INUVIALUIT SETTLEMENT REGION; DRILLING SUMPS FAILURE AND CLIMATE CHANGE REPORT

DRAFT FOR REVIEW

March 11, 2020

Submitted to:
Bob Simpson
Director of Government Affairs and Research, Inuvialuit Regional Corporation

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March 11, 2020

Inuvialuit Regional Corporation
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ATTENTION:

Bob Simpson
Director of Government Affairs and Research

RE: INUVIALUIT SETTLEMENT REGION, DRILLING SUMPS AND CLIMATE CHANGE REPORT

ARKTIS Solutions Inc. is pleased to provide the Inuvialuit Regional Corporation with a final report for the above referenced project. We trust that the information presented in this report satisfies the requirements of the project. Please do not hesitate to contact the undersigned if there are any questions or comments.

Sincerely,

Jamie VanGulck, Ph.D., P.Eng.
Principal, ARKTIS Solutions Inc.

EXECUTIVE SUMMARY

The Project

ARKTIS Solutions Inc. (ARKTIS) was contracted by the Inuvialuit Regional Corporation (IRC) to develop an updated Drilling Waste and Sump Inventory (Inventory) for the Inuvialuit Settlement Region (ISR) based on a review of monitoring, inspection and assessment reports, as well as, previous applicable studies. The updated Inventory attempts to identify any wells for which the owner could not be identified (orphan well sites), documents the status of the sumps and identifies the characteristics of any new sumps since the last inventory done in 2004 (AMEC, 2005). The study also provides insights into the pace and extent of climate change affecting sump failure with associated environmental impacts. The Inventory will also provide a basis for future recommended priorities for methods that could mitigate the environmental impacts from failed sumps, or sumps that could fail in the future.

Project Objectives

The objectives of the study were to:

- Update the well and sump inventory for the ISR and identify the well ownership and requirements for site reclamation.
- Summarize the potential and/or actual environmental impacts from each sump through a review of studies/reports combined with information derived from interviews with Inuvialuit hunters and trappers of the region.
- Evaluate the information that is available to characterizes the sumps in their localized environmental setting and provide recommendations to address information gaps that would aid in the development of remedial action plans.
- Provide a prioritized ranking for potential stabilization or reclamation of the sumps with associated recommendations for possible remedial action.
- Assess potential climate change in the ISR and identify those potential implications that could be associated with future integrity of the sumps.

History and Lands of the ISR

The ISR of the Northwest Territories (shown in Figure 1) has witnessed oil and gas exploration since 1961. Based on findings from an Environmental Studies Research Fund (ESRF) study completed in 2004 (AMEC, 2005), there were 216 exploratory onshore wells listed within the ISR, 72 of which were located on Inuvialuit Lands.

Drilling waste produced from oil and gas exploration and production within the ISR has historically been deposited in sumps typically located near the drilled well. Drilling wastes may contain deleterious or toxic materials and contaminants that could negatively impact the receiving environment if the wastes are released.

The 2004 ESRF study indicated that some sumps had failed to contain their contents and had resulted in impacts to the receiving environment (e.g., changes to water and soil quality, permafrost degradation, landform subsidence). As the sumps were designed and predicated upon permafrost encapsulation to achieve designed containment functions, warming in the region due to climate change may have contributed to past, or potentially future, sump failures. Regional warming is projected to continue with a potential for additional sump failures.

The degradation of drilling sumps is of concern to the Inuvialuit in the ISR because failures to contain the wastes could result in discharges of contaminated materials throughout the region and could pose a material environmental threat to the ISR. Hence, the Inuvialuit view the maintenance and security of those disposal sites to be a priority. The dramatic changes to the Arctic climate has focused concerns about the stability and integrity of drilling waste disposal sites throughout the ISR.

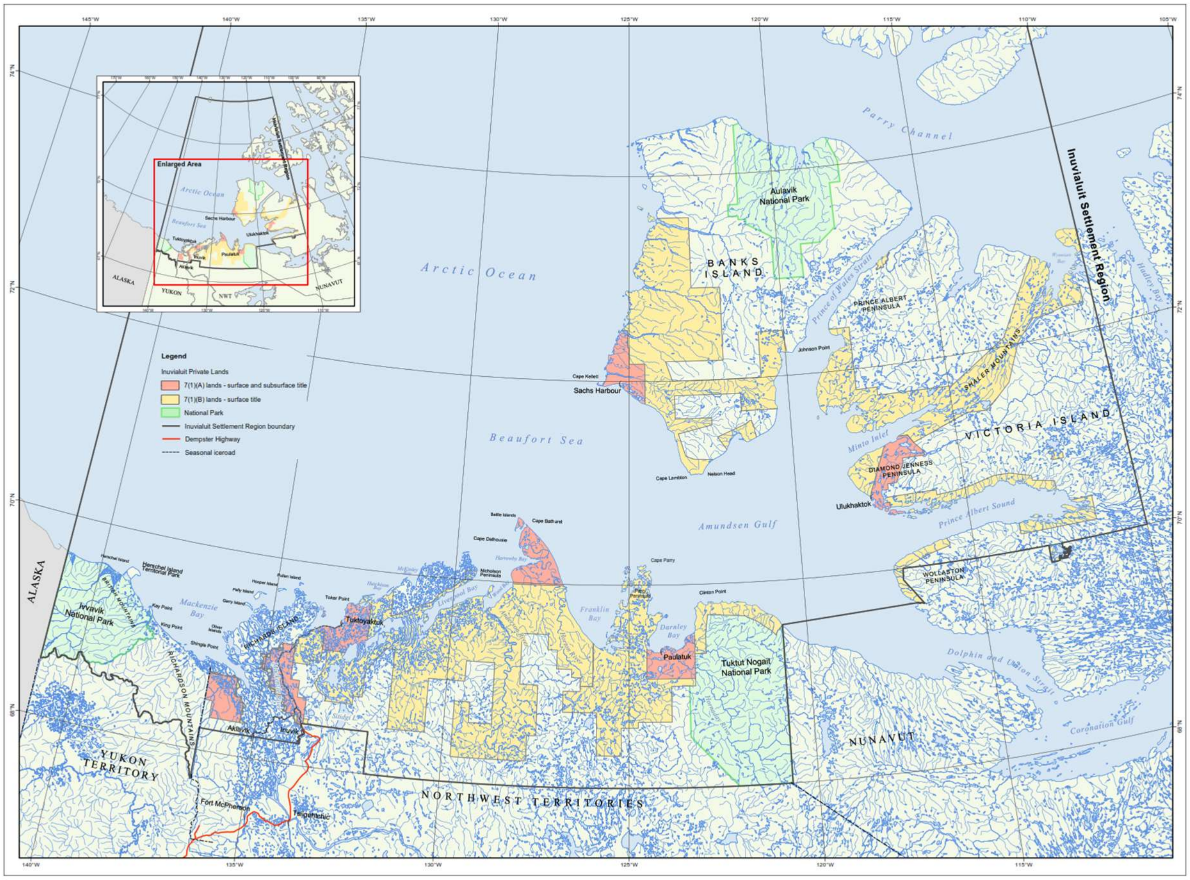

Figure 1. Lands of the Inuvialuit Settlement Region

Key Findings

a. Well and Sump Inventory

A detailed search of records and relevant literature was completed to consolidate available information on drilling waste sumps and secure well sites. A total of 233 onshore wells were identified within the ISR, currently owned by 16 different companies. Only one orphan well was identified – Orksut I-44, whose original owner, Deminex, has apparently become insolvent with no obvious successor or apparent transfer of ownership.

An updated well and sump inventory for the ISR (see Table 1 and Figure 2) was developed to identify responsibilities for the well sites. 2 well sites were currently subject to corporate ownership negotiations, 6 well sites are indicated as having been sold to another company but remain to be confirmed by the supposed buyer(s), 7 well sites had unclear ownership and 4 well sites had no indicated owner.

The licenses and permits for each well site were consolidated and the requirements for remediation/removal of the waste sumps were documented. In general, sump closure was completed shortly following completion of well drilling. Closure requirements varied between sites based on reviews of available data for sumps in the period ranging from 1998 to 2011.

Among the 233 wells reviewed, a total of 223 drilling waste sumps were identified. Corporate requirements for remediation or removal of waste sumps was identified wherever possible and comparative analyses were done to assess industry best practices for the region.

21 well sites have Inuvialuit Water Board (IWB) Water Licenses that specify closure requirements for waste management. Closure and reclamation or remediation plans are available for 6 well/sump sites. 13 additional well sites have documentation that identifies reclamation approaches (at varying levels of detail) for their associated drilling sumps and 5 sump sites have witnessed remediation efforts in response to directions from inspectors.

- A total of 233 onshore wells have been drilled within the ISR.
- The 2019 Canadian Energy Regulator (CER) well list identifies 206 wells in the ISR.
- The 2004 ESRF study identifies an additional 20 wells while other public records identify a further 3 wells and the Government of the Northwest Territories identified an additional 4 wells but no owner indicated.
- 12 new wells have been drilled since the 2004 ESRF study.
- 16 companies currently own wells in the ISR.
- Companies owning large numbers of wells include Imperial Oil (75 wells), ConocoPhillips (37 wells), Shell Canada (22 wells), Suncor (22 wells), Husky (15 wells), Chevron (11 wells) and MGM Energy Corp. (10 wells).
- A single orphan well was identified (Orksut I-44).
- The 2019 CER and 2004 ESRF reports identify the largest number of wells sites but that information is generally limited to owner, location and dates of operation.
- Most records with information on sump conditions were accessed through the NWT Centre for Geomatics sump database.
- The next largest sources for information on sumps was determined to be the IWB registry/library, followed by the Environmental Impact Screening Committee (EISC) database and the 2004 ESRF study for which in-field inspections of 10 sumps to characterize sump condition and the environmental setting was completed.
- IWB water licences are available for 21 well sites. These records outline the management of waste and closure requirements for those sites. Closure and reclamation or remediation plans are available from the IWB public registry for 6 well/sump sites.
- Other documentation sources identified the reclamation approach for drilling sumps at varying levels of detail for 13 well sites.
- Inspector-directed remediation efforts are documented for 5 sump sites.
- There is a total of 233 drilling waste sumps located within the ISR. Among the 233 identified well sites, 6 do not have a drilling waste sump, while 2 sumps are shared between two wells each and 1 sump is shared between another three wells.

Table 1. ISR well and sump counts by region:

CER Designated Region	No. of Onshore Wells	No. of Sumps
Mackenzie Delta	182	172
Arctic Islands	41	41
Mainland	7	7
Yukon Onshore	3	3
Total	**233**	**223**

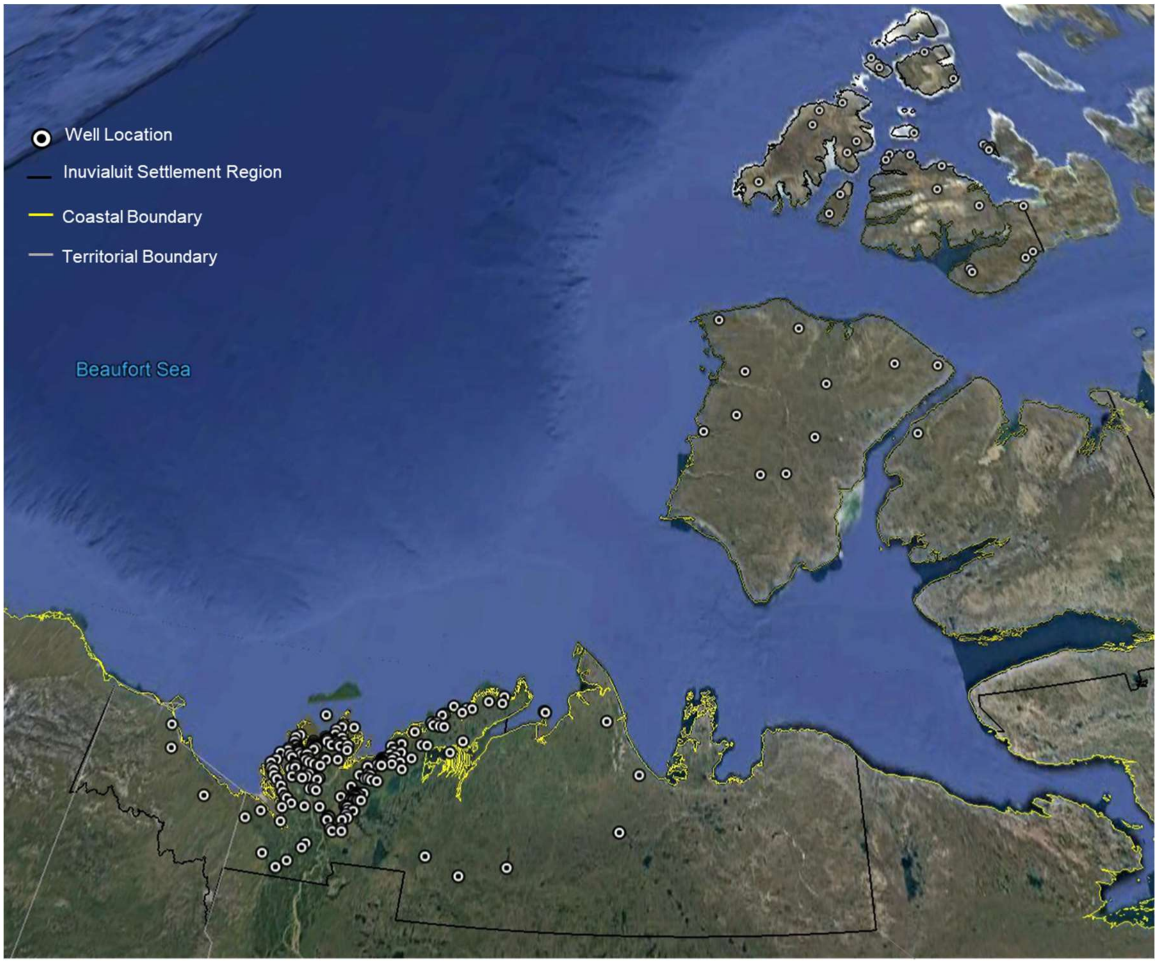

Figure 2. Map of well sites located within the ISR.

b. Identification of Environmental Impacts

Existing and potential impacts on the environment were reviewed using a variety of information sources and estimates of future degradation potential were developed using an established protocol. The study identified the most common potential or actual environmental impacts to result from surface water impingement (see Figure 3), followed by permafrost degradation, sump cover damage, vegetation stress and sedimentation or erosion. There were no discernable temporal or spatial trends observed for environmental impacts related to sump age, geologic setting or region with the following exception: environmental impacts generally appear to manifest approximately 10 years after sump closure or reclamation, although there were many exceptions to this observation. Among the 12 sumps with sufficient information for assessment, all are considered to have the potential to be subject to future degradation. Additionally, Inspectors report that 5 sumps may require additional characterization studies or efforts aimed at remediation or stabilization.

