREAS NSERC has selected the Application to receive funding under the Strategic Partnership Grants for Networks Program, grant number NETGP 523228-18 and has approved the establishment of NSERC PermafrostNet as proposed in the Application (the "**Network**").

WHEREAS the Parties have established and defined their respective rights, obligations, contributions and interests as well as the requisite modus operandi for carrying out the Network under an agreement with an effective date of (DATE) (the "**Agreement**");

WHEREAS the Network's Board has, in accordance with Section 18.4 of the Agreement, approved the addition of the New Partner in the Network;

WHEREAS the parties to the Agreement have authorized the Host Institution to enter into this New Partner Accession Agreement (the "**Accession Agreement**") on behalf of the parties to the Agreement.

ACCORDINGLY, the Lead Institution and the New Partner agree as follows:

1. The signature of the New Partner hereto confirms that the New Partner: i) wishes to join the Network; and ii) has read, understood and agrees to be become a Party to the Agreement and to be bound by the terms and conditions of the Agreement.
2. TABLE B
3. The New Partner has agreed through a letter of support, attached hereto as Schedule 1, to make a contribution to the Network in the form of (specify cash and in-kind) in return for the rights provided for under the Agreement.

4. As determined by the Network's Board of Directors, the New Partner shall be bound by the Agreement from XX to the end of the Agreement, or on dissolution of the Network, whichever comes first.
5. All notices, requests, consents and other communications to the New Partner required under the Agreement shall be sent to the New Partner's contact as set forth in Schedule 2 to this Accession Agreement.
6. The preamble and Schedules 1 and 2 hereto form an integral part of this Accession Agreement.

CARLETON UNIVERSITY

_____
Name:
Title:

Date: _____

_____
[NAME OF NEW PARTNER]

Name: _____

Title: _____

Date: _____

SCHEDULE 1 TO ACCESSION AGREEMENT: NEW PARTNER BUDGET

Network Supporting Organization	Contributions
	Cash/In-Kind
New Partner Name:	
Total	

SCHEDULE 2 TO ACCESSION AGREEMENT: NEW PARTNER CONTACTS

For Network Contractual Matters Contact:
Name:
Title:
Address:
Tel:
Email:

For Scientific Matters Contact:
Name:
Title:
Address:
Tel:
Email:

For Funds Transfers Partner University Contact:
Name:
Title:
Address:
Tel:
Email:

For Cash and In-kind contributions from Partners Contact:
Name:
Title:
Address:
Tel:
Email:

APPENDIX B: Terms of Reference for NSERC PermafrostNet Board of Directors

Terms of Reference: NSERC PermafrostNet Board of Directors

Purpose

To **reflect the interests and concerns** of the public, private and academic sectors involved in the Network.

Responsibilities

Overall responsibility for the management, direction and fiduciary accountability of the Network.

The Board, with input from the Scientific Committee will:

1. Provide leadership by:
    a. Overseeing management and decision making;
    b. Implementing a framework and monitoring measures to advance equity, diversity and inclusion;
    c. Maximizing the relevance of network research and its external support; and
    d. Recruiting and approving new partners.
2. Provide scientific leadership through:
    a. Monitoring of research progress on project milestones toward Network objectives;
    b. Approval of annual research project plans;
    c. Approval of additional projects or termination of projects within years;
    d. Approval of additional Network Investigators as necessary;
    e. Approval of research reports to NSERC, contributing partners and Research Network members; and
    f. Allocation of funding to Network Research projects.
3. Provide financial accountability to NSERC and contributing Network Partners through:
    a. Approval of annual Network budgets;
    b. Approval of within-year reallocations between projects as requested by Network Researchers and/or the Scientific Committee; and
    c. Approval of financial reports.

Membership

The multi-sectoral and multidisciplinary network is represented by:

- Two directors external to PermafrostNet (Includes Chair)
- Seven directors from partner organisations representing
    - Indigenous organization or governments,
    - Industry,
    - Federal government,
    - Provincial governments,
    - Nunavut government,
    - Yukon government, and
    - N.W.T. government.
- Scientific Director.
- One co-Investigator of PermafrostNet who will rotate annually.

Exclusive of the co-Investigator position on the Board, **terms** are for two or three years and renewable. New members will be voted in by the Board of Directors. Members can resign at any time by writing to the Chair. Additional **ad-hoc members** may be invited by the Chair.

Chair The Chair must not be directly affiliated with the Network, see Terms and Conditions of the NSERC Award.

This Is a multi-year term, to be reconfirmed annually, up to 5 years.

Meetings **Twice a year**; additional meetings may be held as required. At least one in-person meeting annually, others may be by video/teleconference.

Confidentiality Members must sign and honour a confidentiality agreement which will be available on the website or from the Director of Operations.

Voting **Quorum** will be more than half of the members entitled to vote. Voting members must be in attendance in person or via video/teleconference. For urgent decisions outside scheduled meetings an email vote may be held. There is no provision for proxy votes. In the event of a tie, the Chair may vote.

Resources Director of Operations, as Board support.

Reporting To the funding agency, Natural Sciences and Engineering Research Council (NSERC).

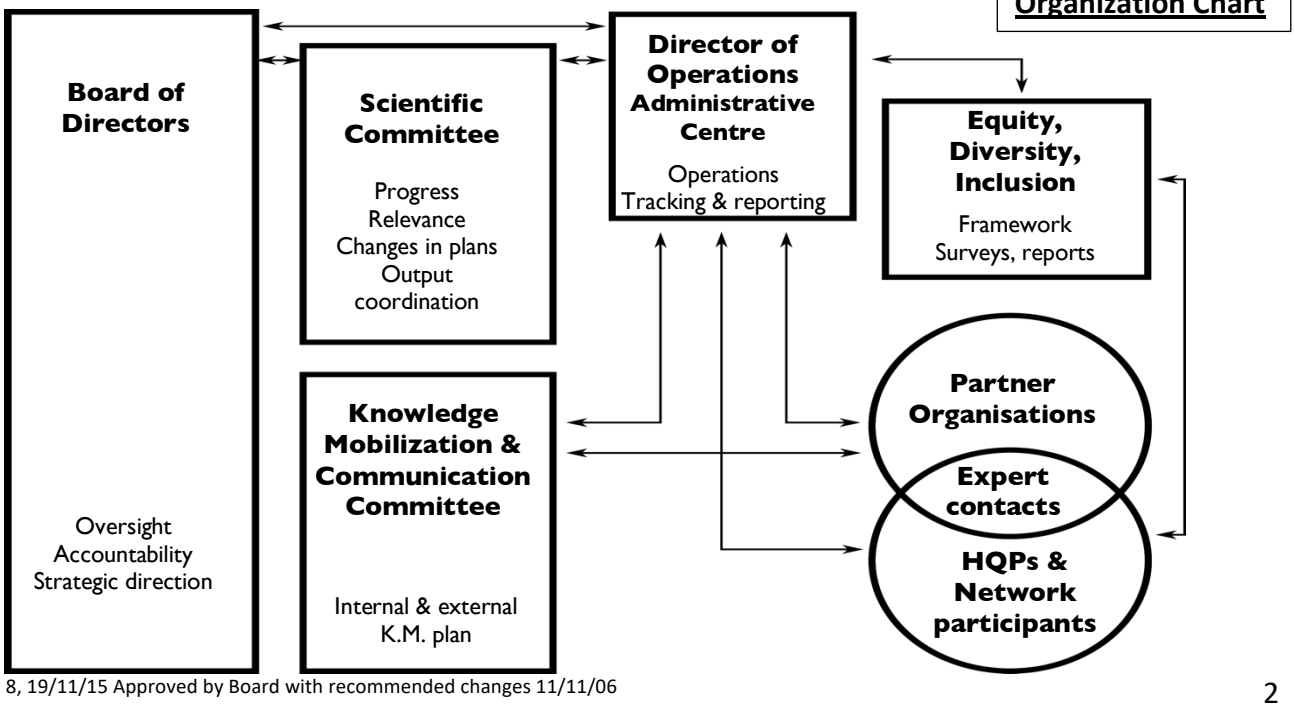
Expenses Membership is not remunerated. Expenses of members representing partner organizations are considered an in-kind contribution; external members may claim appropriate expenses.

Conflicts Actual or perceived conflicts of interest must be communicated to the Chair in writing. The Conflict of Interest Policy will be available on the website or from the Director of Operations.

It is recognized that the members of the Board were deliberately chosen to represent the diverse backgrounds of the Network's stakeholders, and as such could be perceived as having conflicting interests. It is expected that the members of the Board will strike a balance between their own interests and the overall good of the broader network.

Minutes Decisions only, non-confidential and distributed no less than one week after each meeting. Anonymized notes available upon request.

Organization Chart



APPENDIX C: Terms of Reference for NSERC PermafrostNet Board Executive

Terms of Reference: NSERC PermafrostNet Board Executive

Purpose

To advance the activities of the network through oversight of network operations between Board meetings.

Responsibilities

Ensuring implementation and completion of management, direction and fiduciary decisions of the Network as approved by the Board.

The Board Executive, with guidance and oversight of the Board of Directors will:

1. Provide leadership by:
    a. Overseeing implementation of Board decisions;
    b. Planning meeting agendas and materials, and;
    c. Providing guidance on reporting and operations between Board meeting.
2. Provide financial accountability to NSERC and contributing Network Partners through:
    a. Stewardship of annual Network budgets;
    b. Assessment of financial reports prior to Board review; and
    c. Understanding that the Board of Directors makes all final budgetary decisions.

Membership

The composition of the Executive Committee may vary, but ideally will include:

- Two directors, including the Board chair, external to PermafrostNet;
- Scientific Director, and;
- Director of Operations.

The **terms** for the members of the Executive committee will align to the terms on the Board of Directors. New members will be voted in by the Board of Directors. Members can resign at any time by writing to the Chair. Additional **ad-hoc members** may be invited by the Chair.

Chair

The Chair must not be directly affiliated with the Network, see Terms and Conditions of the NSERC Award.

Meetings

No less than once every two months; additional meetings may be held as required. At least one in-person meeting annually, others may be by video/teleconference.

Materials

Chair is aware of and approves meeting materials in advance; send one week in advance.

Confidentiality

External members of the Board of Directors will have a signed confidentiality agreement on file with the Director of Operations.

Voting

If a decision on a discussion is not achieved by consensus, the concern will be taken to the Board for a quorum vote.

Resources

Director of Operations, as Board Executive support.

Reporting

To the Board of Directors.

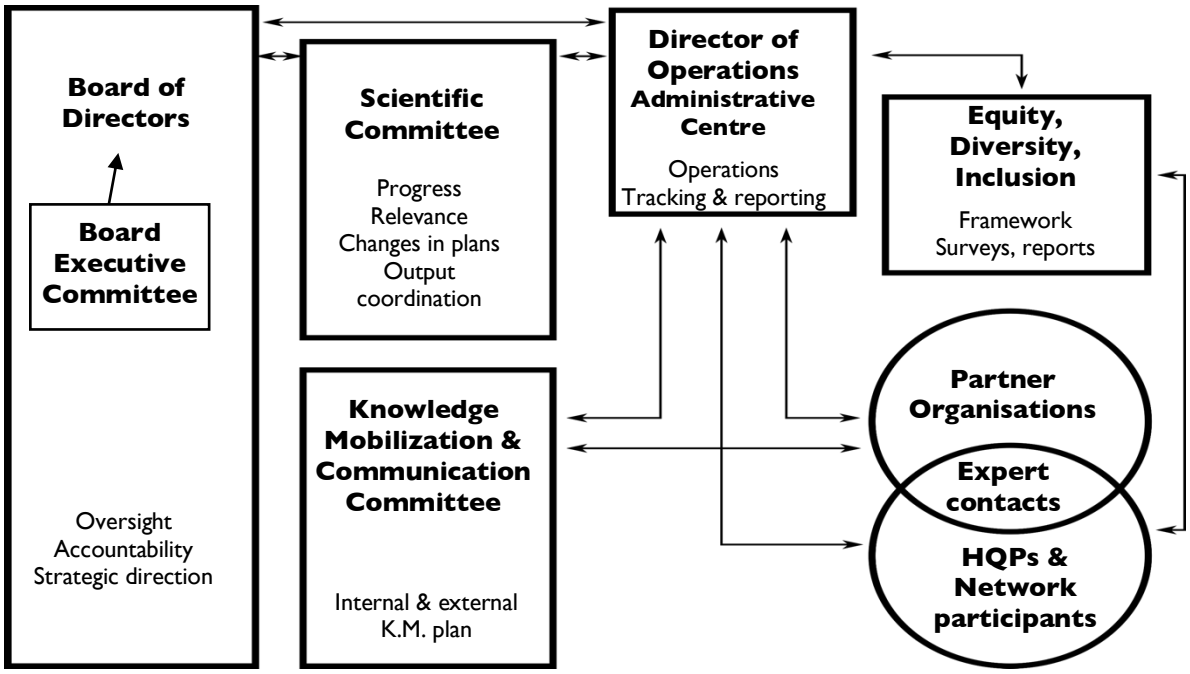
Expenses

Membership is not remunerated. Expenses of members representing partner organizations are considered an in-kind contribution; external members may claim appropriate expenses.

Conflicts Actual or perceived conflicts of interest must be communicated to the Chair in writing. The Conflict of Interest Policy will be available on the website or from the Director of Operations.

Minutes Decisions only, non-confidential and distributed no less than one week after each meeting. Anonymized notes available upon request.

Organization Chart



APPENDIX D: Terms of Reference for NSERC PermafrostNet Scientific Committee

Terms of Reference: NSERC PermafrostNet Scientific Committee

Purpose

To support the Scientific Director in providing **scientific leadership** for enabling and sustaining excellence in network research and training.

To support the development of **strategy and direction** for:

- keeping network research and training relevant to stakeholders,
- managing the research and training program synergistically, and
- producing network-level outputs.

Responsibilities

Review, challenge and recommend to the Board of Directors:

1. research and financial reports from co-applicants,
2. external assessment of network project reports if necessary,
3. annual research project plans, addition or termination of projects,
4. priorities for the Network Data Scientist and the data policy,
5. annual allocation of funding to network research projects,
6. addition or termination of network investigators or partners, and
7. endorsements of external research proposals and/or liaison plans.

Synthesize results into a **final report** at the conclusion of the network.

Membership

The multi-sectoral and multidisciplinary network is represented by:

- two co-applicants,
- one representative from a partner organization,
- one member external to the network, from Canada,
- one international member, and
- the Scientific Director, *ex-officio.*

Terms are for two to three years and renewable. New members require confirmation of the Board of Directors. Members can resign at any time by writing to the Chair.

In searching for new members, priority will be given to any interested and eligible person who is part of an underrepresented group.

While CCADI and PermafrostNet each have significant resources committed for joint work, an **additional member from CCADI** helps ensure progress on joint objectives.

Additional **ad-hoc members** may be invited by the Chair.

Chair

Scientific Director, see Terms and Conditions of the NSERC Award.

Meetings

Twice a year, at least one month before the Board of Directors meets; additional meetings may be held. At least one in-person meeting annually, others may be by teleconference.

Confidentiality

Members must sign and honour the confidentiality agreement that is available from the website or the Director of Operations.

Voting	**Quorum** will be more than half of the members entitled to vote. Voting members must be in attendance in person or via video/teleconference. For urgent decisions outside scheduled meetings an email vote may be held. There is no provision for proxy votes.
Resources	Director of Operations, as committee support.
Reporting	To the Board of Directors.
Expenses	Membership is not remunerated. Expenses of members representing partner organizations are considered an in-kind contribution; external members may claim appropriate expenses.
Conflicts	Actual or perceived conflicts of interest must be communicated to the Chair in writing. The Conflict of Interest Policy is available from the website or the Director of Operations. It is recognized that the members of the Scientific Committee were deliberately chosen to represent the diverse backgrounds of the Network's stakeholders, and as such could be perceived as having conflicting interests. It is expected that the members of the Committee will strike a balance between their own interests and the overall good of the broader network.
Minutes	Decisions only, non-confidential and distributed within one month after each meeting. Anonymized notes available upon request.

APPENDIX E: NSERC PermafrostNet's Equity, Diversity and Inclusion values

NSERC PermafrostNet's Equity, Diversity, and Inclusion (EDI) Values

This document provides values to guide members of NSERC PermafrostNet as they work, both in the lab or field. As a "living document", the Equity, Diversity, and Inclusion Committee (EDIC) is open to hearing all suggestions from members of NSERC PermafrostNet as to how to strengthen and improve these values.

While great strides have been made to support underrepresented populations over the past several decades, systemic barriers within academia and the research ecosystem are, and continue to be, well documented.[1] Systemic barriers include institutional level practices, policies, traditions, and values that can be unintentional, resulting in long-lasting impacts on those affected.

By addressing these barriers, NSERC PermafrostNet will enhance and create a more welcoming network, strengthen research excellence, increase our potential pool of qualified participants, and thereby broaden and diversify the network.

In line with this, NSERC PermafrostNet supports an internal Equity, Diversity, and Inclusion Committee (EDIC) whose overarching goal is to promote an equitable, diverse and inclusive culture within NSERC PermafrostNet. The EDIC, which strives to align with, and foster the guiding principles as set forth by the network as a whole, encourages NSERC PermafrostNet members to read and incorporate the values identified in this document to help reduce systemic barriers.

The EDIC encourages everyone in the network to support an equitable, diverse and inclusive culture, and recognizes that doing so can be a learning process. A learning process that, as a network, will continue to develop and refine over time. To support EDI practices, the EDIC will strive to make all resources (either developed or encouraged by the committee) available to network members in a timely manner.

If you have any questions, or thoughts on improving these values, please contact us through the EDIC Contact Form.

Defining Equity, Diversity, and Inclusion

NSERC PermafrostNet's Equity, Diversity, and Inclusion Committee defines EDI as the following, in line with the Government of Canada[2]:

- **Equity** is defined as the removal of systemic barriers and biases, enabling all individuals to have equal opportunity to access and benefit from the program, network, employment, or other activity in which they are a part of.
- **Diversity** is defined as differences in race, colour, place of origin, religion, immigrant and newcomer status, ethnic origin, ability, sex, sexual orientation, gender identity, gender expression and age.
- **Inclusion** is defined as the practice of ensuring that all individuals are valued and respected for their contributions and equally supported.

[1] https://www.sshrc-crsh.gc.ca/funding-financement/nfrf-fnfr/edi-eng.aspx?wbdisable=true
[2] https://www.sshrc-crsh.gc.ca/funding-financement/nfrf-fnfr/edi-eng.aspx

Guiding Principles

Network Relationships

1. Network activities support relationships and network participants support each other in achieving common objectives.
2. All individuals will be treated with respect, dignity and equity in order to contribute to a safe and healthy work environment that promotes engagement, mental wellness, openness and transparency. We recognize that the network and its science will be more innovative and be stimulated by embracing and including diverse people and their ideas.
3. We will ensure efforts be made to create a collaborative and equitable atmosphere that nurtures both conversations, as well as individual and group initiatives, in order to benefit communities internal and external to PermafrostNet.

Indigenous and Northern Knowledge and Relationships

4. Our research culture is respectful, inclusive and open to learning from Indigenous research methods.
5. We engage with the Indigenous communities where we work and seek and incorporate traditional knowledge and northern knowledge. In doing so, we will both contribute to capacity building in the north and learn from northerners.
6. We acknowledge the lands on which we gather, and the rights of Canada's Indigenous peoples. We respect all Indigenous communities, including those where we do fieldwork.

Recruitment into the PermafrostNet

7. We consider equity, diversity and inclusion when assessing organizational needs, goals, and risks. Secondly, by applying inclusive and transparent practices to support members facing differing circumstances. Lastly, by increasing the participation of underrepresented groups as part of a strategic plan.
8. We will strive to ensure new opportunities within the network are made available in an accessible manner and limit barriers for all community members. This means care will be taken in the posting of positions, search for candidates, in the selection of the hiring committee, interviewing process, and hiring decisions.

APPENDIX F: Terms of Reference for NSERC PermafrostNet Theme Leaders

Terms of Reference: NSERC PermafrostNet Theme Leaders

Purpose

To support the integration of HQP projects and connection of research teams towards the accomplishment of network objectives and outputs.

Responsibilities

Theme Leaders' key tasks:

1. Ensuring that theme research contributes to **network outputs**.
2. Instigating knowledge and technology transfer activities and **interaction with partners**.
3. Ensuring **effective communication** within and across themes, engaging with all co-Investigators in each theme, including them in two or more teleconferences per year and annual in-person meetings. Important outcomes and the names of participants of these meetings should be documented and shared within the network via the Director of Operations*.
4. Raising any concerns about **obstacles** to achieving tasks 1 – 3 with the Scientific Director.
5. Deciding who holds **responsibility** for each of the four key tasks above and communicating this to the Director of Operations.

Membership

Each theme will be led by two experienced academics.

Resources

Internal communications such as videoconferencing, contact list, sharing documented outcomes of meeting, etc. will be supported by the Administrative Centre as required.

The Director of Operations* will support Theme Leaders by sending a reminder four weeks in advance of major Scientific Committee meetings (to be held annually in April and October) if important outcomes have not already been received.

Reporting

Each co-Investigator is responsible to submit a report on individual research projects the to the Administrative Centre twice per year. As such, Theme Leaders are not being tasked with collecting and reporting Theme results to the Scientific Committee (SC) but rather, the Administrative Centre will compile the reports from the individual research projects and disseminate the compilation to the respective Theme Leaders and to the Scientific Committee.

APPENDIX G: Terms of Reference for NSERC PermafrostNet Strategy Committee

Terms of Reference: NSERC PermafrostNet Board of Directors – Strategy Committee

Draft, September 2021

Purpose

To support the NSERC PermafrostNet Board of Directors in leading or catalyzing an open and inclusive strategic thinking exercise for the future of Canadian permafrost research.

Responsibilities

Guide and inform the development of a **vision, strategy, and direction** for permafrost research through an initial roadmap, consultations, events, and stakeholder engagement.

The Strategy Committee, with the guidance and oversight of the NSERC PermafrostNet Board of Directors will:

1. Provide leadership by:
    a. identifying and suggesting initiatives to develop a vision and strategy;
    b. attending planning sessions;
    c. providing contributions and feedback to documents, plans, events, and activities developed by the network; and
    d. engaging and involving stakeholders as required.
2. Provide accountability by:
    a. reflecting the interests and concerns of the NSERC PermafrostNet Board of Directors and members of the network;
    b. ensuring the engagement and involvement of a diverse and inclusive range of stakeholders; and
    c. reporting progress and meeting results to the Board of Directors.
3. Provide financial guidance by:
    a. recommending to the NSERC PermafrostNet Board of Directors strategic planning expenditures that would further the achievement of an open and inclusive strategic thinking exercise; and
    b. identifying alternative funding sources for strategic activities.

Membership

The Strategy Committee ideally will include several members of the Board, as well as Indigenous, government and academic representation. The Chair of the Board and the Director of Operations are further (non-voting) members.

The **terms** for the members will be one year, with annual renewal. New members will be voted in by the Board of Directors. Members can resign at any time by writing to the Chair. Additional **ad-hoc members** may be invited by the Chair.

Chair

Scientific Director, to be reconfirmed by the Board annually.

Meetings

Approximately every two months; additional meetings may be held as required. Meetings may be held by video/teleconference.

Materials

Chair approves meeting materials in advance; send one week in advance.

Confidentiality	External members will have a signed confidentiality agreement on file with the Director of Operations.
Decision-making	**If consensus on a recommendation or decision cannot be achieved,** the concern will be taken to the NSERC PermafrostNet Board of Directors.
Resources	Director of Operations, as committee support.
Reporting	To the NSERC PermafrostNet Board of Directors.
Expenses	Membership is not remunerated. Expenses of members representing partner organizations are considered an in-kind contribution; external members may claim appropriate expenses.
Conflicts	Actual or perceived conflicts of interest must be communicated to the Chair in writing. The Conflict-of-Interest Policy will be available on the website or from the Director of Operations. It is recognized that the members of the committee were deliberately chosen to represent the diverse backgrounds of the Network's stakeholders, and as such could be perceived as having conflicting interests. It is expected that the members will strike a balance between their own interests and the overall good of the broader network.
Minutes	Decisions only, non-confidential and distributed no later than two weeks after each meeting. Anonymized notes available upon request.

APPENDIX H: Co-Investigator Biannual Report and Request for HQP Funding

NSERC PermafrostNet CRSNG
Co-Investigator Bi-annual Report and
Request for HQP Funding

For **bi-annual reporting**, please complete a separate form for each HQP or project, save and email the form(s), using the subject line ***pn_biannual***, to Tristan MacLean, Director of Operations, (tristan.maclean@carleton.ca), April – September for reporting by September 30 and October – March for reporting by March 31.

For **requests for HQP funding outside of the regular reporting periods**, please complete only the fields on page 1, save the form as pdf, and then submit it to Tristan for processing.

A separate form must be filled out for each HQP or project. Note that questions preceded by an asterisk (*) are mandatory. Thanks.

NSERC PermafrostNet CRSNG
Co-Investigator Bi-annual Report and
Request for HQP Funding

* Submission Date:

Project summary

* Theme Number: Project Code:

* Project Name: _____

* Primary Supervisor Name: _____

HQP information

* HQP Name: _____

* Email Address: _____

* University: * Level:

* Start date (real or projected):

* Gender:

* Citizenship:

Co-supervisors and collaborators

* Please list project collaborators and co-supervisors in the table below. For each person, indicate whether there has been interaction within the most recent reporting period. If more lines are needed, use the extra space provided at the end of this form.

Name	Collaborator or Co-supervisor	Organization	Recent interaction
			☐
			☐
			☐
			☐
			☐

Project progress

* Please provide a concise (100–250 words) narrative report on research progress toward milestones and network outputs, as well as any finished degrees.

* Please provide a concise (100–250 words) report on recent interaction with network partners.

If you have any concerns, please describe them here. These may include missing network outputs or problems with upstream linkages with other themes. Include a description of potential or proposed solutions. Finally, identify any possible downstream impacts on other projects or network outputs.

Outreach and publication

Please list any completed or submitted publications (excluding those consisting exclusively of data or code) associated with this project that were generated with the help of network resources since the last bi-annual report. DOIs should be included when available and should be preceded by *doi.org/* (e.g. doi.org/10.1038/d41586-019-01715-4).

Please list any datasets or source code associated with this project that were published with the help of network resources since the last bi-annual report. DOIs should be included when available and should be preceded by *doi.org/* (e.g. doi.org/10.1038/d41586-019-01715-4).

Please list any project-related communication activities that have occurred since the last report. These could include media interviews, podcasts, outreach events, social media or speaking engagements.

Please list any conferences attended by the HQP that were supported by project travel funds.

Other information

Please list any in-kind or additional funding support provided to the Network, the project, or the HQP that would not be otherwise reported on the annual Form 300 that is completed by your institution. For example, if a co-PI put in funding from another source to benefit the project such as additional stipend support for a student.

Description	Value

Has the project been supported by Compute Canada resources? This includes access to the Permafrost Data Science Platform, database, cloud storage, compute cluster, etc.

◉ Yes ○ No

Will this project require funding for the next reporting period?

◉ Yes ○ No

Additional information

If you have any additional information you would like to include, please use this space:

If you have any concerns you would like to raise anonymously, or if you want to provide feedback outside of the reporting periods, please use the online form provided at http://tiny.cc/PermafrostNetFeedback

Email this form (using the subject line “pn_biannual”) by March 31st or September 30th of each reporting period to:

Tristan MacLean
Director of Operation
tristan.maclean@carleton.ca

APPENDIX I: Deviations from proposal projects form

NSERC
PermafrostNet

Deviations from proposal projects form

We expect there will be times when research projects will benefit from deviations away from the original plan. To simplify the procedure the following processes were approved by the Scientific Committee and the form starting on page 3 was created.