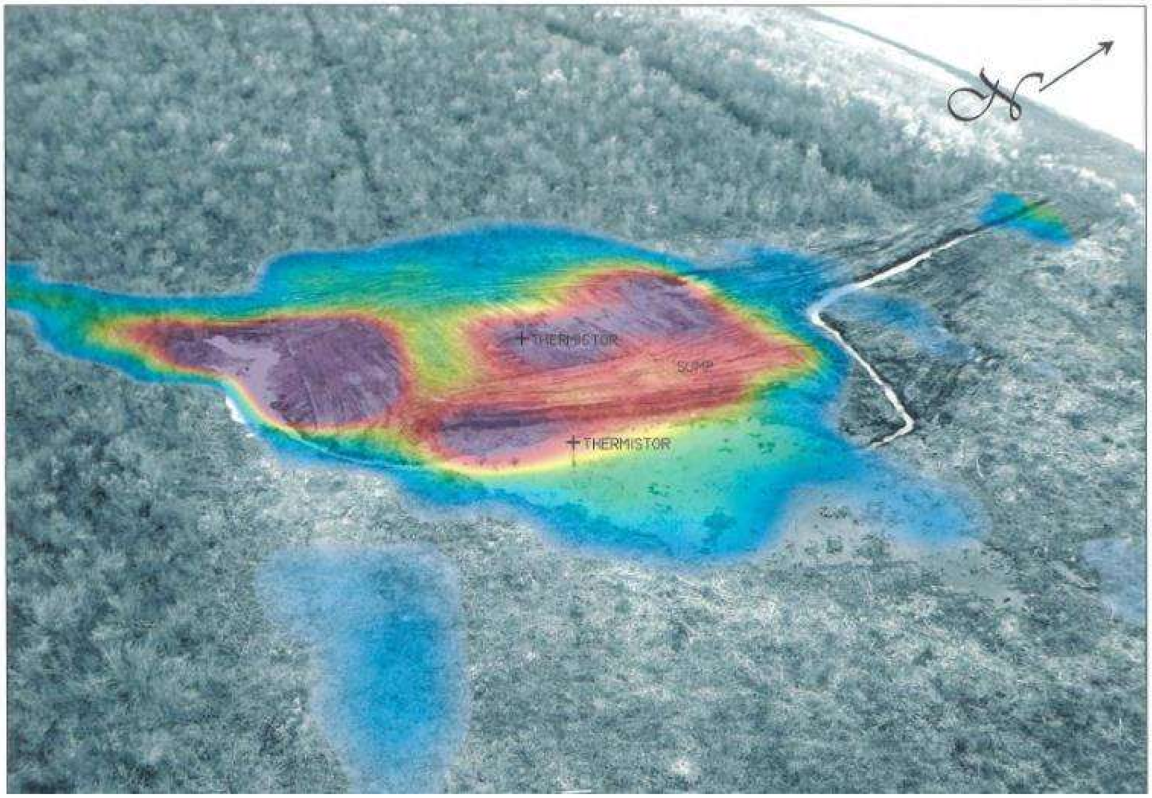

Figure 3. An example of electromagnetic (EM) survey showing contaminant migration beyond sump boundaries, Itiginkpac F-29 sump completed in September 2005.

c. Attributes of Sump Sites

Material information gaps limited the ability of the study team to more fully characterize the sumps or to accurately estimate the potential impacts for the receiving environment: Recommendations for additional testing have been made to inform certain, potential remedial actions.

Most sumps studied are classified as having a 'severe' gap in available information, meaning that information is available only for 0 to 25% of attributes. The most complete attribute information is primarily available for sumps located within the Mackenzie Delta region. For other regions (i.e. Arctic islands, NWT mainland and Yukon) the information is typically limited to include only location and operational or closure dates. "Site attribute information" is generally most abundant for well sites drilled in the period ranging from the 1970's and 1980's, followed by the 2000's.

Information gaps limited a full assessment of the sumps. The information gaps include an understand of the following: pathways and mobility of contaminants, followed by contaminant source characteristics, current site conditions, environmental characteristics, current vegetation community types and current site impacts to vegetation and sump stability. As a result of these limitations, most sumps could not be further classified and ranked as part of this study.

d. Inuvialuit Engagement

The ISR-Community Based Monitoring Program (CBMP) interviewed Inuvialuit hunters and trappers with local knowledge of region and of drilling waste sumps. Surveys, with interview questions developed by the study teams, were done in Inuvik, Tuktoyaktuk and Aklavik with 12 Inuvialuit participants selected as those with critical knowledge of the region. 58 well site locations (see Figure 4) were noted as being a concern by the interviewees with concerns ranging from issues of site safety or hazards, matters of general site cleanup and more specific items related to certain sumps.

Interviews gained from the community survey and certain companies indicated a unanimous agreement that one sump (Taglu D-43**)** should be categorized as being of High Risk.

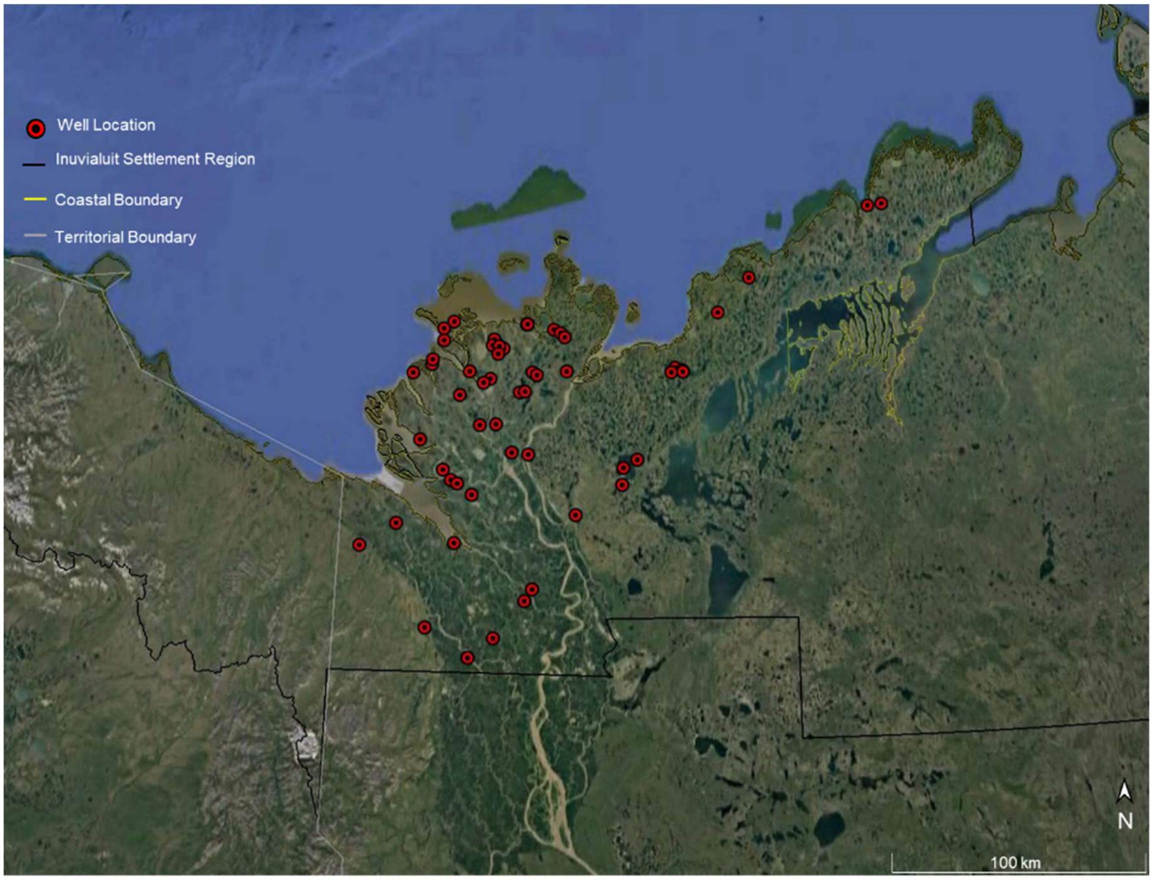

Figure 4. Sites Identified as being of concern through Inuvialuit engagement.

e. Characteristics of Sumps

For sump locations with sufficient information an assessment of temporal (see Figure 5) and spatial trends was completed to assess characteristics and trends such as the age and location.

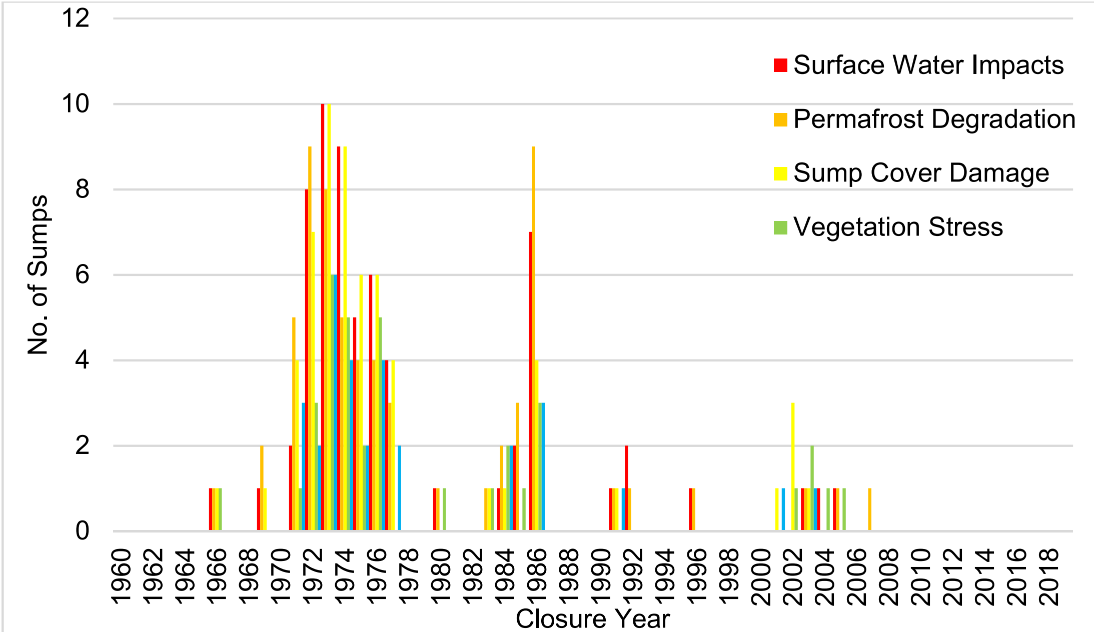

Figure 5. Temporal distribution of sumps with potential and/or actual environmental impacts.

f. Information Gaps and Site Determinations

The key information gaps identified present difficulties in determinations of the pathways and possible, associated mobility of contaminants, contaminant source characteristics, current site conditions, environmental characteristics, current vegetation community types and current site impacts on vegetation and sump stability. Due to information gaps, 119 sites could not accurately be categorized at this time

g. Classifications of Sumps and Rank

A major feature of the study was to develop a ranking system for the sumps to prioritize possible future remediation and mitigation to reduce the risk of future environmental impacts. A management tool was then developed to rank the sumps from "high to low" priority. Sumps were first classified based on available information and the observed degree of degradation, including potential for global instability and surface/soil impacts. Four classes were defined, Class 1 through 3, with Class 1 having the highest degree of sump degradation, and an "unknown" Class that represents sump sites where there was insufficient information. Within each sump classification, each was assigned a "high, medium or low" ranking based on various factors that considered the contaminant source, receptors and pathways for exposure.

Each sump was classified and ranked. 52% (115 of 223) of the sumps had limited information with a rating Classification as "Unknown". The 48% (108 of 223) of the remaining sumps received Class 1 (22%, 24 of 108), Class 2 (44%, 48 of 108) and Class 3 (33%, 36 of 108) ratings. The classifications of sumps were organized by company/consortium ownership as compared with sumps identified by the GNWT as having a higher priority ranking.

In sum:

- Sumps were categorized into four classes based on potential for global instability and information availability.
- The majority of sumps are classified as "Unknown" due to limited available data.
- 24 sumps are classified as "Class 1": Those showing current or imminent global instability failure and considered to be of high priority for potential management action.

- Sumps identified as a potential concern through the CBMP Inuvialuit engagement survey that consisted primarily of sumps Classified as “Class 2” or “Class Unknown”, followed by classes 1 and 3.
- A ranking tool was developed based on various hazard, receptor and exposure pathway factors that contribute to the overall risk presented by a sump. The total risk score for a given sump was used to rank the sumps to prioritize future work either for additional testing and/or remediation/removal plans and/or risk management and monitoring.
- Recommendations were made for possible methods to mitigate and/or remediate sites to an acceptable risk level for each risk ranking.

h. Summary of Sump Classifications: Class 1 Sumps

The location of each Class 1 sump is presented in Figures 6 and 7. The majority (20 of 24) of the sumps classified as Class 1 appear to be attributable to ConocoPhillips, Imperial and Shell (see Tables 2 and 3). These companies represent approximately 83% of the sumps in the ISR.

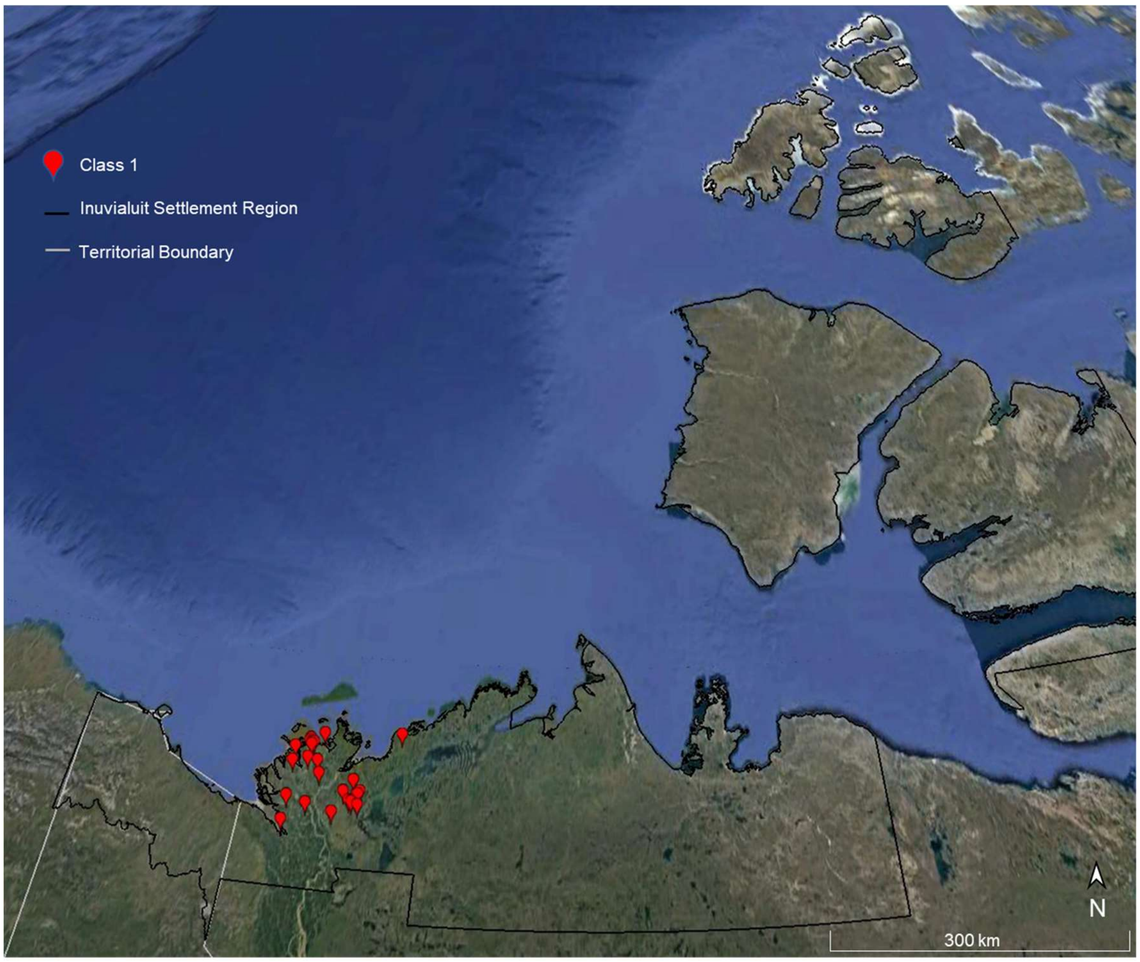

Figure 6. Class 1 sump sites in the ISR

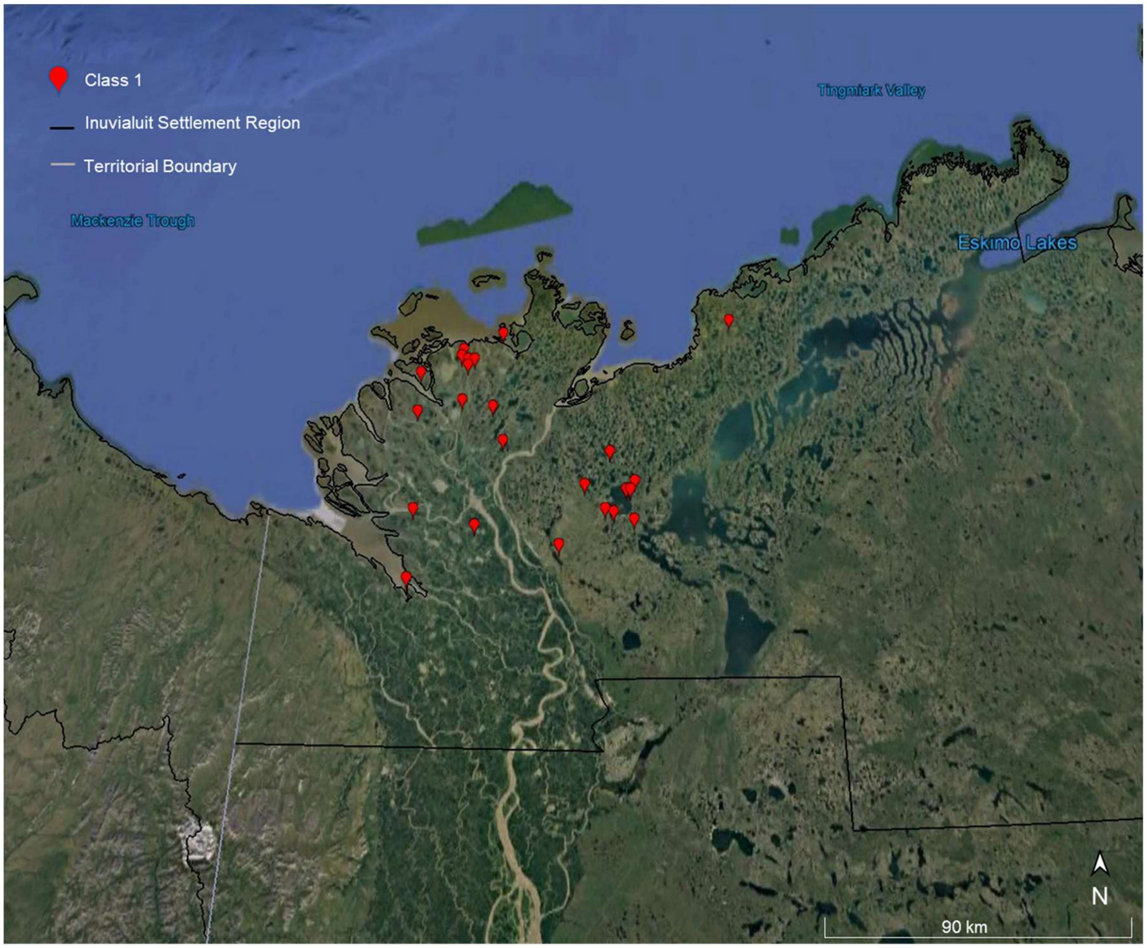

Figure 7. Class 1 sump sites in the ISR - detailed view.

Table 2. Company responsible for the sump and the associated sump classification.

Company	Total Sumps	Class 1	Class 2	Class 3	Class Unknown
Imperial	75	6	17	21	31
ConocoPhillips	37	9	9	10	9
Shell	22	5	9	5	3
Suncor	22	0	3	0	19
Husky	15	0	0	0	15
Chevron	11	0	2	0	9
BP	5	0	0	0	5
MGM Energy Corp.	4	0	4	0	0
Inuvialuit Petroleum	3	0	0	0	3
Japex	3	1	0	0	2
Canadian Natural Resources Ltd.	2	0	2	0	0
Encana	2	0	0	0	2
Deminex	1	0	0	0	1

Company	Total Sumps	Class 1	Class 2	Class 3	Class Unknown
Murphy Oil Company Ltd.	1	0	0	0	1
Repsol Oil and Gas Canada Inc.	1	0	0	0	1
Utility Group Facilities Inc.	0	0	0	0	0
Uncertain	19	3	2	0	14
Total	**223**	**24**	**48**	**36**	**115**

Table 3. Well Sites associated with Class 1 sumps.

Company	Total Class 1 Sumps	Well Site Name	
Imperial	6	• ATERTAK E-41 • TAGLU C-42 • TAGLU D-43	• TAGLU D-55 • TAGLU G-33 • TAGLU WEST P-03
ConocoPhillips	9	• ATIGI G-04 • ATIGI O-48 • PARSONS E-02 • PARSONS F-09 • PARSONS L-43	• PARSONS N-17 • PARSONS O-27 • SIKU C-55 • TOAPOLOK O-54
Shell	5	• KIPNIK O-20 • KUGPIK O-13 • NIGLINTGAK H-30	• UNAK B-11 • UNIPKAT I-22
Japex	1	• MALLIK 3L,4L,5L-38	
Uncertain	3	• IKHIL I-37 • REINDEER D-27	• YA-YA P-53

i. Climate projections

Future climate projections were modeled and used to assess the potential thermal performance of sumps throughout the region to provide a possible quantification of the future potential impacts that may arise from climate change (see Figure 8).

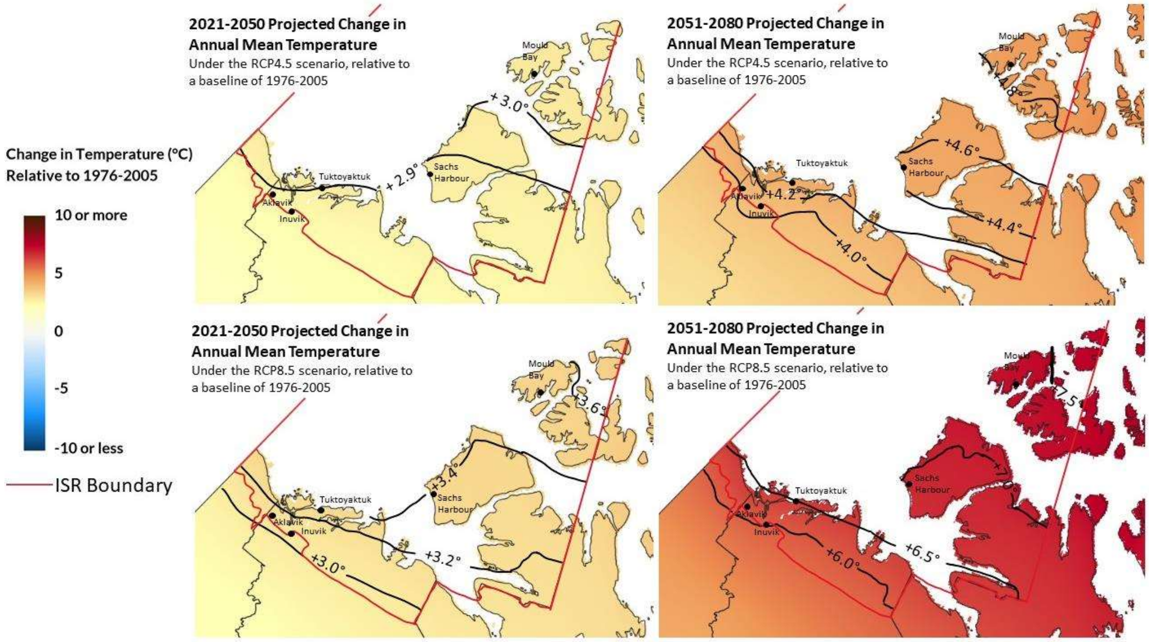

Figure 8. Projected change to mean annual temperature for the short- and long-term future relative to a baseline of 1976 – 2005.

j. Implications of Climate Change on Potential for Sump Degradation

The ground temperature modelling was applied to the Tuktoyaktuk location. However, if all the model conditions, except for air temperature were maintained, and the air temperature changed according to locations in the ISR where mean annual air temperatures reach -3oC to -1.8oC, the annual thaw depth would be predicted to extend into the frozen drilling waste materials with a drilling waste cap of 3.5 m.

Thawing of drilling waste for the RCP4.5 emissions scenario approach conditions predicted to occur in the areas near Inuvik, but which are not predicted to result in thawing above this latitude (see Table 4). For the RCP8.5 emissions scenario, thawing of the drilling waste is predicted to occur throughout the Mackenzie Delta extending to the Arctic Ocean coast. The higher Arctic islands are not predicted to experience conditions that result in the thawing of drilling wastes. 82% of the sumps are located south of the Arctic Ocean.

Table 4. Summary of 2095 mean annual air temperature for the RCP4.5 and RCP8.5 emission scenarios.

Emission Scenario	Inuvik Temperature (°C)	Tuktoyaktuk Temperature (°C)	Mould Bay Temperature (°C)
RCP4.5	-3.8	-4.5	-11.6
RCP8.5	0.3	-0.5	-6.1

Note: Cover thickness of 3.5 m. Red: air temperatures would result in thawing of drilling waste; Orange: air temperatures near conditions to that result in thawing of drill waste; Green: air temperatures below conditions that result in thawing of drill waste.

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NOTICE TO READER

This document was completed under contract by ARKTIS Solutions Inc. for the Inuvialuit Regional Corporation between August 2019 and March 2020. The information contained within this document is provided for information purposes only and is intended to provide a summary of the status of oil and gas drilling waste sumps in the Northwest Territories' Inuvialuit Settlement Region. The study was intended as a desktop exercise that consisted of gathering public available information and communicating with relevant stakeholders where deemed necessary and possible within the scope of this project. Reasonable efforts have been made to ensure the accuracy and completeness of the information contained in this document. For more information on this report, please contact:

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ACKNOWLEDGEMENTS

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Joint Secretariat Inuvialuit Regional Corporation (Inuvik)

- Ms. Chloe Brogan Coordinator Community Based Monitoring Program.

ISR - Community Based Monitoring Program (Inuvik) - Interviewers

- Mr. Max Kotokak, Sr.
- Mr. Alan Kogiak
- Mr. Roy Kimiksana.

CBMP Project Interviewees -Inuvik

- Mr. George Lennie
- Mr. Hans Lennie
- Mr. John Da
- Mr. Gerry Kisoun
- Mr. Douglas Esagok
- Mr. Hank Angasuk, Sr.