The process to request a change:

1. After a discussing with the theme lead, co-investigator completes and sends the attached form to Administrative Centre, with cc to the theme lead, providing the required information specific to each category as outlined below.
2. Administrative Centre confirms details, forwards to Scientific Director.
3. If the proposal has a positive or neutral impact on the budget and the integrity of the project remains intact, Scientific Director reviews and makes the decision.
4. If the proposal has a negative impact on the budget or the integrity of the project is in question, Scientific Director forwards to Scientific Committee for discussion and recommendation to the Board.
5. Board decides.
6. Administrative Centre communicates decision to co-investigator, theme leader and Scientific Committee.

Potential Deviations:

001. Partial/shared funding from another source for an HQP project

In the event that a co-Investigator would like to share the cost of stipend funding for an HQP working on a network project (partial support from the Network, partial support from a different source held by the co-Investigator), NSERC PermafrostNet will support each HQP for travel at $3K per year.

Information required:

- An outline of how the shared cost of stipends supports the mandate of the network research
- Propose positive or neutral impact on budget
- Confirm integrity of the project

002. Changes to a research project

From having difficulty finding HQP to changing priorities for communities in the North, to COVID-19 there will be the need to pivot on some projects.

- If budget and milestones are neutral, information required:
    - An outline of the requested change
    - An explanation of how budget and milestones are neutral
- If there is a negative impact on budget (NSERC PermafrostNet spends more money) and/or changed milestones, information required:
    - An outline of the requested change
    - An explanation of why milestone change is required and/or beneficial
    - How the change impacts other projects and network level outputs
    - Positive or negative impact on budget and milestones
        - Direct cash or in-kind contributions
        - Report on changes by project supervisor (in bi-annual report)

003. Termination of research projects

Information required:

- An outline of the reasons for termination

004. Adding new HQP from existing co-Investigators

In the event an HQP leaves a project, additional help is required on a project, or the level of HQP on a project shifts (i.e. 2 Masters instead of 1 PhD), a new HQP may be beneficial for the completion of the project.

Information required:

- An outline of how the new HQP has complimentary expertise and will support the mandate and outputs of the Network research
- Contact information for the HQP
- The Theme/Project the HQP fits into
- How the change impacts other projects and network level outputs
- Positive, negative or neutral impact on budget and milestones
    - Direct cash or in-kind contributions
    - Report on changes by project supervisor (in bi-annual report)

005. New HQP projects

Information required:

- An outline of the research project and how it supports the mandate of the Network research
- The Theme, project title, HQP level, supervisor, collaborators
- If an HQP is being considered, include contact information
- How the change impacts other projects and network level outputs
- Positive, negative or neutral impact on budget and milestones
    - Direct cash or in-kind contributions
    - Report on changes by project supervisor (in bi-annual report)

NSERC PermafrostNet

Deviations from Proposal Projects Form

We expect there will be times when research projects will benefit from deviations from the original plan. Complete this form using the instructions on pages 1-2. Provide full and complete information in the appropriate sections based on the intended project changes. Indicate N/A in sections which do not apply.

Note: When complete, send the form to the Administrative Centre at tristan.maclean@carleton.ca with a cc to the Theme Leader(s).

A Date received (YYYY-MM-DD):

(For office use only)

Co-investigator Details

First name(s): Last name:

Date of request (YYYY-MM-DD):

Research Project Details

Theme no.: *Select:* Project code/title: Select or type (for 005)

Academic level: *Select:* Supervisor:

Collaborators:

HQP first name(s): Last name:

HQP email:

Reason(s) for project deviation

Check the reason(s) for change (001-005) and provide details in 006:

001 ☐ **Partial/shared funding from another source for an HQP project**

In 006, outline how the shared cost of stipends supports the mandate of the network research

002 ☐ **Changes to a research project**

In 006, outline the requested project change

003 ☐ **Termination of research project**

In 006, outline the reasons for termination

004 ☐ **Adding new HQP from existing co-investigators**

In 006, outline how the new HQP has complimentary expertise and will support the network's research mandate and outputs

005 ☐ **New HQP projects**

In 006, outline the new project and how it supports the network's research mandate; complete *Research Project Details* above.

006 **Provide an outline of the project deviation**

Impacts from project deviation

007 **What are the impacts on milestones?**

008 **What are the impacts on other projects and network level outputs?**

009 **What are the impacts on budget? (Provide a breakdown of costs in 011-017)**

010 **Other information, please specify:**

Budget

Indicate the new total budget in 011 following changes to the project and provide a breakdown in 012-017. If the costs remain neutral, indicate the original budget.

011 Total budget (C$):

Provide a breakdown of:

012 Annual remuneration (including benefits):

013 Materials and supplies:

014 Travel (e.g. fieldwork, conferences):

015 Knowledge and technology transfer (e.g. open access publishing, workshops):

016 Other expenses (e.g. field safety training, meetings):

017 Other information, please specify:

Completed by office staff *only*

B Details confirmed by Administrative Centre — Date (YYYY/MM/DD):

Notes:

C Form sent to Scientific Director for review — Date (YYYY/MM/DD):

Notes:

D Form sent to Scientific Committee for review — Date (YYYY/MM/DD):

Notes:

E Form discussed with Board of Directors — Date (YYYY/MM/DD):

Notes:

F Board decision received — Date (YYYY/MM/DD):

Notes:

G Decision sent to co-investigator, Theme Leader(s), and Scientific Committee by Administrative Centre — Date (YYYY/MM/DD):

Notes:

APPENDIX J: NSERC PermafrostNet data policy

APPENDIX K: Flex Fund request form

NSERC
PermafrostNet

2021 Flex Fund Form

Please see page 2 for additional information. When complete, save the form using your name and send to the Administrative Centre at tristan.maclean@carleton.ca with a cc to the Theme Leader(s).

Requester Details

First name(s): Last name:

Date of request (YYYY-MM-DD):

Research Project Details

Theme no.: *Select:* Project code/title: *Select:*

Supervisor: Trainee:

Funding Request

Amount requested (C$): Basis for request: *Select:*

Provide details regarding:

(a) How the funds will be used (if granted):

(b) How additional resources will assist with reaching milestone(s) and/or support network level outputs:

NSERC
PermafrostNet

2021 Flex Fund: Background and Procedure for Allocation

NSERC PermafrostNet has reallocated funds internally to support immediate activities offsetting COVID-19 restrictions or boosting early progress toward network outputs.

Funding available

- Total budget: $94K. $74K for gradute student or post-doctoral support in the short term (taking a broad view including Northern RA),$20K other needs.

How decisions will be made

- Allocation by a sub-committee of the Scientific Committee
    - Four members, including Stephan as non-voting, unless there is a tie among members eligible to vote
    - Only external members (i.e. member of the Scientific Committee who are not receiving NSERC PermafrostNet funds), or internal members who cannot vote on their own Flex Fund requests
    - Director of Operations will provide administrative support
- As this will be first-come-first-served, decisions may be:
    - Yes, full or reduced amount
    - No
    - Postpone by X weeks and see what else comes in
- Criteria
    - Network research: supporting a project and its milestones, ideally creating additional benefits for and interactions with other graduate students, post-doctoral fellows or partners.
    - Network outputs: supporting the timely completion of network level outputs
- Expediency
    - Up to $5K – the goal is to have a decision within 14 days of the ask
    - More than $5K – the goal is to have a decision within 21 days of the ask

Making requests

- Discuss with theme leader(s)
- Project supervisor sends written request (this form) to Administrative Centre, with cc to theme leader(s)
    - Outline requested additional financial resources required
    - Explain how the additional resources will assist with reaching milestone(s) and/or support network level outputs
- Administrative Centre confirms details, forwards to Scientific Director for review, and emails to sub-committee:
    - If < $5K “if we do not hear from sub-committee by date X (10 days), then we conclude agreement”
    - If > $5K, email responses with quorum (at least 2 of 3 voting members of the sub-committee) are required
- Administrative Centre communicates decision to project supervisor (with expectation for bi-annual report of results), theme leader and SC.

PLEASE NOTE: The NSERC PermafrostNet 2021 Flex Fund is different from the 3-months of funding for grad students announced by NSERC last year.

APPENDIX L: Standard Operating Procedures

PermafrostNet

NSERC | CRSNG

Standard Operating Procedures

Version 200424 – approved 20/06/26 with the understanding that this is a living document and changes, deletions and additions will be vetted and approved by the SC – sample documents added 20/10/19 – revision to sections I.B.2., IV. A, V. H., VII. B. approved by Board 20/11/19.

In order to maintain the friendly and cooperative spirit of the Network proposal, we are proposing some simple guidelines for Network operations. The Standard Operating Procedures (SOP) as outlined below are meant to manage expectations and ensure a standard of practice for all members of the Network.

This is a living document and will expand or contract as new circumstances come up or other standards become unnecessary.

A lexicon of terms can be found in section VIII. A.

Sample documents can be found in section VIII. B.

I. Funding from the Network

This section includes an overview of how and by whom the funds in the network will be administered, how to request funds for transfer, and how to request reimbursement for travel and other admissible expenses.

A. Administration of funds

1. Carleton University

Research Accounting:

- Receives and administers grant funds from and accounts on expenditures to Natural Sciences and Engineering Research Council (NSERC)
- Transfer funds to partner universities for co-Investigator projects upon receipt of duly executed transfer letters
- Compile partner university Form 300 reports and submit to NSERC, at least annually, and more often if required
- Invoice contributing partners annually for cash commitments made in the proposal.

A sample transfer letter can be found in the Appendices, VIII. B. 1.

Research Office:

- Prepares, circulates, ratifies, and requests signature of all partners on the Strategic Partnership Agreement which outlines the responsibilities of partners
- Distribute transfer letters signed by Scientific Director and Carleton University signatory to partner universities for signature by co-Investigator and partner university signatory, at least annually and more often if required

NSERC PermafrostNet, Administrative Centre:

- Supports distribution of transfer letters and disbursements as required
- Reconciles expenses against funds administered by Carleton
- Reports on expenses to Board, twice a year and presents budget to the Board for approval annually
- Provide in-kind reporting forms to contributing partners and request completion and remittance annually.
- Submits Board approved budget and report to NSERC annually

2. Partner Universities

Research Accounting:

- Receive, sign and return transfer letter to Carleton University
- Submit duly executed Form 100 expense reports for each co-Investigator to Carleton University Research Accounting by April 30, annually

Research Office:

- Reviews, offer comments and upon agreement of content, sign the Strategic Partnership Agreement which outlines the responsibilities of partners

Co-investigators:

- After requesting funds sign transfer letter
- Contact the Director of Operations with questions or concerns soonest

3. Contributing partner organizations

Cash contributions:

Contributing partners will provide cash contributions as committed in the proposal annually, upon receipt of an invoice from Carleton University.

In-kind contributions:

Contributing partners will complete and submit an in-kind reporting form annually, as provided by the Network Administrative Centre.

B. Requesting funds by and disbursing funds to co-Investigators

A detailed budget outlining the funding requirements to support project highly qualified personnel (HQP), computers, HQP conference travel, northern research assistants, field work travel, specialized equipment and user fees was approved with the Network Proposal. Going forward, funding will be allocated based on requests from co-Investigators for project HQP, bi-annual reports, and supporting funds as detailed in the proposal budget.

The bi-annual report form has been designed to report on past activities and request renewed and new HQP stipend funding for future periods. The reports are to be submitted in March, and September. A separate form is to be used for each HQP request.

A sample bi-annual report form is included in the Appendices, VIII. B. 2.

1. HQP

To request funding for HQP at the level outlined in the proposal, for projects that were approved in the proposal, the co-Investigator for the project will complete a bi-annual report form and submit it to the Director of Operations. These requests will be added to the proposed budget for the upcoming year, for review and recommendation by the Scientific Committee to the Board of Directors for approval.

2. Northern Research Assistants (NRA)

Co-Investigator sends an email to the Administrative Centre to include the form on the website outlining:

(a) which HQP project and milestones the NRA will be supporting,
(b) what activities are to be undertaken,
(c) the date range and amount requested, and
(d) the additional support and supervision provided by a colleague at a Northern institution

3. Travel allotments for students

As approved in the proposal budget, travel allotments for HQP for conference travel, including travel to the NSERC PermafrostNet Annual General Meeting, in the amount of $3,000 per student, per year will be transferred to the HQP supervior's university in tandem with the stipend allotment for that year. These travel costs are to be administered by the HQP's supervisor.

4. Equipment

As approved in the proposal budget, a transfer to assist with the purchase of computers for HQP in the amount of $375 per year per student will be transferred for all 5 years to the co-Investigator's university in tandem with the stipend and in most cases the total equipment transfer was alotted in year one. For those co-Investigators who did not receive a transfer in year one the equipment transfer will be made with the year two transfer.

5. Materials and supplies

A transfer to assist with the purchase of materials and supplies as outlined and approved in the proposal budget for specific projects will be sent to co-Investigators when the HQP for the project has been engaged,

C. Transfer letters

Funds are transferred to the co-Investigator's university upon receipt of a duly executed transfer letter, see section I. A. 1. Ideally, the letters and transfers will be issued annually, however, in cases where funds are to be transferred at different times, these will be accommodated.

If, when funds are expected, a co-Investigator is not asked to sign a transfer letter or has not received the transfer of funds after signing a letter, the co-Investigator is encouraged to contact the network's Director of Operations to ensure the prompt receipt of funds.

A sample transfer letter can be found in the Appendices, VIII. B. 1.

D. Travel funds

For travel that is to be reimbursed by the Administrative Centre directly, a travel claim, and supporting documentation, such as receipts, boarding passes, claimant declaration, and delegate authorization are to be submitted after each event. Under COVID-19, electronic submission of these items is acceptable, and are to be sent to shirley.mckey@carleton.ca.