CBMP Project Interviewees -Tuktoyaktuk

- Mr. Tyrone Raddi
- Mr. Darrel Nasogaluak
- Mr. Lennie Emaghok

CBMP Project Interviewees -Aklavik

- Mr. Jonas Meyook
- Mr. Renie Arey
- Mr. Danny Gordon

Inuvialuit Regional Corporation (Inuvik)

- Mr. Charles Klengenberg, Manager IRC Lands Division
- Mr. Bob Simpson, Director of Government Affairs

Environmental Impact Screening Committee (Inuvik)

- Ms. Michel Lindsay, Committee Coordinator

ConocoPhillips (Calgary)

- Mr. Garrett Brown, Manager Environmental Operations
- Mr. Sean Ezekiel, Supervisor, Remediation and Liability Management
- Ms. Cate Hydeman Project Coordinator.

Paramount Resources (Calgary)

- Mr. Terence Hughes, Regulatory and Community Affairs Advisor
- Mr. Larry Yoon, Environmental Coordinator.

Imperial Oil Limited (Calgary)

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- Ms. Maria Beehan, Manager
- Mr. Evan Birchard, Arctic Environmental Advisor

Shell Canada (Calgary)

- Mr. Christopher Boyd, LRO Project Manager
- Mr. Grahame Bensted, Manager

Inuvialuit Water Board (Inuvik)

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- Dr. Bijaya Adhikari, Science and Regulatory Coordinator
- Ms. Freda Wilson, Office Administrator

Government of the Northwest Territories (Yellowknife and Inuvik)

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- Mr. Mike Harlow, Manager
- Mr. Nathan Richie, A/ Assistant Deputy Minister, Environment and Natural Resources
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- Mr. Robert Jenkins, Special Advisor, Executive and Indigenous Affairs
- Mr. Mel Williams, Director, Territorial Land Administration
- Mr. Conrad Baetz, Assistant Deputy Minister, Operations
- Mr. Dave Abernethy, A/ Contaminated sites Advisor, Environmental Protection and Waste Management Division
- Mr. Colin Avey, Geomatics Applications Systems Specialist, NWT Centre for Geomatics
- Mr. Kyle Little, Co- Coordinator, Western Arctic Centre for Geomatics
- Mr. Evangelos Kirizopoulos, Geomatics Data Coordinator, NWT Centre for Geomatics

Canada Energy Regulator (Calgary)

- Dr. Bharat Dixit, Manager Arctic and Northern Programs

Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)

- Mr. Michael Roesch

ACRONYMS

AER	Alberta Energy Regulator
ARI	Aurora Research Institute
ARKTIS	ARKTIS Solutions Inc.
ASTIS	Arctic Science and Technology Information System
CCME	Canadian Council of Ministers of the Environment
CER	Canadian Energy Regulator
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
EISC	Environmental Impact Screening Committee
ESRF	Environmental Studies Research Fund
GNWT	Government of Northwest Territories
ILA	Inuvialuit Land Administration
INAC	Indigenous and Northern Affairs Canada
IRC	Inuvialuit Regional Corporation
ISR	Inuvialuit Settlement Region
IWB	Inuvialuit Water Board
NEB	National Energy Board

CONCORDANCE TABLE

The following table provides a cross-reference to the applicable report sections that fulfill the objectives and tasks as presented in ARKTIS' scope of work.

Objective / Task	Report Section
Objective #1: Identify leases and licence holders' requirements for the remediation or removal of waste sumps and secure well sites. Verify if there are any orphaned or abandoned sump and well sites.	Section 2.0
Task 1 - The company/consortium responsible for wells identified in the 2004 ESRF study will be updated and the ownership of the wells installed since 2004 will be identified. If no owner is identified, the well site will be considered orphaned or abandoned.	Sections 2.1 and 2.2
Task 2 - The well ownership list will be used to identify and obtain the leases and licences that are held by the company/consortium.	Section 2.3
Task 3 - The leases and licences will be reviewed to identify the company/consortium's requirements for remediation/removal of the waste sumps and well sites.	Section 2.4
Objective #2: Document the impacts on the environment and the potential for future degradation of drilling site and sumps with consideration given to climate change.	Section 3.0
Task 1 - Relevant studies and reports that contain sump environmental information will be consolidated through the completion of a detailed record and literature search.	Sections 3.1 and 3.2
Task 2 - The impacts on the environment and future degradation will be consolidated through a review of information collected in Task 1.	Section 3.3
Objective #3: Identify information gaps that limit characterization of the sumps and impact on the receiving environment and provide recommendations for additional testing with the aim to inform remediation/removal plans.	Section 4.0
Task 1 – Consolidate the sump information collected in Objective #2 into a standardized reporting protocol and input into a database.	Section 4.1
Task 2 – Identify the information gaps for each sump through a presence/absence evaluation of sump information available compared to the reporting protocol.	Section 4.2
Task 3 – Recommend methods to fill critical information gaps that are needed to inform remediation/removal plans.	Section 4.3
Objective #4: The study information will consolidate the available information that would permit the development of remediation/removal plans to manage and mitigate environmental impacts.	Section 5.0
Task 1 – Develop a risk ranking tool to rank the sumps from high to low priority for reclamation.	Section 5.1
Task 2 – Input the sump information from Objectives #2 and #3 to evaluate the priority rankings for each sump.	Section 5.1
Task 3 – Recommend mitigations and remediation methods to reduce risk and environmental impacts.	Section 5.2
Objective #5: Evaluates the air/ground temperatures in the region and the predicted changes to the future air/ground temperatures. Assess the potential impacts to the receiving environment that could result from the changes in the air/ground temperatures.	Section 6.0
Task 1 – Collect historical climate data and process data for use in predicting climate change within the ISR.	Section 6.1

Objective / Task	Report Section
Task 2 - Evaluate climate data (including air and ground temperature) to date and predict future climate. Includes tasks to evaluate air and ground temperature to date in the region, as well as to provide a projection of near future climate change impacts on air and ground temperature as well as precipitation.	Section 6.2
Task 3 – Use future climate data to predict sump thermal performance and potential impacts.	Section 6.3

1.0 INTRODUCTION

The Inuvialuit Settlement Region (ISR)[1] of the Northwest Territories has been the subject of oil and gas exploration since 1961. Based on findings from an Environmental Studies Research Fund (ESRF) study completed in 2004 (AMEC, 2005), there were 216 exploratory onshore wells listed within the ISR, 72 of which were located on Inuvialuit Lands (see Figure 1). Obviously, the 2004 ESRF study does not include exploratory or drilling operations done after that date, such as the Mackenzie Gas Project anchor wells.

Drilling waste produced from oil and gas exploration and production within the ISR has historically been deposited in sumps typically located near the drilled well. The drilling waste can contain deleterious or toxic materials and contaminants that could negatively impact the receiving environment if the waste materials were released.

The 2004 ESRF study indicated that some sumps had failed to contain their contents and has resulted in impacts to the receiving environment (e.g., changes to water and soil quality, permafrost degradation, landform subsidence). As the sumps were designed and predicated upon permafrost encapsulation to achieve designed containment functions, warming in the region due to climate change may have contributed to sump failures, as noted in the 2004 ESRF study (AMEC, 2005). Warming is expected to continue and therefore there is potential for additional sump failures.

The degradation of drilling sumps is of concern to the Inuvialuit in the ISR because failure of those sumps to contain the wastes could result in discharges of contaminated materials in the ISR and Mackenzie delta region. Such contaminate releases poses a material environmental threat within the ISR. Hence, the Inuvialuit view the maintenance and security of those disposal sites to be a priority. The dramatic changes to the Arctic climate, as recently noted by Environment and Climate Change Canada (Bush and Lemmen, 2019), has focused concerns about the stability and integrity of drilling waste disposal sites throughout the ISR.

The Inuvialuit Regional Corporation (IRC) has contracted ARKTIS Solutions Inc. (ARKTIS) to develop an updated Drilling Waste and Sump Inventory (Inventory) based on a review of monitoring, inspection and assessment reports, as well as, previous applicable studies[2]. The Inventory documented the status of the sumps and identified, where possible, the characteristics of sumps created since the last inventory assessment done in 2004 (AMEC, 2005). The study provides insights into the pace and extent of climate change effecting sump failures and environmental impacts and utilized qualitative assessments to develop future methods to potentially mitigate the environmental impacts of failed sumps or those that might fail in the future due to diminishing permafrost.

[1] The Inuvialuit Settlement Region (ISR), known as Inuvialuit Nunangit Sannaiqtuaq (INS) in Inuvialuktun, is located in the Canadian western Arctic region. It was designated in 1984 in the Inuvialuit Final Agreement (IFA). It extends over 90,650 km^2 of land and includes several sub-regions: the Beaufort Sea, the Mackenzie River delta, the northern portion of Yukon ("Yukon North Slope"), and the northwest portion of the Northwest Territories.
[2] Note: No new field studies were funded or undertaken as part of the study. However, a community survey was done with local hunters and trappers.

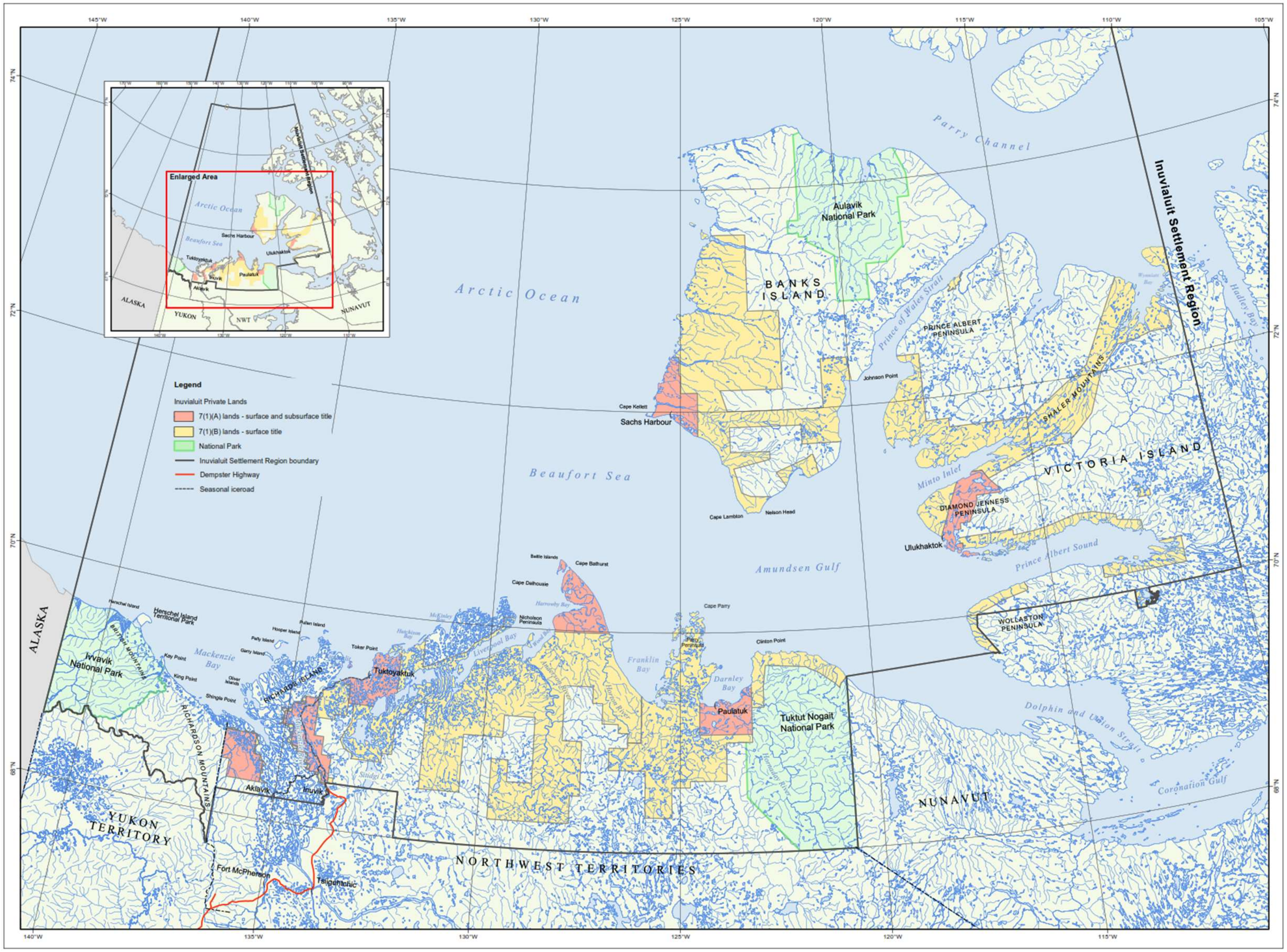

Figure 1. Lands of the Inuvialuit Settlement Region.

The objectives of the study were to:

- Update the well and sump inventory for the ISR and identify the well ownership and requirements for site reclamation (documented in Section 2.0).
- Summarize the potential and/or actual environmental impacts from each sump through a review of studies/reports combined with information derived from interviews with Inuvialuit hunters and trappers of the region (documented in Section 3.0).
- Evaluate the information that is available to characterizes the sumps in their localized environmental setting and provide recommendations to address information gaps that would aid in the development of remedial action plans (documented in Section 4.0).
- Provide a prioritized ranking for potential stabilization or reclamation of the sumps with associated recommendations for possible remedial action (documented in Section 5.0).
- Assess potential climate change in the ISR and identify those potential implications that could be associated with future integrity of the sumps (documented in Section 6.0).

2.0 WELL AND SUMP INVENTORY AND REQUIREMENTS FOR SITE RECLAMATION

The well and sump inventory component of the project consisted of three primary tasks:

- **Task 1** – Present the updated well and sump inventory for the ISR. For each well site, the company/consortium responsible for the well was identified.
- **Task 2** – Consolidate applicable licences and permits for each well site.
- **Task 3** – Summarize the requirements for remediation/removal of the waste sumps.