As a general rule of thumb:

- Economy travel costs are acceptable. Business or first-class travel costs are not permitted.
- Claims for alcohol or incidentals are not permitted.
- If you have not received payment after six weeks of submitting a claim, please contact the Administrative Centre to follow up.
- If you have any questions during the process, please contact the Administrative Centre.
- Per diem costs for meals are allowable and can simplify the claim process when the claimant is mindful of responsible use.

A sample of a travel claim, claimant declaration and delegate authorization can be found in the Appendices, VIII. B. 3., 4., and 5.

1. For HQP

As outlined in I. B. 3., conference and Network Annual General Meeting (AGM) travel funding for students will be transferred to HQP's supervisor who will administer the travel funds directly.

2. For approved events, co-investigators, external board and committee members

For co-Investigators, external Board and Committee members there is a budget to cover travel to the AGMs and some other network sanctioned events. Please confirm in advance of travelling if the event is included in the budget. If the expenses are allowable, they will be reimbursed after the event as outlined in I. D.

3. For fieldwork

The funds for fieldwork as allocated in the proposal budget will accompany the transfer of stipend funding to the supervisor for the HQP who is engaged to do the fieldwork.

4. For collaboration

Specific budget has been set aside to cover travel for pre-determined collaboration events, such as the Data Science Workshop and international and northern collaboration. Please confirm in advance of travelling if the travel you are planning is included in the budget and is approved for reimbursement. If the expenses are allowable, they will be reimbursed after the event as outlined in I. D.

5. Making standard travel claims

a) Carleton University personnel

Carleton University employees may set up their own travel claim for reimbursement. Once submitted, a copy of the claim is to be sent to the Administrative Centre at shirley.mckey@carleton.ca. The claim will be approved following review that the claim is permissable.

b) External to Carleton University personnel

Personnel external to Carleton University shall submit their claim, including the supporting documentation as outlined in I. D., to the Administrative Centre at shirley.mckey@carleton.ca. The claim will be reviewed promptly and entered into the system for reimbursement.

6. Travel claims when there are extended, 'non-Network business' travel included

If you have any questions about extended travel, please contact the Administrative Centre before you book your travel.

The same process for making a travel claim as outlined in I. D. applies, with some additional documentation required:

- If you arrive early or stay after a funded event has concluded for your own purposes, we cannot pay for additional accommodation nights, per diems, ground travel or meals.
- If there is no difference in cost for the flight or ground travel to and from your location, the dates of arrival and departure should not make a difference to the claim. Include a quote from the carrier for the matching Network travel dates.

- If you are travelling on to an additional destination that alters the cost of your travel, provide a quote from the carrier of what a direct return flight or ground transportation from home to the event would have been and we can reimburse for up to the cost of the return travel.
- If you choose to rent a car instead of taking shuttles, taxis or other transportation from airports, train stations, etc., provide estimates of what the costs would have been, and we can reimburse for up to a reasonable cost of the ground transportation. Maps are to be provided if claiming car rental or mileage costs.

E. Other funds

We request that addition funds used in support of the network - such as partial support of HQP from other grants - be reported on in co-Investigator bi-annual reports, and if appropriate, in the Form 300, Statement of Account (Section II, B) submitted by the partner university.

II. Reporting

To ensure that funds are forthcoming from NSERC each year, the network is required to submit financial and narrative reports as outlined below by (confirm dates). To support the reporting process we require information and reports from each of our university, industry and government partners in a timely manner.

A. Bi-annual reporting

Co-Investigators submit to Administrative Centre:

- One fillable report form for each research project
  - submitted (by email) by March 31st and September 30th of each year
  - brief narrative reports
    - HQP activity
    - research progress, results, outputs
    - concerns about possible obstacles to progress, and
    - other information as requested
  - capture in-kind or cash contributions received that would not be recognized in the Form 100 report
- Brief pdf fillable form provided by Administrative Centre by first week of February and first week of August

A sample of a bi-annual report can be found in the Appendices, VIII. B. 2.

B. Form 300 report

A Form 300 report is an expense report required by NSERC which verifies funds spent in a given period. It is completed by each partner university and submitted to host university for compilation and submission to NSERC, at minimum once per year, or more frequently if required.

C. In-kind contribution report

An in-kind contribution report is a form used to report non-monetary contributions of goods or services offered free or at less than the usual charge or when an entity pays for services on the network's behalf.

A sample of an in-kind report can be requested as outline in the Appendices, VIII. B. 6.

D. Dissemination of Research Reports

For HQP projects that receive network funding, there is an expectation that the research will be published as feasible, and that NSERC will be acknowledged for funding received.

- Discuss authorship, as well as use of unpublished network data, in advance of publishing and note the agreement reached.
    - Define how authors should be included and contributions acknowledged
    - Who holds IP?
    - If author is part of a working group, identify this up front – initial conversation to establish co-authorship
    - Key points can include
        - Disclosure of relationship to other research activities that are not part of the Network. Could this cause issues with other co-authors, funders etc.?
        - Is there an "a priori" understanding of who should be lead author, co-authors, order of authorship etc.?
        - What are the norms/rules for inclusion/exclusion of authors, changing authorship etc.
        - What are the expectation around review process, response to journal feedback etc.?
        - Most important thing is to confirm expectations at the outset as authors in the network may not have published together before and may not have shared norms.
- IP on source code – Network-funded code, should be published as open source, the NSERC PermafrostNet Data Policy contains recommendations for chosing a licence.
- Publishing data – consult the NSERC PermafrostNet Data Policy.
- Using data for a publication – acknowledge data source and cite DOI; when using unpublished network data, obtain approval of the major parties involved.

E. How to deal with incorrect or lack of reporting

- Follow up from Scientific Director within 2 months of report
- Scientific Director determines next steps if required

III. Deviations from proposal projects

We expect there will be times when research projects will benefit from deviations from the original plan. To be consistent with the advancement of these changes, the following outlines are proposed.

A. Partial/shared funding for HQP project

In the event that a co-Investigator would like to share the cost of stipend funding for an HQP working on a network project (partial support from the Network, partial support from a different

source held by the co-Investigator), NSERC PermafrostNet will continue to support HQP travel at $3K per year.

The process to advance the change:

- After a discussion with the theme lead, co-Investigator sends written request to Administrative Centre, with cc to theme lead
    - Outline how the shared cost of stipends supports the mandate of the network research
    - Propose positive or neutral impact on budget
    - Confirm integrity of the project
- Administrative Centre confirms details, forwards to Scientific Director
- If the proposal has a positive or neutral impact on the budget and the integrity of the project remains intact, Scientific Director reviews and makes the decision
- If the proposal has a negative impact on the budget or the integrity of the project is in question, Scientific Director forwards to Scientific Committee for discussion and recommendation to the Board
- Board decides
- Administrative Centre communicates decision to Co-Investigator, theme leader and SC

B. Changes to HQP projects

From having difficulty finding HQP to changing priorities for communities in the North, to COVID-19 there will be the need to pivot on some projects. To address these changes with minimal paperwork, the following procedures are proposed.

1. When budget and milestones are neutral

- After discussion with theme leader, project supervisor sends written request to Administrative Centre,
    - Outline requested change
    - Explain how budget and milestones are neutral
- Administrative Centre confirms details, forwards to Scientific Director for decision
- Administrative Centre communicates decision to supervisor, Theme lead and SC

2. Negative impact on budget and/or changed milestones

- After discussion with theme leader, project supervisor sends written request to Administrative Centre, with cc to theme leader
    - Outline requested change
    - Explain why budget and milestone change is required and/or beneficial
    - Positive or negative impact on budget and milestones
        - Direct cash or in-kind contributions
        - Report on changes by project supervisor (in bi-annual report)
- Administrative Centre confirms details, forwards to Scientific Director who reviews and forwards to Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides
- Administrative Centre communicates decision to project supervisor, theme leader and SC

C. New HQP projects

- After discussion with theme leader, project supervisor sends written request to Administrative Centre, with a cc to theme leader
    - Outline the research project and how it supports the mandate of the Network research
    - Propose the required budget
- Administrative Centre confirms details, forwards to Scientific Director who reviews and forwards to Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides
- Administrative Centre communicates decision to project supervisor, theme leader and SC

D. Termination of research projects

- After discussion with theme leader, project supervisor sends written request to Administrative Centre, with cc to theme leader
    - Outline reasons for termination
- Administrative Centre confirms details, forwards to Scientific Director who reviews and forwards to Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides
- Administrative Centre communicates decision to project supervisor, theme leader and SC

E. Adding new HQP from existing co-Investigators

- After discussion with theme leader, co-Investigator sends written request to Administrative Centre, with cc to theme leader
    - Outline how the new HQP has complimentary expertise and will support the mandate and outputs of the Network research
    - Define the milestones, which Theme the HQP fits into
    - Propose the required budget or cost neutral
- Administrative Centre confirms details, forwards to Scientific Director
- Scientific Director reviews and forwards to Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides
- Administrative Centre communicates decision to co-Investigator, theme leader and SC

F. Adding new co-investigator and HQP from partner universities

- Written request to the Administrative Centre which outlines how:
    - the proposed HQP project adds value to the Network and contributes to its objectives and outputs,
    - the new co-investigator will engage in network activities and contribute to governance and collective leadership, and
    - adequate additional financial resources are made available so that the new investigators and their HQP clearly add to network activities and sustainability.
- Administrative Centre confirms details, forwards to Scientific Director

- Scientific Director reviews and forwards to appropriate Theme leader and Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides
- Administrative Centre communicates decision to new co-Investigator, theme leader and SC

G. Adding new co-investigator and HQP from new university partner

- Written request to the Administrative Centre which outlines how:
    - the proposed HQP project adds value to the Network and contributes to its objectives and outputs,
    - the new co-investigator will engage in network activities and contribute to governance and collective leadership, and
    - adequate additional financial resources are made available so that the new investigators and their HQP clearly add to network activities and sustainability.
- Administrative Centre confirms details, forwards to Scientific Director
- Scientific Director reviews and forwards to appropriate Theme leader and Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides
- Administrative Centre communicates decision to new co-investigator, theme leader and SC
- New Co-investigator provides the Administrative Centre with the contact information for the new university's Research office to facilitate the addition of the new university to the network and the signing of the partnership agreement.

IV. Changes to partner organizations

A. Adding new supporting organizations - approved 20/09/30

New supporting organizations and universities may be added to NSERC PermafrostNet when three conditions are met:

1. Significant additional benefit is afforded to the Network in achieving network milestones and objectives as well as for producing network-level outputs.
2. No significant financial disadvantage is created for existing supporting organizations and universities.
3. The new supporting organization or university is willing to sign the existing NSERC PermafrostNet Strategic Network Agreement.

As approved in the network proposal budget, the administrative costs to support the network, were funded by NSERC at an estimated level of $10,000 per partner, per year (over 5 years of network). This includes administrative salaries, equipment, publications, dissemination, annual general meeting, and governance meetings, but not costs applied directly to HQP stipends, user fees, material and supplies, student travel, fieldwork, collaboration, and field safety training. The calculation is based on 28 supporting organizations and 11 universities.

To sustain administrative support of the network at the current level, and to be equitable to those supporting organizations and universities that contributed to the proposal and the current operation

of the network, new supporting organizations and universities would be required to provide a minimum of $10,000 cash per year toward the support of the research, plus in-kind contributions as deemed feasible by the partner. New universities could administer contributions by submitting a Form 300 Statement of Account each year to report on contributions made by their industry partners that are directed to support network research, or on graduate student support from the universities; or by contributing cash directly to the network in support of Indigenous engagement.

The process would include:

- Written request to the Administrative Centre which outlines:
  - how the proposed addition would add value to the Network and contribute to its objectives and outputs,
  - how the new supporting organization or university would engage in network activities and contribute to governance and collective leadership, and
  - what additional financial resources would be made available so that the addition of the supporting organization or university clearly adds to network activities and sustainability.
- Administrative Centre confirmation of details and forwarding to Scientific Director
- Scientific Director reviewing and forwarding to Scientific Committee
- Scientific Committee discussion and recommendation to the Board
- Board discussion and decision
- Administrative Centre informing Scientific Committee, the new supporting organization or university and the existing partners.

The rights afforded and obligations agreed to by new partners would be the same as those afforded the original supporting organizations or universities who signed on to the NSERC PermafrostNet Strategic Network Agreement. The new supporting organization or university would be obliged to sign this agreement.

B. Withdrawal or cessation of team members - to be revisited in spring 2021

V. Engagement

In general, the network encourages the development of follow up projects and having co-Investigators actively and openly engage with partners.

A. How to encourage industry partners to engage - A – E to be revisited in spring 2021

B. Handling industry partner requests

C. How are people able to work on other projects, networks

D. How to work with the overlap in new projects

E. Co-investigators working on external projects, networks

F. Letters of support for co-investigators or partner organizations

- If the letter of support provides only information to support a bid for external support, this decision can be made by the Scientific Director.
- If the letter of support offers a contribution to a partner's bid for external support, this decision is to be approved by the Scientific Committee.

G. Letters of support for external organizations

- If the letter of support is for an external organization, this decision is to be approved by the Scientific Committee.