2.1 Well and Sump Inventory

A detailed records search was completed to develop a well and sump inventory for the ISR current to 2019. The search updated the well inventory that was completed as part of the 2004 ESRF study (AMEC, 2005) and involved obtaining the well record list from the Canadian Energy Regulator (CER) and complementing this data with information collected from various public databases, authoritative sources, and from the oil and gas companies. Hence, the updated inventory enumerates the sump locations and their descriptions in the ISR, as summarized below:

The 2004 ESRF study documented wells drilled within the ISR to 2004 (AMEC, 2005) and. identified locations and ownership of 216 onshore wells within the ISR. In September 2019, ARKTIS received the updated onshore oil and gas well list for the ISR from the Canada Energy Regulator (CER) that was current to March 2019. The well list contained 206 unique onshore well locations within the ISR, including 9 more drilled since 2004. Twenty of the wells identified in the 2004 ESRF study were absent from the 2019 CER list for reasons not yet ascertained.

Other public records, such as regulatory inspections, licences, project descriptions, monitoring reports and studies were reviewed in addition to the CER and ESRF records. Databases and authoritative sources from which records were sought included the following:

- Arctic Science and Technology Information System (ASTIS) on-line database[3]
- Aurora Research Institute (ARI) research database[4]
- Canada Energy Regulator (CER) on-line database[5]
- Crown Indigenous Relations and Northern Affairs Canada (CIRNAC) on-line publications[6]
- Environmental Impact Screening Committee (EISC) on-line public registry[7]
- Environmental Studies Research Fund (ESRF) on-line publications database[8]
- Government of the Northwest Territories (GNWT) on-line databases[9]
- Inuvialuit Regional Corporation (IRC) / Inuvialuit Land Administration (ILA) on-line documents database[10]
- Inuvialuit Settlement Region (ISR) on-line database[11]
- Inuvialuit Water Board (IWB) on-line public registry[12]

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[3] http://www.aina.ucalgary.ca/scripts/mwimain.dll?HOME
[4] https://nwtresearch.com/research-projects
[5] https://www.cer-rec.gc.ca/bts/pblctn/index-eng.html
[6] https://www.canada.ca/en/crown-indigenous-relations-northern-affairs.html
[7] http://www.screeningcommittee.ca/
[8] https://www.esrfunds.org/174
[9] https://www.enr.gov.nt.ca/en/resources
[10] https://www.irc.inuvialuit.com/documents-and-resources-1
[11] http://www.aina.ucalgary.ca/isr/
[12] https://www.inuvwb.ca/register

- Inuvialuit Water Board (IWB) on-line documents library[13]
- NWT Centre for Geomatics on-line sumps database[14]
- NWT Discovery Portal[15]
- Internet search

An additional 3 wells were identified in these databases, compared to the CER (2019) record, all of which were drilled after 2004. Additional discussions with the GNWT identified another 4 wells in the ISR.

Table 1 lists the total number of wells identified by the various sources reviewed. It also includes the quantity of documentation obtained from each source containing relevant information on wells and/or sumps. In total, 233 onshore well locations were identified within the ISR based on the various sources.

A summary table of onshore wells drilled in the ISR that documents their information (e.g., location, owner, dates and status.) is included in Appendix B.

Table 1. ISR well count by database and collected documentation.

Source	No. Wells	Available (%) (x/233)	No. Documents
ARI[1]	60	25.8	22
ASTIS	0	0.0	6
CER	206	88.4	1
CIRNAC	0	0.0	0
EISC	44	18.9	15
ESRF	216	92.7	6
GNWT[2]	230	98.7	0
IRC/ILA	0	0	0
ISR Database	0	0.0	5
IWB Library	5	2.1	6
IWB Registry	22	9.4	95
NWT Centre for Geomatics	84	36.1	81
NWT Discovery Portal	0	0.0	1
Proponent (ConocoPhillips)	1	0.4	2
Proponent (Shell)	8	3.4	3
World Wide Web	0	0.0	7
Total	**233**	**100**	**250**

[1] ARI research studies were not available. The researchers contacted ARI with requests for the various reports, but they were not available. Researchers were directed to contact the applicable licensee. Several studies referenced by ARI were obtained in this way.
[2] No documents were provided by the GNWT, but well lists provided to them were confirmed with additional wells/sumps and priority sumps identified.

[13] https://www.inuvwb.ca/documents
[14] https://www.mapstest.geomatics.gov.nt.ca/Html5Viewer/index.html?viewer=NWT_SUMP
[15] http://nwtdiscoveryportal.enr.gov.nt.ca/geoportal/catalog/main/home.page

A summary of the available documentation obtained is provided in Table 2. Collected documentation was consolidated within a digital database that is provided as a digital attachment to this report (on USB key). The folder structure within the digital database is organized as follows:

- Well name
  - Source database
    - Document type

Provided among the tables in Appendix B is a tally of the databases reviewed with noted presence/absence of information for each well, and a list of the available documentation from all sources containing information on wells and sumps.

Table 2. Summary of collected documentation for well sites.

Document	No. Wells	Available (%) (x/233)	No. Documents
2004 ESRF Study	216	92.7	1
2019 CER Well List	206	88.4	1
Annual Report	5	2.1	11
Closure and Reclamation Plan	6	2.6	5
Environmental Site Monitoring Report	6	2.6	10
Letter	6	2.6	4
Project Description	14	6.0	15
Research Licence	60	25.8	22
Research Study	0	0.0	24
Summary Report	45	19.3	24
Sump Monitoring Report	3	1.3	8
Sump Report	84	36.1	81
Water Licence	21	9.0	14
Water Licence Inspection Report	13	5.6	25
Water Licence Report	7	3.0	4
2004 ESRF Study	216	92.7	1

Table 3 lists the current distribution of wells and associated drilling waste disposal sumps in the ISR by region as designated by the CER. Some well sites have no associated drilling waste sump, while some sumps are shared between two or more well sites. The distribution of onshore wells and sumps in the ISR is shown in Figure 2.

Table 3. ISR well and sump counts by region.

CER Designated Region	No. of Onshore Wells	No. of Sumps
Mackenzie Delta	182	172
Arctic Islands	41	41
Mainland	7	7
Yukon Onshore	3	3
Total	**233**	**223**

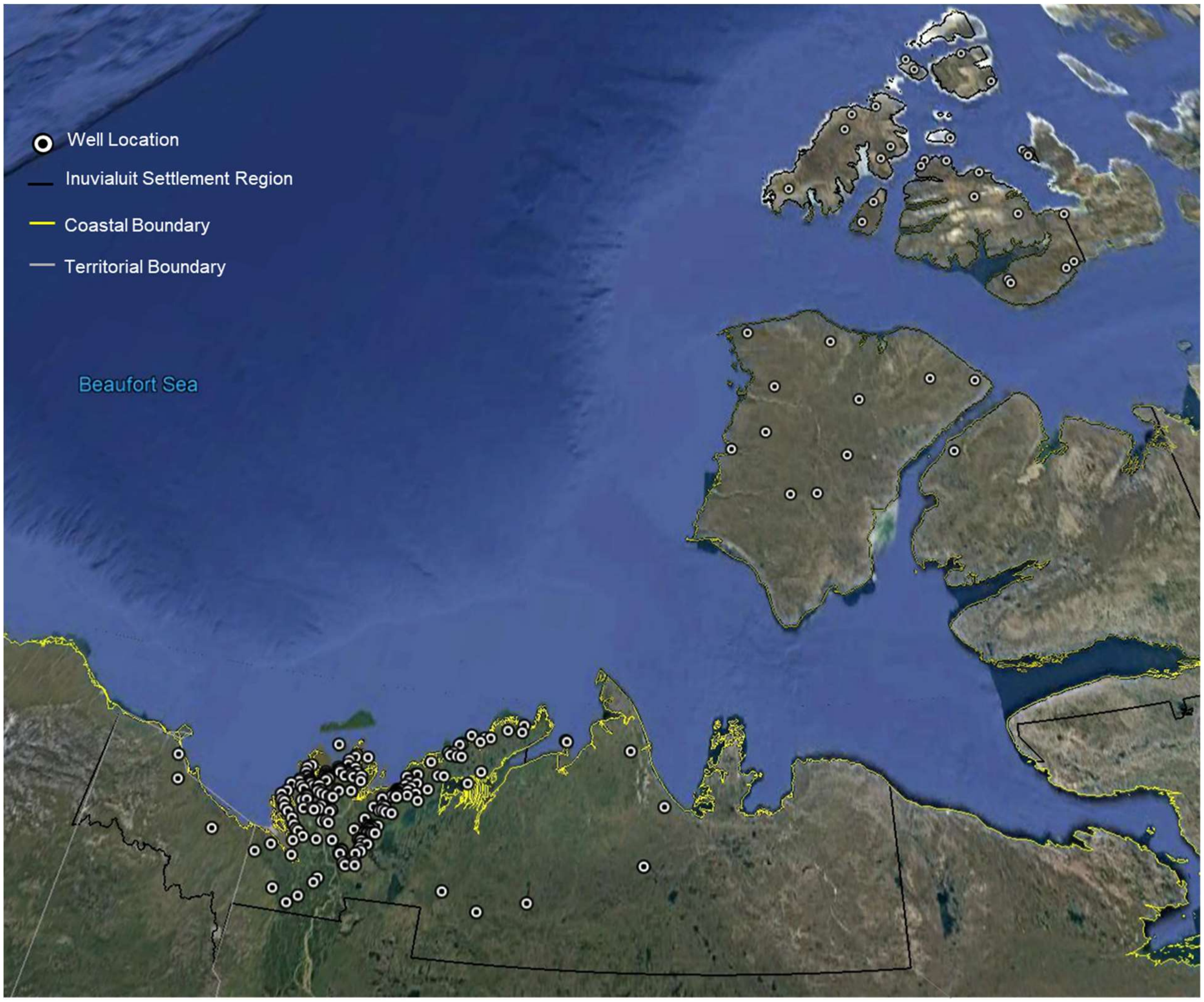


Figure 2. Map of wells within the ISR.

2.2 Well Ownership

Using the data collected and described in Section 2.1, the ownership of each well was identified. The following paragraphs summarize the approach applied to identify the company or consortium responsible for the well sites.

Consistent with the approach utilized in the 2004 ESRF study, databases from the CER were the primary source of information used to initially identify the consortium/company responsible for the well at time of its development. Due to name changes, mergers and acquisitions, the ownership of the well may have changed over time. Reports collected from various public records described above were utilized to update, if required, the consortium or company responsible for the well. Additionally, the consortium or company was also updated using the Canadian Corporate Reports (https://digital.library.mcgill.ca/hrcorpreports/home.htm), a database of current & historical companies in Canada.

A breakdown of well ownership by company was identified from the various sources and is provided in Table 4. A summary table of ownership for each well is included in Appendix B.

In January 2020, the authors completed interviews with Imperial, Shell, ConocoPhillips, and (Paramount) MGM Energy. Table 4 provides a summary of wells that were confirmed to be within their portfolio[16].

The records search revealed that currently solvent companies (either majority or minor interest holders) are associated with all the onshore wells drilled in the ISR except one (Orksut I-44), which was the only "orphan well" identified. The owner, Deminex, became insolvent with no successor company indicated in the public records. The land is currently owned by the ILA. The methodology used to assign well ownership was based solely on the project definition of 'orphan[17]' and is not to be construed to be a legal opinion regarding corporate responsibility or ownership.

[16] Note, Shell and ConocoPhillips are currently in a legal process regarding ownership of select wells in the ISR. As such, there is some discrepancy between the ownership from the records search and that provided by the oil and gas company.

[17] In the upstream oil and gas industry, typically an orphan is a well, pipeline, facility or associated site which has been investigated and confirmed as not having any legally responsible or financially able party to deal with its abandonment and reclamation (AMEC, 2005).

Table 4. ISR well and sump counts by database and owner.

Company	Well Sites and Owner Identified by Source							Current Well Total	Well Percent (%) (x/233)	Current Sump Total	Sump Percent (%) (x/223)
	2004 ESRF	NWT Centre for Geomatics	2019 CER	EISC	IWB	ARI	Proponent				
Imperial	74	39	69	1		17	75	**75**	**32.2**	**75**	**33.6**
ConocoPhillips	45	21	44	3		11	37	**37**	**15.9**	**37**	**16.6**
Shell	23	22	19	24	1	22		**22**	**9.4**	**22**	**9.9**
Suncor	3		19	2	3			**22**	**9.4**	**22**	**9.9**
Husky	15		14					**15**	**6.4**	**15**	**6.7**
Chevron	12	2	8	4		2		**11**	**4.7**	**11**	**4.9**
MGM Energy Corp.			10	3	9	3	10	**10**	**4.3**	**4**	**1.8**
BP	8		6		1	1		**5**	**2.1**	**5**	**2.2**
Japex	4		5		3	4		**5**	**2.1**	**5**	**2.2**
Canadian Natural Resources Ltd.			5	2	3			**3**	**1.3**	**3**	**1.3**
Inuvialuit Petroleum	3		1	3	1			**3**	**1.3**	**3**	**1.3**
Encana	2		2					**2**	**0.9**	**2**	**0.9**
Deminex	1		1					**1**	**0.4**	**1**	**0.4**
Murphy Oil Company Ltd.	1		1					**1**	**0.4**	**1**	**0.4**
Repsol Oil and Gas Canada Inc.			1	1				**1**	**0.4**	**1**	**0.4**
Utility Group Facilities Inc.			2	1	1			**1**	**0.4**	**0**	**0**
Petro-Canada	21							**0**	**0**	**0**	**0**
Devon	3		0					**0**	**0.0**	**0**	**0**
Northrock	1		0					**0**	**0.0**	**0**	**0**
Uncertain[1]								**19**	**8.2**	**19**	**8.5**
TOTAL	**216**	**84**	**206**	**44**	**22**	**60**	**122**	**233**	**100.0**	**223**	**100.0**

[1] Wells with uncertain ownership include 2 wells whose ownership is currently under review between Shell and ConocoPhillips, 6 wells indicated as sold to Shell by ConocoPhillips but as yet remain unconfirmed by Shell, 7 wells with unclear ownership from contradictory sources, and 4 wells identified as present by the GNWT but with no indicated owner provided.

2.3 Licences And Permits

For each well site licenses and permits that pertain to land and water use were collected from various sources. Land and water use regulatory instruments were accessed so that any remediation or reclamation requirements could be summarized.

Records from the CER (2019) identified 55, and 158 wells in the ISR that are currently suspended and abandoned, respectively. Eleven wells are classified as "other" and 6 have unknown status. In general, a suspended well is a well in which drilling or production operations have temporarily ceased. An abandoned well is one that has been permanently plugged (downhole abandonment and surface abandonment). Well suspensions and abandonments are regulated by the CER in the ISR and therefore the requirements and timing for suspension and abandonment may be well-specific.

The practical and logistical constraints that govern crew mobilization and site access may influence timing to complete reclamation or remediation of a well site (including a sump). Such activities may be planned to coincide with the timing for completing well suspension and/or abandonment activities.

IWB records on closure or reclamation conditions were accessed as part of the information compilation completed in Section 2.1, .Data indicate that no water licences were issued for 68 wells drilled prior to the Water Act coming into force (1973) and the water licence records appear to be inconsistent for older sites. Based on a review of the IWB registry,14 IWB water licences were identified for 21 well sites and 18 sumps. A list of the wells for which water licences were identified and obtained is provided in Table 5.

Based on information provided by the GNWT,156 and 68 wells are located on lands owned by the GNWT and ILA, respectively. These landowners may have specific reclamation/remediation requirements that may be addressed within a land lease.

Table 5. IWB water licences for ISR well and sump sites.

Well Name	Well Owner	Water Licence #	Sump Present
IKHIL J-35	Inuvialuit Petroleum Corporation	N3L1-1710	Yes
IKHIL N-26	Inuvialuit Petroleum Corporation	N3L1-1710	Yes
SATELLITE F-68	Repsol Oil and Gas Canada Inc.	N5L8-1837	Yes
KURK M-15	Suncor Energy Inc.	N7L1-1759	Yes
MALLIK 3L-38	Japex	N7L1-1769	Yes
MALLIK 4L-38	Japex	N7L1-1769	Yes
MALLIK 5L-38	Japex	N7L1-1769	Yes
TUK B-02	Canadian Natural Resources Ltd.	N7L1-1771	Yes
TUK M-18	Canadian Natural Resources Ltd.	N7L1-1771	Yes
KUGPIK L-46	Suncor Energy Inc.	N7L1-1776	Yes
ITIGINKPAK F-29	Canadian Natural Resources Ltd.	N7L1-1777	Yes
LANGLEY K-30	MGM Energy Corp.	N7L1-1787	Yes
NUNA I-30	Petro-Canada	N7L1-1788	Yes
UMIAK N-16	MGM Energy Corp.	N7L1-1797	Yes
UMIAK N-05	MGM Energy Corp.	N7L1-1802	Yes
KUMAK I-25	MGM Energy Corp.	N7L1-1815	Yes
UNIPKAT M-45	MGM Energy Corp.	N7L1-1815	Yes
APUT D-43	MGM Energy Corp.	N7L1-1822	No
ATIK P-19	MGM Energy Corp.	N7L1-1822	No

Well Name	Well Owner	Water Licence #	Sump Present
LANGLEY E-07	MGM Energy Corp.	N7L1-1822	No
UNIPKAT I-22	Shell Canada Resources Limited	N7L1-1831	Yes
Total No. Available Licences		**14**	**-**
Total No. Wells with Available Licences (x/233)		**21**	**-**
Total No. Sumps with Available Licences (x/223)		**18**	**-**

The sumps in the ISR are located on lands leased/administered by the ILA or GNWT. Based on data provided by the GNWT, 153 sumps are on GNWT land and the remainder (69) on private ILA lands. Seven sumps are in areas of other or unknown ownership. A map of the sumps on non-private lands and private ILA lands is provided in Figure 3 and Figure 4.

Figure 3. Regional map of sumps on lands excluding private ILA lands.

Figure 4. Regional map of sumps private ILA lands.

2.4 Sump Remediation/Reclamation

A key component of this study was to identify from records the sumps and the current containment of drilling wastes or contact water at those sites. It is acknowledged that the drilling waste sump is only one aspect of reclamation liabilities that may exist at a drill site. Other potential liabilities, outside the scope of this study include, but are not limited to, suspension and abandonment of the well; reclamation or remediation of the disturbed land area; reclamation or remediation of supporting facilities (e.g., camp accommodations or fuel storage.); and camp sumps.

Here, available leases, licences and other well site records are reviewed to identify typical requirements for remediation or removal of waste sumps and well sites. Industry best practices are also discussed for comparison to the methods employed at specific well sites. Although the focus of this report was on the drilling waste sump, there are other disturbances at a well site which may also require remedial efforts and pose environmental risks. These are not accounted for in this study.

2.4.1 Water Licence Requirements for Closure and Reclamation

The IWB water licences collected and discussed in Section 2.3 were reviewed to identify the closure conditions for drilling waste sumps. The IWB conditions summarized below are typical within many of the licences.

1. *The Licensee shall, to the satisfaction of an Inspector, contain all drilling Waste in a Sump near the drill site, or at an alternative Sump location as approved by an Inspector.*
2. *The Sump shall be constructed of materials that normally exhibit low Permeability and in a manner that prevents intrusion of runoff Water.*
3. *All drilling Waste shall be contained in the drill Waste Sump a minimum of one (1) metre below the active layer.*
4. *In the event the initial Sump do no consist of low permeability materials, the Licensee shall construct an offsite Sump to the satisfaction of an Inspector.*
5. *The Licensee shall construct and maintain the Sump to the satisfaction of an Inspector.*
6. *There shall be no disposal of Drilling Fluids from any Sump into any Water or onto any land surface.*
7. *Prior to closure, the Licensee shall ensure that Chloride concentrations in the drill Waste sump do not exceed 100,000 mg/L.*
8. *The Licensee shall, prior to abandonment of a Sump, obtain a representative sample from the Sump using the information requirements outlined in the "Sampling and Analytical Requirements for Characterization of Sump Supernatant Fluids".*

2.4.2 Requirements for Closure and Reclamation from Other Documentation

Accompanying the IWB water licenses, closure and reclamation or remediation plans were available from the IWB public registry for 6 well/sump sites (Table 2). Additional closure and reclamation details for 13 well and sump sites are available from the various documentation obtained in Section 2.1. The reclamation approach for drilling sumps was consolidated from these sources and summarized in Table 6. The current reclamation status of the sumps and any remediation efforts as directed by an inspector are also summarized.

Table 6. Reclamation requirements for drilling sumps as specified in compiled documentation additional to regulatory records.

Well Name	Sump Reclamation Requirements	Sump Reclamation Status	Sump Reclamation Date	Inspector Directed Remediation Effort	Sources
Atik P-19	No sumps will be used during the Project. All drilling waste will be trucked or barged out of the Mackenzie Delta.	No sumps present.	No sumps present.	No sumps present.	Kavik-Axys Inc., 2007. MGM Energy Corp. - Ellice, Langley and Olivier Drilling, Completion and Testing Project, Winters 2007-2008, 2008-2009, and 2009-2010.
Ikhil J-35/ Ikhil N-26	Two sumps used to contain drill cuttings. Sumps will be covered with native material and topped with gravel or re-vegetated. Sumps will be contoured so as to ensure future stability. A monitoring program will be implemented to assess effectiveness of the sump restoration. If problems such as slumping or seepage are identified, remedial measures will be implemented as required.	The drilling sumps were capped in accordance with the Abandonment and Restoration Plan. Seeding of the sumps was to take place during summer 1999.	1998	No documented information.	North of 60 Engineering Ltd., 1998. Abandonment and Restoration Plan for Water Use Permit N3L-1710. North of 60 Engineering Ltd., 1998. Wrap-up Report for Water Licence N3L1-1710. North of 60 Engineering Ltd., 1998. Ikhil Development – Class B Water Permit.
Ikhil I-37	No documented information.	Capped.	1973	No documented information.	Kavik-Axys, 2011. ConocoPhillips Canada Ikhil I-37 Well Environmental Site Assessment and Ikhil I-37 and Siku C-55 Well Sites Vegetation Reconnaissance Surveys.
Ikhil UGFI 02/ J-35	No drilling waste sumps or pits will be constructed on-site.	No sumps present.	No sumps present.	No documented information.	Canadian Petroleum Engineering Inc., 2011. Environmental Impact Screening Committee, Project Description for Screening Ikhil UGFI 02/J-35 Gas Well 2011/2012 Drilling and Facilities Tie-In Program Ikhil, NWT.
Itiginpak F-29	Employ a mix/bury/cover strategy to sump abandonment. The sumps, once covered, may be revisited the following winter should maintenance work be required. Sump must have thick soil cap (>1.5 m above surrounding ground level) that it does not thaw through to allow surface water into the sump or to release drilling waste. The area of contaminated cap soils in north half of sump should be covered by 1.5 m of thaw-stable fill. Surface of cap must be graded to drain properly. A top slope of 2.5% is recommended to promote runoff. Seasonal thaw in containment zone around perimeter of sump must not extend deeper than top of the ice cap, which is about elevation 2.8 m. Provide drainage path for water ponding on east side of ramp. Protect sump cap from erosion caused by drainage. Remove salt contaminated soils in the area north of the sump and in east pond area by covering with sufficient soil (>1.5 m) that it becomes encapsulated in permafrost. Establish cover of grasses over the sump and adjacent disturbed areas.	Capped.	2003	Subsidence areas need to be filled to prevent further subsidence and destabilization.	Inuvialuit Environmental & Geotechnical Inc., 2001. Project Description for the Proposed Petro-Canada Kurk/Napartok Winter 2001/2002 Drilling Program. Kiggiak-EBA Consulting Ltd., 2006. Itiginpak F-29 Sump Remediation Plan.
Kugpik L-46	Mix-bury-cover.	Covered.	2002	No documented information.	INAC, 2002. Industrial Water Use Inspection Report – N7L1-1776-2, April 26, 2002.
Kurk M-15	Cap. The site will continue to be monitored for evidence of change. If erosion is demonstrated to be ongoing, consideration from remedial options such as the placement of rip-rap will be considered.	Capped.	2002	No documented information.	WorleyParsons, 2014. Proposed Interim Closure and Reclamation Plan for Kurk M-15, Water Licence N7L1-1759.

Well Name	Sump Reclamation Requirements	Sump Reclamation Status	Sump Reclamation Date	Inspector Directed Remediation Effort	Sources
Langley K-30	Cap.	Capped.	2003	Recommended that the site be revisited and a plan of action be provided to address subsidence.	Newpark Environmental Services, 2005. Site Investigation and Downloading of Temperatures, Chevron Canada Resources, Langley K-30.
Mallik 3L-38, 4L-38 and 5L-38	One drilling waste sump for 3L, 4L and 5L wells. Cuttings sump will be backfilled with the original material which was excavated during its construction. The surface elevation of the backfilled sump will be a minimum of one metre above the ground level.	Covered and capped.	2002	No documented information.	Canadian Petroleum Engineering Inc., 2001. Mackenzie Delta Gas Hydrate Research and Development Project.
Nuna I-30	A mix/bury/cover strategy for sump abandonment will be used. All contents will be at least 1.2 m below the active layer. The backfill cover over the sumps will provide a minimum of 2 m of overlap on all sides to prevent migration due to runoff or rain entering the excavation area. An electromagnetic survey will be completed the summer following camp closure (summer 2004) to ensure contents of the sump have not migrated.	Capped.	2003	No documented information.	Inuvialuit Environmental & Geotechnical Inc., 2002. Project Description for the Proposed Petro-Canada Nuna Winter 2002/2003 Drilling Program.
Parsons F-09	No documented information.	Capped.	1972	No documented information.	Hobbit Environmental Consulting Inc., 2013. Subsurface Site Assessment, Parsons F-09.
Satellite F-68	Contaminated soil and waste collected during the remediation program are disposed of in a constructed containment structure at site.	It is speculated that the Area of Suspected Buried Debris could have been the drill sump area. Fill material was placed in the Area of Suspected Buried Debris.	1972	No documented information.	Golder, 2012. Summary Report of the Detailed Site Description Program Conducted in 2011 at the Panarctic Satellite F-68 Wellsite, Satellite Bay, Prince Patrick Island, NWT. Golder, 2019. IWB Water Licence N5L8-1837 2018 Annual Report.
Tuk B-02 & M-18	One drilling waste sump for both B-02 and M-18 wells. Drilling fluid will be diluted as much as possible with freshwater to minimize freezing point depression. Drilling fluids will be sealed with a freshwater layer prior to backfilling. The sump will be backfilled with soil excavated from the sump during construction.	Drilling sump was backfilled and restored. Excavated material was placed back into the sump in layers. Water was used to fill any voids or pore spaces in each layer and allowed to freeze before the next layer was placed, creating a continuous frozen mass. Excavated material placed back into the sump was overlapped at the edge of the sump to prevent water percolating down walls of sump. The active layer was allowed to re-establish itself over top of the frozen sump. A seed mixture was used to revegetate the site.	2002	No documented information.	Inuvialuit Environmental & Geotechnical Inc., 2001. Project Description for the Proposed Anderson Resources Ltd Tuk 2 Winter 2001/2002 Drilling Program Water Licence Application. Devon Canada Corporation, 2003. NWT Water Licence #N7L1-1771: Final Report, Tuk 2 Winter Drilling Program 2001-2002. Golder, 2017. Inuvialuit Water Board Water Licence N5L8-1837, Reclamation, Closure and Monitoring Plan.
Umiak N-05	No documented information.	Capped.	2005	A proposal for remediation of the northwest corner should be put forward to ensure that the sump remains well drained and stable, in a way that prevents or limits any further migration of drilling waste sump fluids into the receiving environment. A reassessment will be required for possibility of leaching from the sump for hydrocarbons and the reason for the large, long crack on top.	GNWT, 2016. Industrial Water Use Inspection Report – N7L1-1802, August 15, 2016. GNWT, 2017. Industrial Water Use Inspection Report – N7L1-1802, August 2, 2017.