H. Newsletter

Aim: communicate relevant information effectively end engagingly
Audience: Network participants
Source of information: Network participants
Administrative Centre

- supports and encourages engagement
- edits and sends newsletter

Frequency: four times a year

- well timed to coincide with information of relevance to the members
- **Spring** (Late Jan. / early Feb.): announce year end March 31 and report due date
- **Summer** (May / early June): save the date for AGM
- **Autumn** (Mid Sep.): registration and program links for AGM
  (September 2020: include pointer to Members Area)
- **Winter** (Late Nov / early Dec.): AGM report, announce next AGM, holiday greeting

Content

- developments in the field – commentary on major new insight, projects, or initiatives globally.
- summary of a recent publication by network members
- list of recent publications by network members
- report on recent event
- relevant governance decision
- new tools available for members
- welcome to new participants
- congratulations (graduations, Nobel prizes, knighthood)
- other news for the good of the network
- upcoming deadlines (network events, conferences)

Responsibilities

- Network participants
  - Provide content
- Knowledge Mobilization and Communications Coordinator
  - design the format initially
    - how many articles/news bits in each issue
    - formatting and logistics of email / website
  - gather content
  - develop the first draft
  - consult with team members for edits and suggestions
  - incorporate agreed upon changes
- Director of Operations
  - oversight
  - approval
  - mobilization of additional resources, e.g., HQP

Production

1. **solicit content**, 2 months in advance
   a. inclusive and transparent
   b. point to editorial process
      i. edited, prioritized transparently, approval by Admin Centre
   c. simple how-to instructions
      i. email content to the Administrative Centre
      ii. formatting, photo files, etc.
   d. in current newsletter
   e. on website, Member
2. **editorial process**
   a. publications collated by Admin Centre
      i. submission any time for web/social media, instructions on website
   b. edit for clarity and consistency
      i. major edits need contributor approval
   c. prioritize for relevance and balance
      i. excluded content will be returned to the contributor with an explanation
3. **approval**
   a. by Director of Operations
      i. if unavailable, then by Scientific Director
4. **distribution**, after approval
   a. email
   b. highlights in keywords
   c. link from website to MailChimp archives
   d. access to all newsletters from the website

VI. Conflict of Interest and Confidentiality

In the case of a network employee or employee of a partner that has signed the partnership agreement, the employee is first and foremost subject to the Conflict of Interest and Confidentialty policies of their own organization.

A. Conflict of interest

- All members of Boards, Committees, Sub-committees whose organization is not included in the Strategic Partnership Agreement will be required to sign a form annually.
- The signed form will be kept on file with the administrative centre.

A sample of the Conflict of interest form can be found in the Appendices, VIII. B. 7.

B. Confidentiality

- All members of Boards, Committees, Sub-committees whose organization is not included in the Strategic Partnership Agreement will be required to sign a form annually.
- The signed form will be kept on file with the administrative centre.

A sample of the Conflict of interest form can be found in the Appendices, VIII. B. 8.

VII. Governance

A. Updating the Standard Operating Procedures

- Propose changes, together with a rationale, to Administrative Centre
- Administrative Centre sends redlined version to Scientific Committee
- Scientific Committee discusses and makes recommendation to the Board
- Board decides

B. Replacing Board and Committee Members

1. **To solicit nominee(s) to fill a vacancy on the Board, Scientific Committee and Knowledge Mobilization and Communication Committee**
    a. A call out in the form of an email to the appropriate audience for a balanced membership to request nominations (and/or self-nominations) to fill a vacant position on the Board or committee
        i. As examples, to fill a position to be occupied by a co-Investigator, an email will be sent to all co-Investigators; a Northern seat, sent to Northern stakeholders; a government seat, sent to government stakeholders, etc.
    b. A slate of potential candidates will be prepared and circulated to the Board or committee members with the seat to fill requesting a vote
    c. Decisions in Face-to-face meetings:
        i. If more than one nominee than a ballot vote will be called during the meeting. Two members (not named on the ballot) and the Director of Operations will be asked to count the ballots.
        ii. If only one nominee, the nominee will leave the room and the Chair will present the name of the nominee and ask if there are any objections to approving the nominee for an open member position.
            1. If no objections are expressed, the nominee will be acclaimed into the position.
            2. If an objection is received, the call for a motion and a seconder to vote for the nominee will be put forward by the Chair. A discussion and a call for a vote will be held. The decision will rest with the majority.
    d. Decisions by Email request:
        i. An email, under the Chair's signature and including a slate of the nominee(s) (pdf file), will be sent to all current Directors on the Board, requesting any objections or request to discuss and the vote be submitted by a given date. The members will have the option to reply to the email, or print the slate of

nominee(s), sign and return the completed form by email, by the same given date.

ii. If no objection or request for discussion is requested by the given date, the members' vote by email will proceed.

iii. If an objection is received by the given date, a videoconference will be called to discuss, after which a vote will proceed. The decision will rest with the majority.

e. In the case of both the Board and the Scientific Committee, the name and contact information will be sent to NSERC for approval.

2. To solicit nominee(s) to fill a vacancy on the Equity, Diversity and Inclusion Committee

- Network participants will be invited to form the EDIC, and priority will be given to any member who is part of an underrepresented group who expresses an interest in joining.

The onboarding process for any new members will be outlined by the committee.

VIII. Other

IX. Appendices

A. Lexicon of terms

Administrative Centre	The offices and personnel of the support staff of the Network, including space in the ARISE Building on the Carleton University campus – includes Data Scientist, Nick Brown, Director of Operations, Shirley McKey and Knowledge Mobilization and Communications Coordinator, Tristan MacLean
Bi-annual report	The template provided by the network to facilitate co-Investigator reporting on activities and to request HQP funding for future periods.
Board of Directors	The governing body with the purpose of reflecting the interests and concerns of the public, private and academic sectors involved in the Network, and responsible for the overall management, direction and fiduciary accountability of the Network. The multi-sectoral and multidisciplinary network is represented by: ▪ Two directors external to NSERC PermafrostNet (Includes Chair) ▪ Seven directors from partner organizations representing • Indigenous organization or governments, • Industry, • Federal government, • Provincial governments, • Nunavut government, • Yukon government, and • N.W.T. government. ▪ Scientific Director. ▪ One co-Investigator of PermafrostNet who will rotate annually. Exclusive of the co-Investigator position on the Board, terms are for two or three years and renewable. New members will be voted in by the Board of Directors. Members can resign at any time by writing to the Chair. Additional ad-hoc members may be invited by the Chair. Please see Appendix
Co-Investigator	A co-applicant in the proposal who receives NSERC PermafrostNet funding for their HQP projects.
Collaborator	A co-applicant in the proposal who does not receives NSERC PermafrostNet funding for their research projects.
Director of Operations	The person who provides direction for all network operations and ensures good communication, control and accountability on a day-to-day basis.
Duly Executed	A phrase used to summarily state that all the relevant, legal, formal requirements involved in the signing of a binding agreement are complete.
Form 300	Expense report which verifies funds spent in a given period, completed by partner universities and submitted to host university for submission to NSERC
HQP	Highly qualified personnel – Masters, PhD and Postdoctoral Fellows
In-kind contribution	An in-kind contribution is a non-monetary contribution of goods or services offered free or at less than the usual charge. Similarly, when a

	person or entity pays for services on the network's behalf, the payment is an in-kind contribution.
NSERC	Natural Sciences and Engineering Research Council of Canada – Federal funding agency for the network
NSERC PermafrostNet	NSERC Permafrost Partnership Network for Canada – also referred to as the network
Research Project	A sub-theme of a network theme, as outlined in the proposal, which identifies the HQP resources assigned, the working title and milestones expected.
Project Supervisor	Lead co-Investigator on a research project
Scientific Committee, SC	The guiding body to provide scientific leadership for enabling and sustaining excellence in network research and training. To support the Scientific Director in the development of strategy and direction for: • keeping network research and training relevant to stakeholders, • managing the research and training program synergistically, and producing network-level outputs. The multi-sectoral and multidisciplinary network is represented by: • two co-applicants, • one representative from a partner organization, • one member external to the network, from Canada, • one international member, and • the Scientific Director, *ex-officio.* **Terms** are for two to three years and renewable. New members require confirmation of the Board of Directors. Members can resign at any time by writing to the Chair.
Scientific Director	The principal investigator who chairs the Scientific Committee and is responsible for the scientific leadership and direction of the network, reporting to the Board of Directors.
Theme leader	An experienced academic who ensures uninterrupted coordination of the research during the network period, supporting integration of HQP projects and connection of research teams towards the accomplishment of network objectives and outputs.
Transfer	The grant funds disbursed to a co-Investigator's institution from the host institution during a specified period.
Transfer letter	The legal document which outlines the terms of the grant funding to be disbursed to a co-Investigator's institution from the host institution during a specified period. Requires the signatures of the Scientific Director, the host institution's assigned signatory, the co-investigator who is to receive the funds, and the assigned signatory of his/her institution.

B. Sample documents

1. Transfer letter
2. Bi-annual report form
3. Travel claim
4. Claimant declaration
5. Delegate authorization
6. In-kind contribution report
7. Conflict of interest form
8. Confidentiality form

B.1. Sample Transfer Letter

NETWORK FUNDS TRANSFER AGREEMENT

Transfer of Funds Agreement
Between Carleton University "Primary Institution" and
University of X "Collaborating Institution"

Date:	
Principal Investigator (Carleton University):	Stephen Gruber
Co-Investigator (Collaborating Institution):	
Funding Agency:	NSERC
Funding Agency Reference Number:	NETGP-523228-18
Carleton University Fund Number:	319653
Project Title:	NSERC Permafrost Partnership Network for Canada
Grant Period:	June 30, 2019 – June 29, 2024
Sub-Grant Period:	April 1, XXXX - March 31, XXXX
Amount:	
Use of Funds:	

General Terms and Conditions:
By signing and returning this Agreement to the Primary Institution, the Collaborating Institution agrees to abide by the conditions herein:

This award shall be administered in accordance with the policies and procedures of the Tri- Agency, including but not limited to, the *Agreement on the Administration of Agency Grants and Awards by Research Institutions "The Agreement"* (http://www.science.gc.ca/default.asp?lang=En&n=56B87BE5-1) to which the recipient institution is a signatory, and the *Tri- Agency Financial Administration Guide* which may be found on their website at http://www.nserc-crsng.gc.ca/Professors-Professeurs/FinancialAdminGuide- GuideAdminFinancier/index_eng.asp.
The Collaborating Institution may not disburse any funds until all applicable compliance certificates (e.g., human, animal, and/or biohazard) have been obtained. Collaborating Institution must ensure that applicable certificates are maintained, in accordance with the provisions of *The Agreement*, for the duration of the grant period.
Prior approval from the Primary Institution is required to make any significant changes to the project plans. All expenses incurred must be eligible according to agency guidelines and related to the objectives for which the project was awarded funding. Carleton University accepts no responsibility or obligation for funds expended in excess of the amount quoted above or funds expended before or after the Grant Period.
Each party shall be responsible for its negligent acts or omissions and the negligent acts or omissions of its employees, officers, or directors, to the extent allowed by law.

Any equipment purchased with the sub-granted funds remains the property of the Collaborating Institution, and not the individual researcher. Equipment may be purchased using funds allocated in the budget as equipment. Equipment may not be purchased using funds allocated for HQP or Postdoc salaries.
The Collaborating Institution may not issue a sub-grant of this award.

An accountable advance payment will be issued to the Collaborating Institution upon receipt of the fully executed Agreement.

FUND TRANSFER INSTRUCTIONS to be provided by the Collaborating Institution

An annual Statement of Account (Form 300), reporting on the period ending March 31st, must be returned by April 30th of each year to the attention of:

Erin Feltmate
Research Financial Services
Erin.Feltmate@carleton.ca

301 Robertson Hall
Carleton University
1125 Colonel By Drive, Ottawa, ON, K1S 5B

A brief annual narrative report form (template will be provided) on each research project, including a description of HQP, research progress, results, deliverables, future HQP requirements, and any concerns, (and potentially other touch points for the purposes of reporting to the Network's Board of Directors), must be submitted twice annually (by email) by March 31st and September 30th of each year to the attention of:

Shirley McKey
Director of Operations
shirley.mckey@carleton.ca

Future institutional transfers will occur annually, or bi-annually, based on the Board of Director's approved budget for that fiscal year and may be adjusted based on progress, amount spent from previous transfers, and any changes to the scientific direction recommended by the Board.

Future payments may be withheld if the above-mentioned Form 300 or narrative report are not received in a timely manner, or the balance reported on the Form 300 is more than 50% of previous transfers. In the latter case, a second Form 300 may be requested at a later date to justify the transfer of funds.

Unspent funds may be carried over from one year to the next until the end of the Grant Period, subject to confirmation of budget plans with the Principal Investigator. Any unspent balance remaining at the

end of the Grant Period must be returned to the University with the final Form 300 Statement of Account.

The Collaborating Institution agrees to keep complete and accurate records on the use of Agency funding, including verifiable audit trails with complete supporting documentation for each transaction, for at least seven years and make the records available to the University, upon reasonable notice.

This Agreement may be executed in any number of counterparts by the parties hereto in separate counterparts, each of which when so executed shall be deemed to be an original and all of which taken together shall constitute one and the same agreement. Delivery by facsimile or by electronic transmission in portable document format (PDF) of an executed counterpart of this Agreement is as effective as delivery of an originally executed counterpart of this Agreement.

Agreed and accepted:

Carleton University _____ _____ Christine Rivas Date	By Authorized Official of Collaborating Institution: _____ _____ Name Date
Acting Director, CORIS	Title

By Principal Investigator <u>OR</u> Co-Investigator of Carleton University: _____ _____ Stephen Gruber Date	By Principal Investigator <u>OR</u> Co-Investigator of Collaborating Institution: _____ _____ Name Date
Professor, Department of Geography and Environmental Studies	Title

B.2. Sample Bi-annual Report

NSERC PermafrostNet CRSNG
Co-Investigator Bi-annual Report and
Request for HQP Funding

For bi-annual reporting , please complete a separate form for each HQP or project, save and email the form(s), using the subject line *pn_biannual*, to Shirley McKey, Director of Operations, (shirley.mckey@carleton.ca), by March 31st or September 30th of each reporting period.

For requests for HQP funding outside of the regular reporting periods , please complete only the fields on page 1, print the page to pdf, and then submit it to Shirley for processing.

A separate form must be filled out for each HQP or project. Note that questions preceded by an asterisk (*) are mandatory.

NSERC PermafrostNet CRSNG
Co-Investigator Bi-annual Report and
Request for HQP Funding

Submission Date: _____

Project summary
Theme Number: Project Code:

Project Name: _____
Primary Supervisor Name: _

HQP information
HQP Name: __
Email Address: _____
University: * Level:
Start date (real or projected):
Gender:
Citizenship:

Co-supervisors and collaborators
Please list project collaborators and co-supervisors in the table below. For each person, indicate whether there has been interaction within the most recent reporting period. If more lines are needed, use the extra space provided at the end of this form.

Name	Collaborator or Co-supervisor	Organization	Recent interaction
			☐
			☐
			☐
			☐
			☐

Project progress

Please provide a concise (100–250 words) narrative report on research progress toward milestones and network outputs, as well as any finished degrees.

Please provide a concise (100–250 words) report on recent interaction with network partners.

If you have any concerns, please describe them here. These may include missing network outputs or problems with upstream linkages with other themes. Include a description of potential or proposed solutions. Finally, identify any possible downstream impacts on other projects or network outputs.

Outreach and publication

Please list any completed or submitted publications (excluding those consisting exclusively of data or code) associated with this project that were generated with the help of network resources since the last bi-annual report. DOIs should be included when available and should be preceded by *doi.org/* (e.g. doi.org/10.1038/d41586-019-01715-4).

Please list any datasets or source code associated with this project that were published with the help of network resources since the last bi-annual report. DOIs should be included when available and should be preceded by *doi.org/* (e.g. doi.org/10.1038/d41586-019-01715-4).

Please list any project-related communication activities that have occurred since the last report. These could include media interviews, podcasts, outreach events, social media or speaking engagements.

Please list any conferences attended by the HQP that were supported by project travel funds.

Other information

Please list any in-kind or additional funding support provided to the Network, the project, or the HQP that would not be otherwise reported on the annual Form 300 that is completed by your institution. For example, if a co-PI put in funding from another source to benefit the project such as additional stipend support for a student.

Description	Value

Has the project been supported by Compute Canada resources? This includes access to the Permafrost Data Science Platform, database, cloud storage, compute cluster, etc.

◉ Yes ○ No

Will this project require funding for the next reporting period? ◉ Yes ○ No

Additional information

If you have any additional information you would like to include, please use this space:

If you have any concerns you would like to raise anonymously, or if you want to provide feedback outside of the reporting periods, please use the online form provided at http://tiny.cc/PermafrostNetFeedback

Email this form (using the subject line "pn_biannual") by March 31st or September 30th of each reporting period to:

Shirley McKey Director of Operations
shirley.mckey@carleton.ca

B.3. Sample Travel Claim

TRAVEL CLAIM FORM NSERC PermafrostNet

Name:				
Address: (or Carleton employee number)				
Project Number (Internal use):				
Event / Travel description:				
Date of travel (DD/MM/YY)	From:		To:	
Accompanied by: (if ride sharing or hosting a meal)		Phone:		

Please number each receipt on the front and include the number in the first column below. Any questions? Email shirley.mckey@carleton.ca or call 613-520-2600 ext. 2510. Thank you.

Receipt(s)							
No.	Date (DD/MM/YY)	Details (attach additional details if required)	Amount ($)				
			Car Mileage ($0.57 per km ON or $0.54 per km QC)	Transportation (Plane, Train, Bus, Taxi, Parking, etc.)	Hotel stay	Food expenses	Other expenses
SUB TOTALS							
TOTAL AMOUNT CLAIMED							

Please return claim to:

	Provinces & US	Yukon	NWT	Nunavut
Breakfast	$20.35	$22.75	$24.15	$27.35
Lunch	$20.60	$20.90	$29.30	$33.20
Dinner	$50.55	$60.25	$62.70	$88.45

Shirley McKey
PermafrostNet/Geography
Carleton University
B450A Loeb 1125
Colonel By Drive Ottawa
ON K1S 5B6
shirley.mckey@carleton.ca

Proof of payment and travel:

Please include the event program or a meeting confirmation with each claim.
For all expenses, include all original receipts and card payment slips (as proof of payment and to reflect tips if applicable).
For transportation, please include your original receipt, original ticket(s) and boarding pass(es).
For mileage claim, please include a detailed Google Maps as a proof of mileage and a receipt at your destination.

Signature: _____ Date: _____

B.4. Sample Claimant Declaration

Carleton University Travel and Expense Reimbursement

Claimant Declaration

This form must be attached to the supporting documentation package for any Travel and. Expense Reimbursement or Advance request that has been filled out electronically by a Delegate on behalf of a claimant.

Instructions:

Fill in the Event Destination (if applicable), Event Dates, and Purpose of Claim fields, as applicable to the Claim.
Check the box for either a Reimbursement or Advance Request.
Print the form.
Sign and date the appropriate declaration.
Deliver the form to your delegate along with the supporting documentation for your request.

Claimant Name Claimant ID #

Event Destination: Event Dates:

Purpose of Claim:

☐ Reimbursement

I certify that all expenses submitted are in accordance with University policy and will not be used as claims to other organization(s) or for Income Tax purposes.

Signature (Claimant) Date

☐ Advance

I confirm that I am requesting these funds to be used for the purpose of an event on behalf of Carleton University. This is a cash advance and I will report on it within 10 working days of the end of my event. I will provide all required supporting documentation when submitting my claim, including this advance. If I do not provide an accounting for this advance, I understand that I may receive a Statement of Other Income (T4A) from the University.

Signature (Claimant) Date

References (to be completed by Delegate)
Document Code:
Delegate Name:
Payment Amount Requested:

For use with the Travel and Expense Reimbursement System only

La Carleton UNIVERSITY Canada's Capital University

B.5. Sample Delegate authorization

This action is now done on-line and requires the travellers full name and contact information as indicated on the Travel Claim.

B.6. In-kind contribution report

Not an easy report to include as a sample. If you would like a sample please contact the Administrative Centre and an Excel template of the report will be sent to you.

B.7. Sample Conflict of Interest Form

NSERC Permafrost Partnership Network for Canada
(NSERC PermafrostNet)
Conflict of Interest Policy for External Board and Committee Members[1]

PURPOSE
NSERC Permafrost Partnership Network for Canada (NSERC PermafrostNet) is a not-for-profit Strategic Partnership Research Network funded through Natural Sciences and Engineering Research Council of Canada.
In an effort to maintain public confidence in the program and to ensure that management of confidentiality through governance processes are independent and transparent, NSERC PermafrostNet has adopted the NSERC Strategic Partnership Grants for Networks, Management Structure and Conflict of Interest Framework for NSERC Networks (Appendix A, attached).
This policy applies to all members of the NSERC PermafrostNet Board of Directors, and of any committee, sub-committee or working group of the Network ("NSERC PermafrostNet Committee") and employees[1].
The procedures set out below are designed to assist individuals participating in NSERC PermafrostNet to comply with the requirements described above.
RELATED POLICIES

Confidentiality Policy

RELATED FORMS
Conflict of Interest Declaration
Confidentiality Declaration

PROCESS

At the time of his or her appointment as a member of the Board of Directors or Scientific Advisory Committee, a network partner or member, or a network employee[1], (all referred to as 'member' going forward) shall review this Policy. Following such review, the member shall complete NSERC PermafrostNet's Conflict of Interest Declaration, (Appendix B attached).

In addition to the written Declaration, members shall declare their interests orally at a meeting of the Board or Committee.

Members shall make disclosure annually at the first Board or Committee meeting following NSERC PermafrostNet's Annual General Meeting, and thereafter from time to time as necessary.

The meeting Chair shall remind members of their obligation at the outset of each meeting; the Secretary of the meeting shall record disclosure of the conflicts of interest of members in the minutes of the meeting during which disclosure occurs, members shall update annually their declarations; if circumstances change during the period of their appointment, members shall immediately inform the Board/Committee Chair of the change in their situation.

A member in an actual conflict of interest shall absent himself or herself from that part of the meeting during which related matters are discussed, considered and/or voted on. The Secretary of the meeting shall reflect the absence of the member in the minutes.

A member who has a potential or perceived conflict of interest shall declare it and shall seek the advice of the Board/Committee Chair in exercising his or her discretion in regard to the potential conflict; the Chair shall report the conflict of interest to the Board/Committee and the Board/Committee shall determine the appropriate action in response;

[1] In the case of a network employee or employee of a partner that has signed the partnership agreement, the employee is first and foremost subject to the Conflict of Interest and Confidentiality Policies of their own organization.

The actions range from:

declaration that the conflict is minor or insignificant and should result in no further action;
declaration that the member concerned should not vote, but may otherwise participate in the discussion; and
declaration that the member concerned should not participate in the discussion, should leave the room, and should not vote.

If any member objects that another member is in an actual or potential conflict of interest, or is not taking the appropriate steps to deal with the conflict, the meeting Chair will call for a vote of the Board or Committee to determine the appropriate course of action.

For complaints regarding NSERC PermafrostNet procedures, the Director of Operations will be alerted to the complaint, and with the advice of the Board Chair the management team, will fully address the issue and if warranted, put in place corrective measures.

For complaints by one NSERC PermafrostNet member that one or more Board or Committee members has/have behaved unethically, the NSERC PermafrostNet management team will require that the complaint be formal, in writing, and detailed.

All records relevant to the situation will be submitted to the NSERC PermafrostNet Director of Operations for opinion;
NSERC PermafrostNet management will then take these opinions into account, propose a plan on how to proceed, seek the approval of the Board Chair to implement the plan; and
inform the Board during the next scheduled Board meeting of the issue and how it wasaddressed.

APPENDIX A

NSERC Strategic Partnership Grants for Networks

Management Structure and Conflict of Interest Framework for NSERC Networks

Interactions between university researchers and the private sector are an essential feature of the NSERC Networks. Annual General Meetings and Theme meetings are essential to ensure network integration. Interactions with the broader user sector are also important. These interactions may lead to gains and benefits to the network participants and are desirable and natural outcomes of being involved in the network. Such interactions, however, may place network participants in a position of potential, apparent or actual conflict of interest.

NSERC is ultimately responsible to the government and, therefore, to taxpayers, for the integrity of all the Networks and their operations. The responsibility for developing, implementing and managing of Conflict of Interest Policy, to ensure that network operations and decisions are not biased by conflict of interest, is delegated to each network Board, which represents the highest authority in the management structure of the network.

Network participants such as members of the Board and advisory committees who do not receive NSERC funds are recognized as playing a unique role in the networks. They bring an important perspective as a result of their particular knowledge, often as representatives of organization in the field of interest of the network. Nevertheless, they are still required to disclose any financial interest or position of influence in a business in the same area of interest as the network, other than that of their main employer.

The Conflict of Interest Policy is intended to enable the network Board and network participants to recognize and disclose situations that may be open to question and to ensure that such situations are appropriately resolved. The policy builds upon and is complementary to those of the organizations that make up the network boards, of the participants and of the administrators.

1.0 Definitions

"Avoidance" means refraining from, or withdrawing from, participation in activities or situations that place an individual participating in the network in a potential, apparent or actual conflict of interest relative to his or her network duties and responsibilities.

"Conflict of interest" means a situation where, to the detriment or potential detriment of the network, an individual is, or may be, in a position to use research knowledge, authority or influence for personal or family gain (financial or other) or to benefit others.

"Director of Operations" means the senior managerial employee of the network who reports to the Board of Directors.

"Disclosure" means the act of notifying in writing the Board of Directors, through the Director of Operations, of any direct or indirect financial interests and positions of influence held by an individual participating in the network which could lead to a potential, apparent or actual conflict of interest.

"Financial interest" means an interest in a business in the same area as the network as described in Section 2.1 of this Appendix.

"Network" means a group funded by NSERC under the Strategic Partnership Grants for Networks.

"Network Board of Directors" means the committee that is responsible for the overall management and finances of the network.

"Network Participant" means network investigators and their research teams, employees of the network administrative centre, private, public sector and other participants, member of network Boards of Directors and advisory committees.

"Position of influence" includes any position that entails responsibility for a material segment of the operation and/or management of a business.

Disclosure

Upon joining the network, each network participant is obliged to disclose in writing to the Board, through the Director of Operations, any direct or indirect financial interests and positions of influence that could lead to a potential, apparent or actual conflict of interest (examples

provided in Section VII of the Conflict of Interest Policy). In addition, these submissions must be updated whenever the network participants circumstances change in a way that would necessitate a further disclosure. The individual also has the obligation to disclose any potential, apparent or actual conflict of interest when it arises during network committee or Board meetings so that the committee or Board is aware of the situation and can take appropriate action.

Management of Conflict of Interest

The Board is charged with the responsibility of managing conflict of interest and determining and implementing the appropriate course of action. This management system is based on disclosure, as described in Section 2.0 of this Appendix. All disclosures constitute confidential information that will be available to the Board, or a sub- committee thereof, for the evaluation and resolution of any conflict of interest or allegations of conflict of interest brought before the Board or its conflict of interest sub-committee.

While it is recognized that it may be difficult to completely avoid situations of potential, apparent or actual conflict of interest, complete avoidance or divestment may be required in certain cases. Such divestment should not consist of a sale or transfer of assets to family members or other persons for the purpose of circumventing the conflict of interest compliance measures as directed by the Board.

A network participant who is involved with, or has an interest in, or deals in any manner with a third party which might cause a conflict of interest, must not be present or participate in any network decisions, including committee decisions, if the declared potential conflict of interest could influence the decision or actions of the network. It is the obligation of the network participant to declare such potential, apparent or actual conflict of interest before discussions take place

so that the committee or Board is aware of the situation in order to ensure that the network participant is out of the room when the discussion and decision process on the item in question are taking place. This course of action should be recorded in the minutes of the meeting.

Any question raised by a network participant or company regarding the potential conflict of interest of a network participant will be raised at the Board level and must be documented in writing. The Board will determine the extent to which the question should be pursued and in such cases will consult the network participant in question. If necessary, the network participant will be asked to respond in writing.