Well Name	Sump Reclamation Requirements	Sump Reclamation Status	Sump Reclamation Date	Inspector Directed Remediation Effort	Sources
Umiak N-16	The sump will be backfilled and capped. Sump wastes will be buried approximately 3.5-4 m below the level of the surrounding active layer and an additional 1-1.5 m of backfill cap will be compacted above the level of the surrounding ground surface. First, the soil from the "subsurface soil" stockpile will be removed from the ice pad surrounding the sump and be used to backfill the sump. The backfill will be replaced in layers. Each layer up to the level of the surrounding active layer will be thoroughly watered, trackpacked, and allowed to freeze, before the next layer of fill is replaced. Above the active layer level, the soil backfill will be placed without watering and compacted by track packing. Material from the "surface soil" stockpile will be placed and compacted on the top of the sump cap. The backfill cover over the sump will provide a minimum of 2 m of overlap on all sides, be 1 m above the surrounding ground level and have a minimum 2% grade, to reduce settling, and prevent runoff or rain entering the sump area. The sump will be revegetated with a seed mix agreed to by the Inspector.	Capped.	2004	A reassessment will need to be done on this sump as there is a possibility of sump leaching, large wide cracks on the sump.	Encana, 2004. Project Description for the Proposed EnCana Corporation Burnt Lake Drilling Program, Winter 2004. GNWT, 2017. Industrial Water Use Inspection Report – N7L1-1797, August 2, 2017.
Unipkat I-22	Waste material will be excavated from the drilling sump and transported to approved landfills. The excavation will be backfilled and graded so that it will have a slight depression and resemble the natural ponds in the area. It is not anticipated that the grade will be brought back to original surface elevation.	Drilling waste muds and some petroleum hydrocarbon affected soils from around the main drilling sump are excavated and removed. Willow staked along the riverbank and reseeding areas of sparse vegetation. Recontoured the bank of Arvoknar Channel in the area of the former sump, installing coconut matting, and removal of wood pilings.	2011	A plan of action was requested in regard to preventing future erosions from occurring and reaching the bentonite blanket and the contaminated soil that remains on site.	Inuvialuit Environmental & Geotechnical Inc., 2010. Proposed Unipkat I-22 Sump Remediation Project Description. GNWT, 2014. Industrial Water Use Inspection Report – N7L1-1831, July 31, 2014. Inuvialuit Environmental & Geotechnical Inc., 2019. Unipkat I-22 2019 Pile Removal Program.
Unipkat M-45 & Kumak I-25	One sump for wells Kumak I-25 and Unipkat M-45. Drilling fluid and mud will be mixed with frozen soil to ensure there are no free fluids and to facilitate freeze-down of this material before backfilling the sump. Spoil piles will be removed from the ice pads and used to backfill the sump. Salvaged organic material is used as a surface layer on the cap. On completion, frozen waste will be in contact with undisturbed permafrost and will be at least 3 m below the active layer, and 3-4 m below original ground surface before the sump is capped. The sump cap is designed to be approximately 1-2 m above local elevation, accounting for expected settlement. Backfill will provide 2-4 m of overlap on all sides to prevent potential subsidence around the perimeter of the sump and surface ponding on the sump cap. The sides of the cap will be contoured to shed water and provide positive drainage away from the sump cap.	Sampling, closure and capping of the remote sump complete. The northeast corner of the sump was remediated at the end of March 2008 which included bringing in additional soil material and re-contouring that material with existing material. The area on the east side slope at the northeast corner of the sump cap was re-contoured and seeded in late August 2009 to address slumping, subsidence and ponding adjacent to the sump cap	2007	No documented information.	Kavik-Axys Inc., 2006. Chevron Canada Limited, Taktuk, Langley and Farewell Drilling Program, Winter 2006-2008. Chevron, 2008. 2007 Annual Report, Type B Water Licence N7L1-1815, Chevron 2006-2007 Taktuk, Langley and Farewell Drilling Program. MGM Energy Corp., 2009. Water Licence N7L1-1815, Annual Water Report 2008, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program. MGM Energy Corp., 2010. Water Licence N7L1-1815, Annual Water Report 2009, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program: 2006-2008

2.4.3 Best Recommended Practices

This section presents a summary of best recommended practices for drilling waste management and provide a point of comparison for the reclamation methods implemented at the existing drilling waste sumps listed in the Section 2.4.1 and 2.4.2.

As summarized from the ESRF 2004 study “Drilling Waste Management Best Recommended Practices” (ESRF, 2005):

“Minimize the possible impacts of abandonment and restoration in the Mackenzie Delta Region, by practicing the following recommendations.

- *At completion of drilling the well, mix the fluids discharged with sump spoil material at a 3:1 ratio or allow the discharged fluids to freeze in naturally prior to backfilling.*
- *Before backfilling, if large amounts of snow have accumulated in the sump, remove the snow.*
- *Backfill and compact the spoil material in shallow lifts.*
- *Keep the drilling waste a minimum of 1 metre below the active layer.*
- *Contour the sump cap so snow will not be trapped and accumulate there.*
- *Design the sump cap to protect the thermal integrity of the sump.*
- *Take into account the settlement profile of the sump cap so that the potential for a pond to form is minimized.*
- *Restore the sump area to promote revegetation.*
- *Replace salvaged organic layer on top of the sump cap.*
- *Re-contour the site, if subsidence is impacting the containment of the drilling waste.*

Minimize the possible impacts of the in-ground sumps in the Mackenzie Delta Region, by practicing the following monitoring recommendations.

- *Conduct an EM Survey to determine if there is any lateral movement.*
- *Measure and monitor thermistor readings to determine the thermal response of the drilling waste and controls.*
- *Conduct a visual inspection of the site for such things as drainage, slumping, vegetation response, and cap stability.*
- *Adapt the monitoring program to the changing conditions.*
- *Submit all the monitoring program data to INAC Water Resources Division for storage in the central database.”*

The best recommended practices for drilling waste management were also detailed in the AMEC 2009 study “Assessment of Drilling Waste Disposal Options in the Inuvialuit Settlement Region” (AMEC, 2009) :

- *Recommended option for drilling waste disposal in the ISR was on-site waste injection, followed by on-site sump disposal, disposal outside the NWT, off-site waste injection, and off-site landfill disposal.*
- *Favourable areas for construction and use of drilling waste disposal sumps include upland areas located outside the Mackenzie Delta, those that are not located in protected areas, are not utilized by the Inuvialuit for traditional land uses and are not located in sensitive areas utilized by wildlife.*
- *Use of a sump as a disposal method is recommended only under the following conditions:*
    - *When no regional waste disposal facility is available;*

- *When on-site waste injection is not feasible;*
- *When the drilling waste is water based and will freeze under site conditions;*
- *Where the environment is favourable for construction and long-term containment; and,*
- *Where wastes are generated during an exploration program.*

The Alberta Energy Regulator (AER) *Directive 050: Drilling Waste Management* (AER, 2019) also sets out the requirements for the treatment and disposal of drilling waste generated in Alberta. The directive sets out salt, hydrocarbon, and metal endpoints for soils that have received drilling wastes and describes the requirements for its assessment. The directive also details the requirements and designs for various disposal methods including sumps, earthen-bermed storage systems, landspraying, disposal onto forested public lands, liquid pump-off, mix-bury-cover, landspreading, biodegradation, subsurface disposal, transport to waste management facilities, mobile thermal treatments, alternative methods, and remixing a former drilling waste disposal.

Additional recommended best practices were obtained from the scientific literature, notably Kokelj *et al.*(2010):

- *If passive long-term freezing of wastes is the design objective, then areas south of the treeline, or in the Mackenzie Delta where mean average ground temperature is typically above -4ºC, should be avoided. Alternatively, engineered active freezing systems using thermosyphons or possibly other means could be utilized for frozen containment at warm permafrost sites.*
- *In tundra setting of the western Arctic where mean average ground temperature is typically below -5ºC, tall shrubs tend to proliferate on disturbances such as sump covers causing snow to accumulate. This can promote the ground to warm and near-surface thawing may occur at decadal time scales. For tundra environments, management of shrub and snow conditions could be considered to assist the maintenance of frozen ground conditions.*
- *Climate warming can lead to the thawing of drilling-mud sumps and those situated in warm permafrost will thaw more quickly than those constructed in colder environments. The effects of warming air temperatures alone can be compounded by the effects of shrub growth and snow accumulation.*
- *Several environmental factors can cause the thermal regime of a sump to change overtime, indicating the necessity to develop long term management plans related specifically to monitoring, mitigation and reclamation.*

2.5 Conclusions and Key Findings

An updated well and sump inventory for the ISR was developed and presented in Appendix B. The inventory identified the consortium or company responsible for the well. In select cases, 2 wells were currently under negotiation with more than one owner regarding their ownership, 6 wells are indicated as sold to another company but remained to be confirmed by the supposed buyer, 7 wells are indicated to have an unclear ownership from contradictory sources, and 4 wells are identified by the GNWT with no indicated owner provided. No current well owner could be located for 1 well. Relevant reports/studies that documented the sump and local environmental conditions were collected from various sources for evaluation of potential and/or actual environmental effects (described in Section 3.0).

The licenses and permits for each well site were consolidated and the requirements for remediation/removal of the waste sumps were documented. In general, sump closure was completed in a short timeframe after well drilling while equipment and labour resources were at site and involved placement of a mineral soil cover over the drilling waste. The intent of that design was to promote for the freezing of the drilling waste through permafrost aggradation. Based on the available data for recently constructed sumps (1998 to 2011), the closure requirement details varied to a large extent between sites. Sumps developed prior to this timeframe may have limited reclamation requirements. Documentation was frequently not available to evaluate sumps post-closure.

An overview and summary of study key findings based on industry best practices for sump construction and closure was developed:

- A total of 233 onshore wells have been drilled within the ISR.
- A total of 223 drilling waste sumps are present within the ISR. Out of the 233 identified well sites, six have no drilling waste sump, while two sumps are shared between two wells each, and one sump is shared between another three wells.
- 55 and 158 wells in the ISR are suspended and abandoned, respectively, while 11 wells are classified as other and 6 have unknown status.
- 16 companies currently own wells in the ISR.
- Companies owning large numbers of wells include Imperial Oil (75 wells), ConocoPhillips (37 wells), Shell Canada (22 wells), Suncor (22 wells), Husky (15 wells), Chevron (11 wells) and MGM Energy Corp. (10 wells).
- 19 wells have uncertain or unconfirmed owners.
- A single orphan well was identified (Orksut I-44). The land is currently owned by ILA.
- The 2019 CER well list identifies 206 wells in the ISR.
- The 2004 ESRF study identifies an additional 20 wells while other public records identify a further 3 wells and discussions with the GNWT identified another 4 wells.
- 12 new wells have been drilled since the 2004 ESRF study.
- The 2019 CER and 2004 ESRF well lists identify the largest number of wells, but information is generally limited to owner, location and dates of operation.
- Most records with information on sump conditions are provided by the NWT Centre for Geomatics sump database.
- The next largest source for information is the IWB registry/library, followed by the EISC database and then the 2004 ESRF study for which in-field inspections of 10 sumps to characterize sump condition and the environmental setting was completed.
- IWB water licences are available for 21 well sites including 18 sumps which outline the management of waste and closure requirements.
- Closure and reclamation or remediation plans are available from the IWB public registry for 6 well/sump sites.
- Other documentation identified the reclamation approach for drilling sumps at varying levels of detail for 13 well sites.
- 186 sump sites have no available documentation on the reclamation/remediation approach.
- Inspector directed remediation efforts are present for 5 sump sites.

3.0 SUMMARY OF POTENTIAL AND/OR ACTUAL ENVIRONMENTAL IMPACTS FROM SUMPS

The following two tasks are presented in this section of the report.

- **Task 1** – Consolidate relevant studies, reports, and Inuvialuit engagement that inform the well site and sump environmental condition.
- **Task 2** – Summarize the potential and/or actual impacts from sumps on the surrounding environment.

This information was reviewed to identify the actual and/or potential impacts on the environment and future degradation. In addition, interviews with industry and local community members and proponents were conducted to receive input on and identify potential sumps of concern.

3.1 Consolidation of Documentation Containing Environmental Information

Relevant studies and reports that contain sump environmental information were consolidated through the detailed record and literature search completed in Section 2.0 and summarized in Table 2. Section 3.3 provides further details of the records sourced and the summary of potential and/or actual impacts from the sumps.

3.2 Inuvialuit Engagement

The ISR-Community Based Monitoring Program (CBMP) was sub-contracted to interview Inuvialuit hunters and trappers with local knowledge of region and of drilling waste sumps of concern to local communities. CBMP is a joint undertaking of the IRC and the Inuvialuit Game Council and administered by the Joint Secretariat. The CBMP implements Inuvialuit led monitoring and research activities and supports initiatives that serve Inuvialuit interests.

From the interview surveys completed in Inuvik, Tuktoyaktuk and Aklavik, local knowledge was obtained from 12 Inuvialuit participants. The participants were selected by the IRC as those with critical knowledge of the region that could usefully aid in the information gathering portions of this study. Interview questions were developed by ARKTIS, the IRC and the CBMP staff for the use by the CMBP interviewees. The questions (provided in Appendix B) were designed to highlight:

- Specific sumps that were considered by local hunters and trappers as potentially problematic
- Provide input and observations as to sump performance and potential environmental impacts
- Provide input about certain areas considered to be sensitive in nature

Written records of the responses to the interview questions were compiled and a report was completed by the CBMP for ARKTIS. The CBMP final report and summary is considered to be confidential and is not included within this report. However, it has been provided to the IRC for future reference.

Based on the interviews, 58 well site locations were noted as being a concern (Figure 5). The concerns documented ranged from issues of site safety or hazards, matters of general site cleanup, and specific items related to certain sumps. In general, the concerns identified reflected concerns about the sites but may not have raised specific concerns about cited drilling waste sumps.

The findings of the surveys were documented and summarized and used for comparative purposes with other more formal license and inspection data accessed from governmental files. The final report from the CBMP provided an important point of reference for the study team and served to ensure that the observations and concerns of local hunters and trappers were considered as part of the study.