Non-compliance

If a network participant is discovered to be in conflict of interest where disclosure and prior approval have not been sought or granted, the Board will require the network participant to:

account to the network for any gain or benefit made directly or indirectly, arising from an involvement with, or an interest in, or from dealing in any manner with a third party that gives rise to a conflict of interest; and

withdraw from the involvement; or

withdraw from the network; or

take appropriate action as determined by the Board of Directors.

APPENDIX B

Declaration

Interactions between university researchers and the private sector are an essential feature of the Natural Sciences and Engineering Research Council of Canada Strategic Partnership Program ("NSERC Program"). For the objectives of the NSERC Program to be achieved many kinds of interactions among network participants in the NSERC Permafrost Partnership Network for Canada (NSERC PermafrostNet) must occur. These interactions may lead to gains and benefits to the individuals participating in the NSERC PermafrostNet network and are desirable and natural outcomes of being involved in NSERC PermafrostNet. Such interactions, however, may place individuals participating in the NSERC PermafrostNet network in a position of potential, apparent, or actual conflict of interest.

Name:	Address:
	Email:

Affiliation with NSERC PermafrostNet (please select one):

❑ Director

❑ Committee Member ❑ Other: _____ Specify:

Committee name(s) _____

I, the undersigned, *(print full name)*

confirm that I have reviewed the definitions for "Conflict of Interest" and "Disclosure" as outlined within the text of the NSERC PermafrostNet *Conflict of Interest Policy.*

❑ I hereby declare and make Disclosure of the following actual or potential Conflict(s) of Interest which may arise in the conduct of my duties and responsibilities on behalf of NSERC PermafrostNet (attach additional sheet if required).

Identify Affiliation	Indicate Why There May be An Actual or Perceived Conflict of Interest

OR: ❑ I am not aware of any actual or potential Conflict(s) of Interest with respect to my involvement with NSERC PermafrostNet. (initial)_____

I have read and understand the NSERC PermafrostNet Conflict of Interest Policy and will adhere to the Policy during my affiliation with NSERC PermafrostNet. Specifically, if any circumstances change and/or come to my attention regarding any actual or potential Conflict of Interest, I will make Disclosure to the NSERC PermafrostNet immediately.

Signed:_____ Date: _____

B.7. Sample Confidentiality Form

NSERC Permafrost Partnership Network for Canada (NSERC PermafrostNet) Confidentiality Policy for External Board and Committee Members[1]

PURPOSE

NSERC Permafrost Partnership Network for Canada (NSERC PermafrostNet) is a not-for-profit Strategic Partnership Research Network funded through Natural Sciences and Engineering Research Council of Canada. In an effort to maintain public confidence in the program and to ensure that management of confidentiality through governance processes are independent and transparent, NSERC PermafrostNet has adopted the Confidentiality policy as laid out in the NSERC Permafrost Partnership Network for Canada (NSERC PermafrostNet) Strategic Network Agreement, Section 7, "Confidentiality".

This policy applies to all members of the NSERC PermafrostNet Board of Directors, and of any committee, sub-committee or working group of the Network ("NSERC PermafrostNet Committee") and employees[2].

The procedures set out below are designed to assist individuals participating in NSERC PermafrostNet to comply with the requirements described above.

RELATED POLICIES

Conflict of Interest Policy

RELATED FORMS

Confidentiality Declaration

Conflict of Interest Declaration

CONFIDENTIALITY as per Section 7, Strategic Partnership Agreement

Each Party (the "**Provider**") may disclose information it considers confidential to another Party or the other Parties (the "**Recipient(s)**") to facilitate Network Research. **"Confidential Information"** means without limitation, all scientific, technical, business, financial, legal, marketing or strategic information and data that:

is non-public, protected, confidential, privileged or proprietary in nature;
may have actual or potential economic value, in part, from not being known;
is however fixed, stored, expressed or embodied (and includes, without limitation, samples, prototypes, specimens and derivatives);
disclosed during discussions, telephone calls, meetings, tests, demonstrations, correspondence or otherwise;
that is consistently treated as confidential; or
any part or portion thereof, related to the Network Research project pursuant to this Agreement.

In order to be considered as Confidential Information, the aforementioned information has to be specifically marked as "Confidential" or identified as confidential at the time of disclosure.

Any Confidential information disclosed orally shall be reduced to written version that is marked as above and given to the Recipient within fifteen (15) days of disclosure.

The Recipient shall protect, keep and treat as confidential any Confidential Information, unless such disclosure is authorized by the Provider in writing, or unless disclosure is required by law including but not limited to applicable

[2] In the case of a network employee or employee of a partner that has signed the partnership agreement, the employee is first and foremost subject to the Conflict of Interest and Confidentiality Policies of their own organization.

statute, regulation or other enactment or by lawful order, including a subpoena, of a court or administrative or regulatory authority having jurisdiction, provided Recipient provides Provider with immediate notice of such requirement upon Recipient's receipt of notice of the same. Confidential Information shall be kept confidential and protected by the Recipient with at least the same degree of care as it uses to protect its own confidential information, but not less than a reasonable degree of care.

Nothing in this Network Agreement prevents any Party from disclosing Confidential Information that it owns or that it has the right to disclose outside of this Agreement or the Network.

Unless written permission is obtained from the Provider, the Recipient shall not use any Confidential Information in the performance of Network Research where such use would knowingly compromise exploitation of any resulting Arising IP. Confidential Information may be disclosed within Recipient's organization and to the Scientific Committee, as required to perform Network Research.

Obligations of confidentiality and restrictions relating to publication or disclosure of Confidential Information shall not apply to, and no Party to this Agreement shall be liable for a disclosure to another Party or to a third Party of, Confidential Information that:

Is already known to the Recipient to which it is disclosed prior to disclosure by the Provider without breach of the provisions of this Agreement;

Is or becomes part of the public domain without breach of this Agreement;

Is lawfully obtained from third parties that have no confidentiality obligations to the disclosing Party;

Is independently developed by one Party without reference to Confidential Information provided by the other Party.

Notwithstanding any other provision of this Agreement each Party may make public at any time and without prior approval of any other Party, the following information regarding this Agreement: the project Title, names of the applicants and individuals who are Network Investigators, amount awarded, duration, institute or faculty or department involved, the field of research, and summary of the research proposal prepared by the applicant for public release, and cost estimates for the Party's involvement in the Network.

As directed by the Provider, Confidential Information shall, upon request or Termination of this Agreement, be returned to the Provider or destroyed by the Recipient. Recipient shall not keep copies of Confidential Information, unless authorized in writing by owners of the Confidential Information or required to do so by law.

Unless otherwise decided by the concerned Provider(s), and subject to the exemptions and exceptions provided for in this Agreement, all obligations of confidentiality and restrictions on the use of Confidential Information cease to apply five (5) years after the expiration of this Agreement.

DECLARATION

Affiliation with NSERC PermafrostNet (please select one):

❑ Director ❑ Committee Member
❑ Other: _____
Specify:
Committee name(s) _____

I, the undersigned, (print full name) _____
have read and understand the NSERC PermafrostNet Confidentiality policy and will adhere to the Policy during my affiliation with NSERC PermafrostNet.

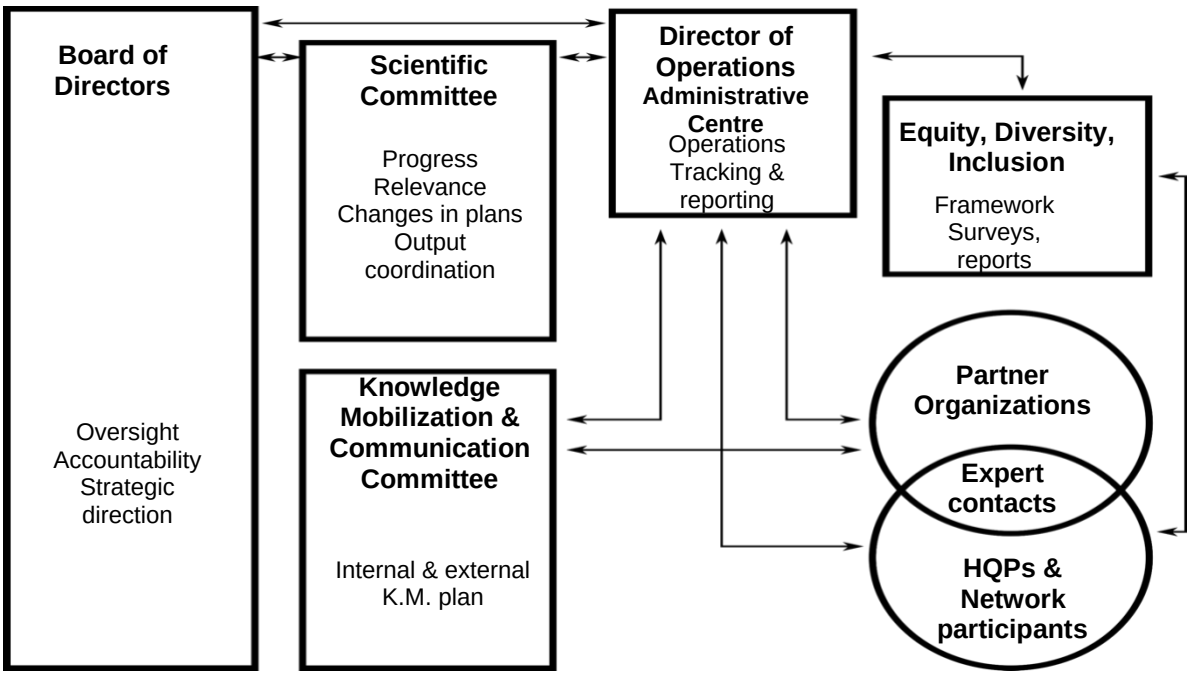
NAME: _____

SIGNATURE: _____

TITLE: _____

DATE: _____

Organizational Chart



Governance, partners and scientific expertise

Board of Directors
Current Members

Lukas Arenson
Stephan Gruber
Anick Guimond
Linda Ham
Janet King – Chair
Manny Kudlak
David Moore
Trevor Lantz
Megan Nichols
Carolyn Relf

Co-Investigators

Chris Burn
Claude Duguay
Daniel Fortier
Duane Froese
Stephan Gruber
Jocelyn Hayley
Shawn Kenny
Antoni Lewkowicz
Joe Melton
Brian Moorman
Bernhard Rabus
Pascale Roy-Léveillée

Scientific Committee
Current Members

Fabrice Camels
Christine Dow
Stephan Gruber
Jocelyn Hayley
Peter Pulsifer
Ted Schuur

Knowledge Mobilization and Communications Committee
Current Members

LeeAnn Fishback
Kumari Karunaratne
Julie Carl (Chair)
Tristan MacLean
Eduardo Marquez
Nicole McRae
Peter Morse

Equity, Diversity and Inclusion Committee
Current Members

Tristan MacLean
Joe Melton
Kala Pendakur
Pascale Roy-Léveillée
Kate Swan

Administration Centre

Nick Brown,
Data Scientist
Stephan Gruber
Scientific Director
Tristan MacLean,
KM and Communications Coordinator
Shirley McKey,
Director of Operations
Emma Stockton,
Administrative Assistant

Collaborators

Michel Allard
Fabrice Calmels
Alex Cannon
Stephanie Coulombe
Cathie Findlay-Brook
Erika Hille
Brian Horton
Elyn Humphreys
Michael Krautblatter
Melissa Lafrenière
Anne-Marie Leblanc
Nicole McRae
Brendan O'Neill
Ashley Rudy
Sharon Smith
Oliver Sonnentag
Christopher Spence
David Stillman
Stephen Wolfe

Partner Organizations

BC Ministry of Forests, Lands and Natural Resources
BGC Engineering Inc.
Canada Centre for Mapping and Earth Observation, Natural Resources Canada
Canada-Nunavut Geoscience Office
Churchill Northern Studies Centre
ECCC, Atmospheric Science and Technology
ECCC, Canadian Centre for Climate Services
Fort Severn First Nation
Federation of Canadian Municipalities
Geological Survey of Canada
Government of Nunavut: Climate Change
Government of NWT: Environment and Natural Resources
Gwich'in Renewable Resources Board
Inuvialuit Game Council
MacDonald, Dettwiler and Associates Ltd.
Ministère des Transports du Québec, Direction générale des projets et de l'exploitation aéroportuaires
National Research Council
Northwest Territories Department of Infrastructure
Northwest Territories Geological Survey
Ontario Ministry of Natural Resources and Forestry
SRK Consulting Inc.
Standards Council of Canada
Tr'ondëk Hwëch'in Government
Transport Canada
Yukon Government: Department of Environment
Yukon Government: Transportation Engineering Branch
Yukon Government: Yukon Geological Survey
Yukon Government: Yukon Parks

APPENDIX M: Table - Overview of project deviations.

Appendix Table 1: Overview of project deviations.

Project Title, HQP position and supervisor (proposal project code)	Status	Reason
Theme 1		
Standardization of permafrost characteristics - PDF, D. Froese (T1-PDF2)	In progress	Suitable candidate was too far post-PhD to qualify as PDF thus hired as research associate.
Effects of cryostructure on permafrost thaw and temperature-dependent properties – PhD, D. Froese (T1-PhD1)	Cancelled	Unable to recruit in time.
Strength and consolidation behaviour of permafrost sediments - MSc, J. Hayley (T1-MSc1)	In progress; part of a PhD	Additional non-network funding and suitable candidate enabled incorporation of milestones into a PhD.
Syngenetic permafrost of unglaciated Yukon - MSc, D. Froese (T1-MSc2)	In progress; part of a PhD	Additional non-network funding and suitable candidate enabled incorporation of milestones into a PhD.
Theme 2		
Using repeat ERT to monitor permafrost thaw - PhD, A. Lewkowicz (T2-PhD1)	Cancelled	Retirement of co-investigator.
Synthesizing observations to develop a responsive monitoring network - PDF, T. Lantz (T2-PDF1)	Recruiting early	Project brought forward by a year.
Theme 3		
Simulating land cover change and its influence on permafrost with CLASS-CTEM - MSc, J. Melton (T3-PhD1)	In progress; converted to MSc	PhD level resources were swapped with T3-MSc1 to reflect the complexity and importance of that project. Externally funded PDF of Co-I contributed to accomplishing milestones.
Incorporation of excess ground ice and its impacts into CLASS-CTEM - PhD, J. Melton (T3-MSc1)	In progress; converted to PhD	See above.
Simulating the development of lowland thermokarst - PhD, C. Duguay (T3-PhD2)	Cancelled	Unable to recruit in time.
Theme 4		

Scientific and stakeholder surveys to prioritize thaw impacts and hazards - MSc, S. Lamoureux (T4-MSc1)	Cancelled; funds into new Theme 4 PDF	Retirement of co-investigator.
Improving the management of permafrost hazards by using value of information theory - MSc, M. Turetsky (T4-MSc2)	Cancelled; funds into new Theme 4 PDF	Departure of co-investigator.
Quantifying permafrost thaw-driven hazards contributing to water quality change - MSc, S. Lamoureux (T4-MSc4)	Cancelled; funds into new Theme 5 PhD	Retirement of co-investigator.
Permafrost recovery in drained lakes and ponds -MSc, P. Roy-Léveillée (new project)	In progress	Created new project to achieve milestones of T4-PhD2.
Spatial distribution of thermokarst initiation - MSc, P. Roy-Léveillée (new project)	In progress	Created new project to achieve milestones of T4-PhD2.
Understanding and prediction of thaw-induced mass movement in steep mountains - MSc, S. Gruber (T4-PhD1).	In progress; converted to MSc	Unable to recruit PhD on time, split into two MSc projects.
Understanding and prediction of thaw pond initiation and evolution pathways - PhD, P. Roy-Léveillée (T4-PhD2)	Split; in progress	Converted into two MSc projects, T4-MSc5 and T4-MSc6.
Improved prediction of thermokarst in peatlands and abrupt loss of forests and lichen - PhD, M. Turetsky (T4-PhD3)	Cancelled; funds into new Theme 4 PDF	Departure of co-investigator.
Understanding and prediction of thaw-driven flash flooding and water quality change - PhD, S. Lamoureux (T4-PhD5)	In progress	New supervisor (M. Lafrenière) due to retirement of original co-investigator.
Scientific and stakeholder surveys to prioritize thaw impacts and hazards - PDF, P. Roy-Léveillée (new project)	In progress	Created new project to achieve milestones of T4-PhD3.
Theme 5		
Land use planning and mass-wasting hazards near Fort Severn - MSc, P. Roy-Léveillée (T5-MSc1)	Converted to new Theme 5 PhD (T5-PhD4)	Combination of project funds from T4-MSc4 and T5-MSc1.
Management of water in winter near linear infrastructure, Blackstone Uplands - PhD, C. Burn (T5-PhD2)	Cancelled	Unable to recruit in time.
Timing of sump stability, western Arctic coast - PhD, C. Burn (T5-PhD3)	In progress	Converted to an MSc.
Land use planning and mass-wasting hazards near Fort Severn and water quality change - PhD, P. Roy-Léveillée (new project)	In progress	This project combines T4-MSc4 and T5-MSc1.

APPENDIX N: Example Transfer of Funds agreement

Carleton UNIVERSITY
Canada's Capital University

Carleton Office for Research Initiatives and Services (CORIS)
1301 Dunton Tower
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Tel: (613) 520-2600 ext. 3591

Transfer of Funds Agreement
Between Carleton University "Primary Institution" and University of X "Collaborating Institution"

Date:	
Principal Investigator (Carleton University):	Stephan Gruber
Co-Investigator (Collaborating Institution):	
Funding Agency:	NSERC
Funding Agency Reference Number:	NETGP-523228-18
Carleton University Fund Number:	319653
Project Title:	NSERC Permafrost Partnership Network for Canada
Grant Period:	June 30, 2019 – June 29, 2024
Sub-Grant Period:	April 1, XXXX - March 31, XXXX
Amount:	
Use of Funds:	

General Terms and Conditions:

By signing and returning this Agreement to the Primary Institution, the Collaborating Institution agrees to abide by the conditions herein:

1. This award shall be administered in accordance with the policies and procedures of the Tri- Agency, including but not limited to, the *Agreement on the Administration of Agency Grants and Awards by Research Institutions "The Agreement"* (http://www.science.gc.ca/default.asp?lang=En&n=56B87BE5-1) to which the recipient institution is a signatory, and the *Tri- Agency Financial Administration Guide* which may be found on their website at http://www.nserc-crsng.gc.ca/Professors-Professeurs/FinancialAdminGuide- GuideAdminFinancier/index_eng.asp.
2. The Collaborating Institution may not disburse any funds until all applicable compliance certificates (e.g., human, animal, and/or biohazard) have been obtained. Collaborating Institution must ensure that applicable certificates are maintained, in accordance with the provisions of *The Agreement*, for the duration of the grant period.
3. Prior approval from the Primary Institution is required to make any significant changes to the project plans. All expenses incurred must be eligible according to agency guidelines and related to the objectives for which the project was awarded funding. Carleton University accepts no responsibility or obligation for funds expended in excess of the amount quoted above or funds expended before or after the Grant Period.
4. Each party shall be responsible for its negligent acts or omissions and the negligent acts or omissions of its employees, officers, or directors, to the extent allowed by law.
5. Any equipment purchased with the sub-granted funds remains the property of the Collaborating Institution, and not the individual researcher. Equipment may be purchased using funds allocated in the

Carleton UNIVERSITY
Canada's Capital University

Carleton Office for Research Initiatives and Services (CORIS)
1301 Dunton Tower
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Tel: (613) 520-2600 ext. 3591

budget as equipment. Equipment may not be purchased using funds allocated for HQP or Postdoc salaries.

6. The Collaborating Institution may not issue a sub-grant of this award.

An accountable advance payment will be issued to the Collaborating Institution upon receipt of the fully executed Agreement.

FUND TRANSFER INSTRUCTIONS to be provided by the Collaborating Institution

An annual Statement of Account (Form 300), reporting on the period ending March 31st, must be returned by April 30th of each year to the attention of:

Erin Feltmate
Research Financial Services
Erin.Feltmate@carleton.ca

301 Robertson Hall
Carleton University
1125 Colonel By Drive, Ottawa, ON, K1S 5B

A brief annual narrative report form (template will be provided) on each research project, including a description of HQP, research progress, results, deliverables, future HQP requirements, and any concerns, (and potentially other touch points for the purposes of reporting to the Network's Board of Directors), must be submitted (by email) by March 31st of each year to the attention of:

Shirley McKey
Director of Operations
shirley.mckey@carleton.ca

Future institutional transfers will occur annually, or bi-annually, based on the Board of Director's approved budget for that fiscal year and may be adjusted based on progress, amount spent from previous transfers, and any changes to the scientific direction recommended by the Board.

Future payments may be withheld if the above-mentioned Form 300 or narrative report are not received in a timely manner, or the balance reported on the Form 300 is more than 50% of previous transfers. In the latter case, a second Form 300 may be requested at a later date to justify the transfer of funds.

Carleton University
Canada's Capital University

Carleton Office for Research Initiatives and Services (CORIS)
1301 Dunton Tower
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Tel: (613) 520-2600 ext. 3591

Unspent funds may be carried over from one year to the next until the end of the Grant Period, subject to confirmation of budget plans with the Principal Investigator. Any unspent balance remaining at the

end of the Grant Period must be returned to the University with the final Form 300 Statement of Account.

The Collaborating Institution agrees to keep complete and accurate records on the use of Agency funding, including verifiable audit trails with complete supporting documentation for each transaction, for at least seven years and make the records available to the University, upon reasonable notice.

This Agreement may be executed in any number of counterparts by the parties hereto in separate counterparts, each of which when so executed shall be deemed to be an original and all of which taken together shall constitute one and the same agreement. Delivery by facsimile or by electronic transmission in portable document format (PDF) of an executed counterpart of this Agreement is as effective as delivery of an originally executed counterpart of this Agreement.

Agreed and accepted:

Carleton University	By Authorized Official of **Collaborating Institution**:
_____ _____ Christine Rivas Date	_____ _____ Name Date
Acting Director, CORIS	Title

By Principal Investigator OR Co-Investigator of Carleton University:	By Principal Investigator OR Co-Investigator of **Collaborating Institution**:
_____ _____ Stephen Gruber Date	_____ _____ Name Date
Professor, Department of Geography and Environmental Studies	Title

Carleton UNIVERSITY
Canada's Capital University

Carleton Office for Research Initiatives and Services (CORIS)
1301 Dunton Tower
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Tel: (613) 520-2600 ext. 3591

Appendix Table 2: Partner collaborative contributions to NSERC PermafrostNet

Interaction	Network Partner
Board of Directors	1. Environment and Climate Change Canada 2. BGC Engineering 3. Ministère des Transports du Québec 4. Natural Resources Canada 5. Government of Northwest Territories 6. Transport Canada 7. Yukon Government, Energy, Mines and Resources 8. Inuvialuit Game Council
Scientific Committee	1. Yukon Research Centre 2. University of Alberta 3. University of Calgary 4. University of Waterloo 5. Carleton University 6. University of Victoria and Environment and Climate Change Canada 7. National Snow and Ice Data Center (University of Colorado) 8. Northern Arizona University
Knowledge Mobilization and Communication Committee	1. Geological Survey of Canada, Natural Resources Canada 2. Northwest Territories Geological Survey 3. SRK Consulting (Canada) Inc. 4. Churchill Northern Studies Centre 5. Canadian Centre for Climate Services, Environment and Climate Change Canada
Equity, Diversity and Inclusion Committee	1. Standards Council of Canada 2. University of Alberta 3. Carleton University 4. Laurentian University / Université Laval 5. ArcticNet 6. University of Victoria and Environment and Climate Change Canada
Contribute to network research projects	1. Government of Northwest Territories – Department of Infrastructure (DOI) 2. Yukon Geological Survey 3. Environment and Climate Change Canada - ASTD 4. Government of Nunavut - Climate Change Secretariat 5. Ministère des Transports du Québec 6. Geological Survey of Canada 7. BGC Engineering Inc. 8. BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development 9. MDA Systems Ltd. 10. Transport Canada 11. SRK Consulting 12. Natural Resources Canada - Canada Centre for Mapping and Earth Observation (CCMEO) 13. Arctic Gateway Group

	14. Parks Canada 15. Polar Continental Shelf Project

APPENDIX O: In-Kind contributions to the network

Appendix Table 3: Detailed In-kind contributions from NSERC PermafrostNet partners

BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$96,000
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	$43,750
5) Provision of services	$122,500
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$262,250
BGC Engineering Inc.	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$3,450
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$3,450

Churchill Northern Studies Centre (CNSC)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	
2) Donation of equipment, software	$70
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	$441
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$511
Environment and Climate Change Canada - ASTD	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$3,600
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	$46,400
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$50,000
Government of Northwest Territories – Department of Infrastructure (DOI)	*At 30 months (Dec 31, 2021)*
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	*$11,760*

2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	*$11,760*
Government of Nunavut - Climate Change Secretariat (CCS)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify):	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): Participation in network teleconferences and workshops	$8,500
Total of all in-kind contributions	$8,500
Inuvialuit Game Council (IGC)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify):	

In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	$23,650
3) Other (specify): Participation in network teleconferences and workshops	
Total of all in-kind contributions	$23,650
MDA Geospatial Services Inc. (MDA)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	
2) Donation of equipment, software	
3) Donation of material	$120,000
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$120,000
Ministère des Transports du Québec (MTQ)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$5,600
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	$125,000
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	

Total of all in-kind contributions	$131,400
Natural Resources Canada - Canada Centre for Mapping and Earth Observation (CCMEO)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$20,000
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$20,000
Natural Resources Canada (NRCan) - Geological Survey of Canada	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$16,625
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$16,625
SRK Consulting	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	

In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$6,650
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$6,650
Standards Council of Canada (SCC)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$13,500
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$13,500
Transport Canada (TC)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	

6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	$22,776
3) Other (specify): Dissemination and meeting participation.	$6,288
Total of all in-kind contributions	$29,064
Tr'ondëk Hwëch'in Government (THG)	At 30 months (Dec 31, 2021)
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$880
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): Dissemination and meeting participation.	
Total of all in-kind contributions	$880
Yukon Geological Survey (YGS)	*At 30 months (Dec 31, 2021)*
Cash contributions to direct costs of research	
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	*$389,175*
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	*$6,889*
5) Provision of services	*$38,395*
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	

3) Other (specify): _____	
Total of all in-kind contributions	$434,459

Carleton University	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$215,961
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$34,407
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	
5) Provision of services	$84,000
6) Other (specify): _____	
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	$24,030
2) Salaries of managerial and administrative staff	$13,200
3) Other (specify): furniture and equipment	$103,000
Total of all in-kind contributions	$440,191
University of Alberta	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$20,000
Total of all in-kind contributions	$20,000
University of Victoria	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$10,000
Total of all in-kind contributions	$10,000
Laurentian University of Sudbury	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$0
Total of all in-kind contributions	$0
Royal Military College of Canada	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	$4,000
Total of all in-kind contributions	$4,000

University of Montreal	At 30 months (Dec 31, 2021)
Cash contributions to indirect costs of research	
Total of all in-kind contributions	$0
University of Laval	At 30 months (Dec 31, 2021)
In-kind contributions to direct costs of research	
1) Salaries for scientific and technical staff	$10,822
2) Donation of equipment, software	
3) Donation of material	
4) Fieldwork logistics	$5,000
5) Provision of services	
6) Other (specify): Scholarship support/Student stipends	$5,486
In-kind contributions to indirect costs of research	
1) Use of organization's facilities	
2) Salaries of managerial and administrative staff	
3) Other (specify): _____	
Total of all in-kind contributions	$21,308