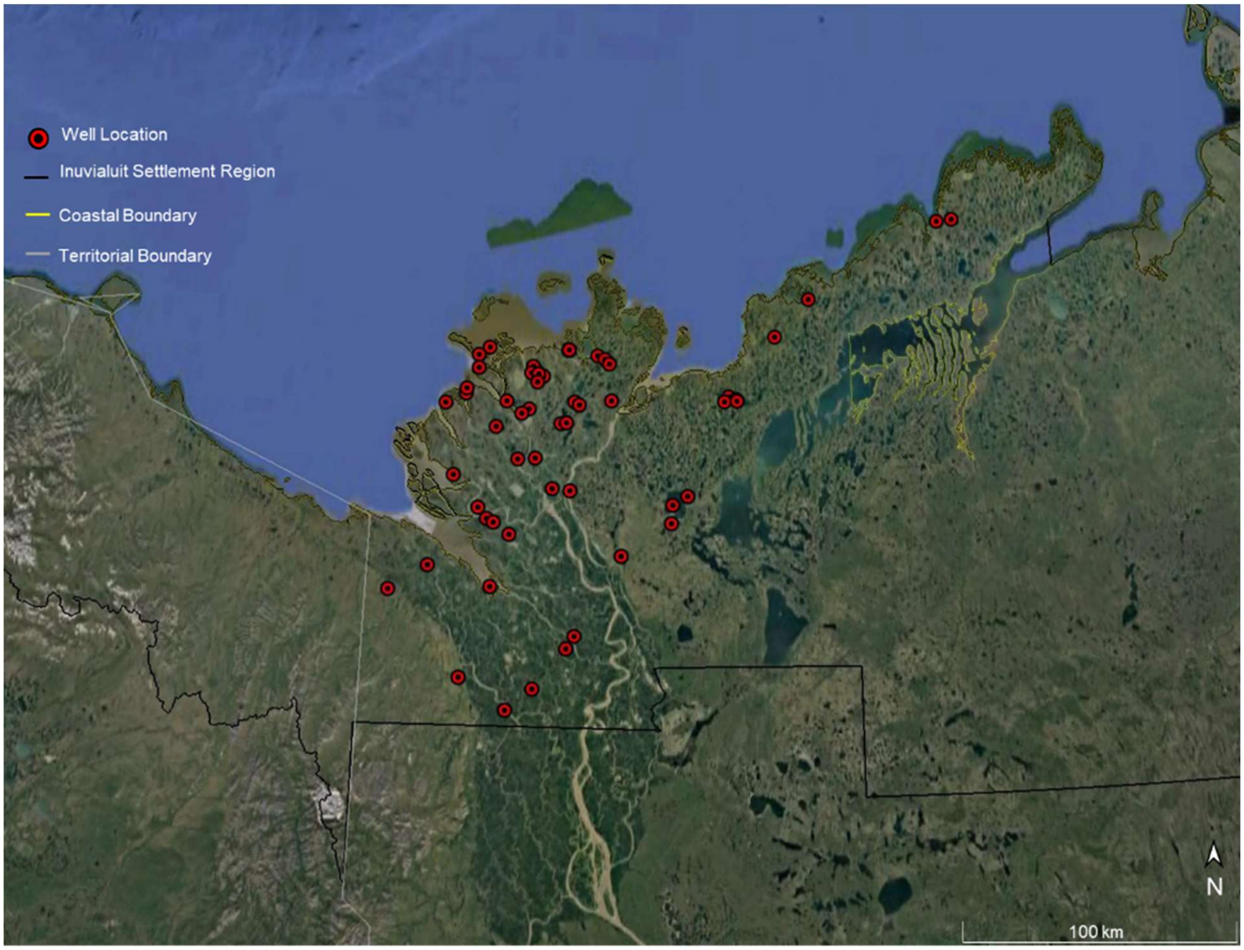


Figure 5. Map of the well sites identify by the CBMP interviews as having concern(s).

3.3 Potential and/or Actual Environmental Impacts

Using the documentation collected in Section 2.0, the potential and/or actual environmental impacts associated for each sump were consolidated. Of the 223 sump sites, environmental data were available for 104 sites (46.6% of total sumps). Thus, more than half of the sump sites (119 sites or 53.4% of total wells) had insufficient data available to fully assess the current state of condition.

For the sump sites with available and sufficient environmental data, the environmental impacts were categorized according to visual or measurable attributes as follows:

- **Surface water impacts** – Sumps were classified as having an impact on surface water if:
    - Samples of surface water associated with the sump had concentrations of chloride (chloride used as indicator species) that exceeded background concentrations by over 30%;
    - Inspections or studies stated the sump had an impact on surface water; or,
    - Drilling mud, visible hydrocarbons or other indicators related to drilling waste were noted during inspections and/or assessments at the surface.
- **Permafrost degradation** – Sumps were classified as experiencing permafrost degradation if:

  - The average depth of the active layer on or around the sump was greater than background by 30% or more
  - Drilling waste remained unfrozen or was escaping; or,
  - Inspections or studies stated the active layer thickness to be increasing or ground thawing as occurring.
- **Sump cover damage** – Sumps were classified as having cover damage if:
  - Inspections or studies stated the cover had collapsed, experienced significant subsidence, cracking, sloughing or ponding; or,
  - Drilling waste was observed to be escaping.
- **Vegetation stress** – Sumps were categorized as experiencing vegetation stress if:
  - Inspections or studies noted the presence of stressed vegetation areas or areas of limited regrowth potentially due to sump impacts on soil such as salt related stress impacts.
- **Sedimentation or erosion occurrence** – Sumps were categorized as experiencing sedimentation or erosion if:
  - Inspections or studies documented the occurrence of sedimentation or erosion.

A breakdown of the number of sumps within each environmental impact category is provided in Table 7. The most common impact observed was that of surface water intrusion, followed by permafrost degradation, sump cover damage, vegetation stress and sedimentation or erosion. A summary of the potential and/or actual environmental impacts identified for each sump is provided in the tables in Appendix B.

Table 7. ISR well sump counts by potential and/or actual environmental impact category.

Potential and/or Actual Environmental Impact	No. of Sumps (x/223)	Percent (of Sumps with Available Data)
Surface water impacts	65	82.3
Permafrost degradation	64	66.7
Sump cover damage	61	56.5
Vegetation stress	35	35.0
Sedimentation or erosion	31	34.4

When sufficient data was available, using sump characteristics such as the age and location of each sump, an assessment of temporal and spatial trends was completed to understand:

- Does sump age correlate to potential and/or actual environmental impacts?
- Is there a predominant geologic and/or environmental setting that is more susceptible to potential and/or actual environmental impacts?

Figure 6 shows the temporal distribution of sumps with potential and/or actual environmental impacts. Figure 7 and Figure 8 show the spatial distribution based on surficial geology and region, respectively, of sumps with impacts. Based on the available data, no discernable temporal or spatial trends associated with sump potential and/or actual environmental impacts were observed.

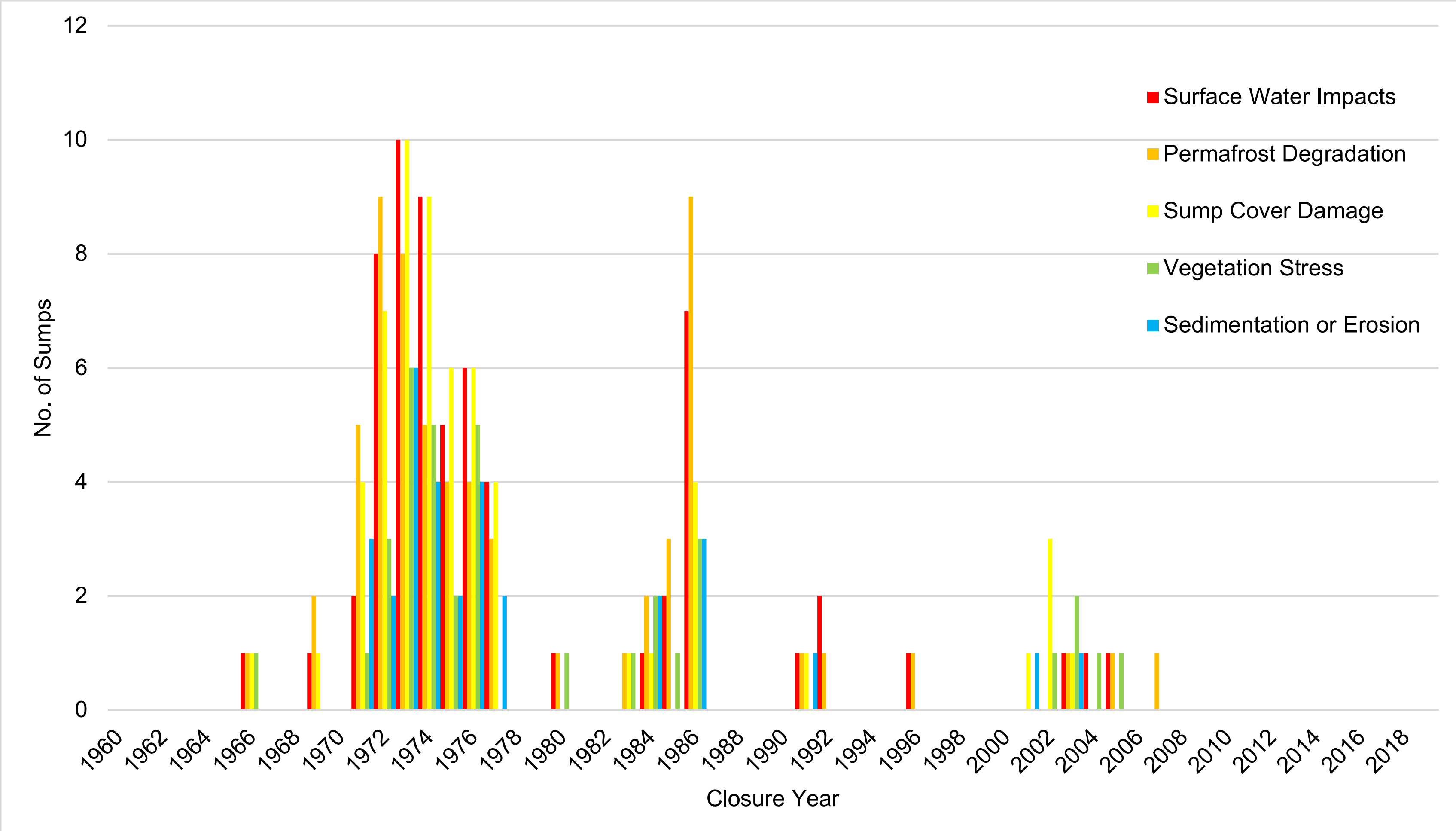


Figure 6. Temporal distribution of sumps with identified potential and/or actual environmental impacts.

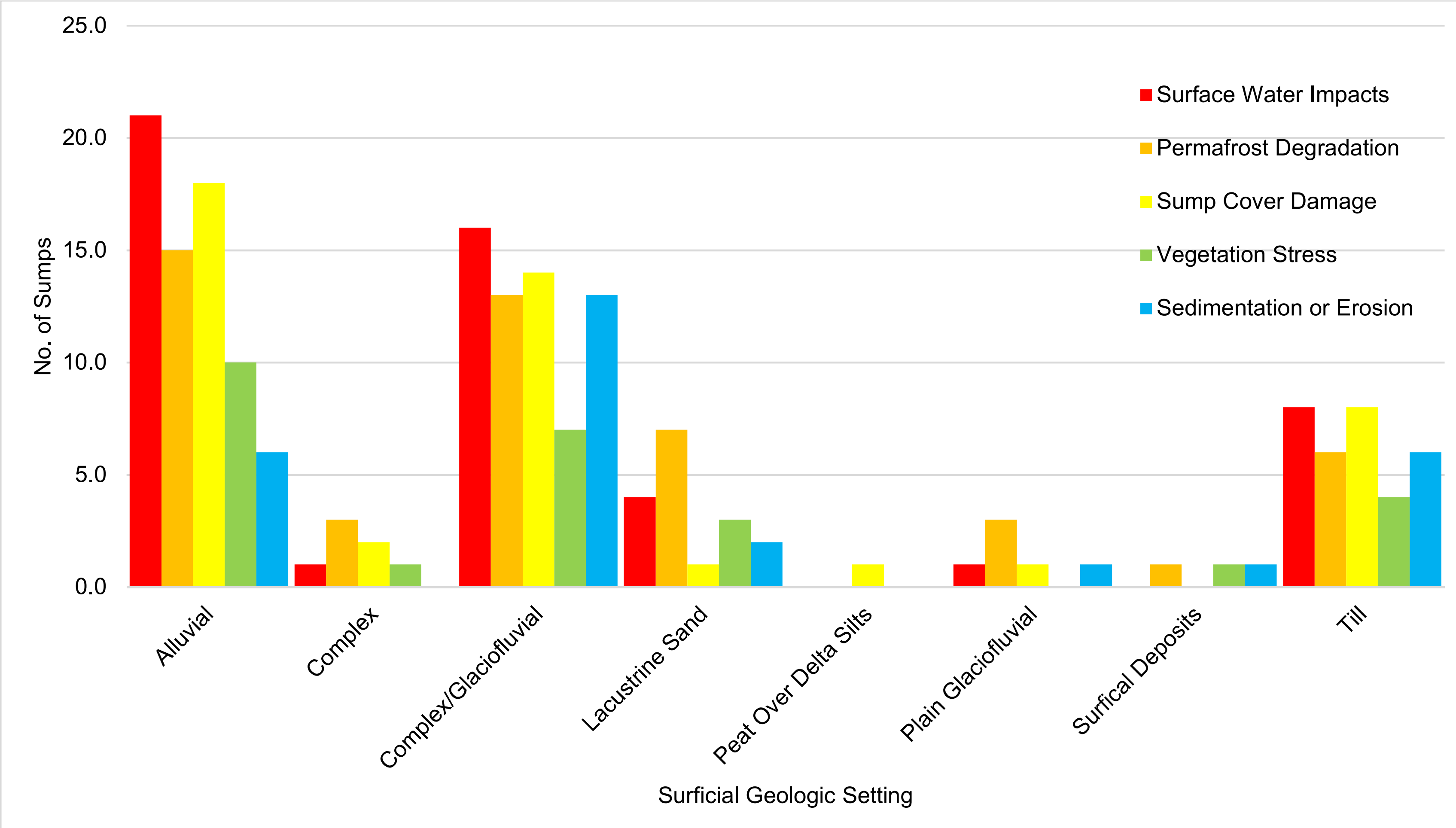


Figure 7. Surficial geological distribution of sumps with identified potential and/or actual environmental impacts.

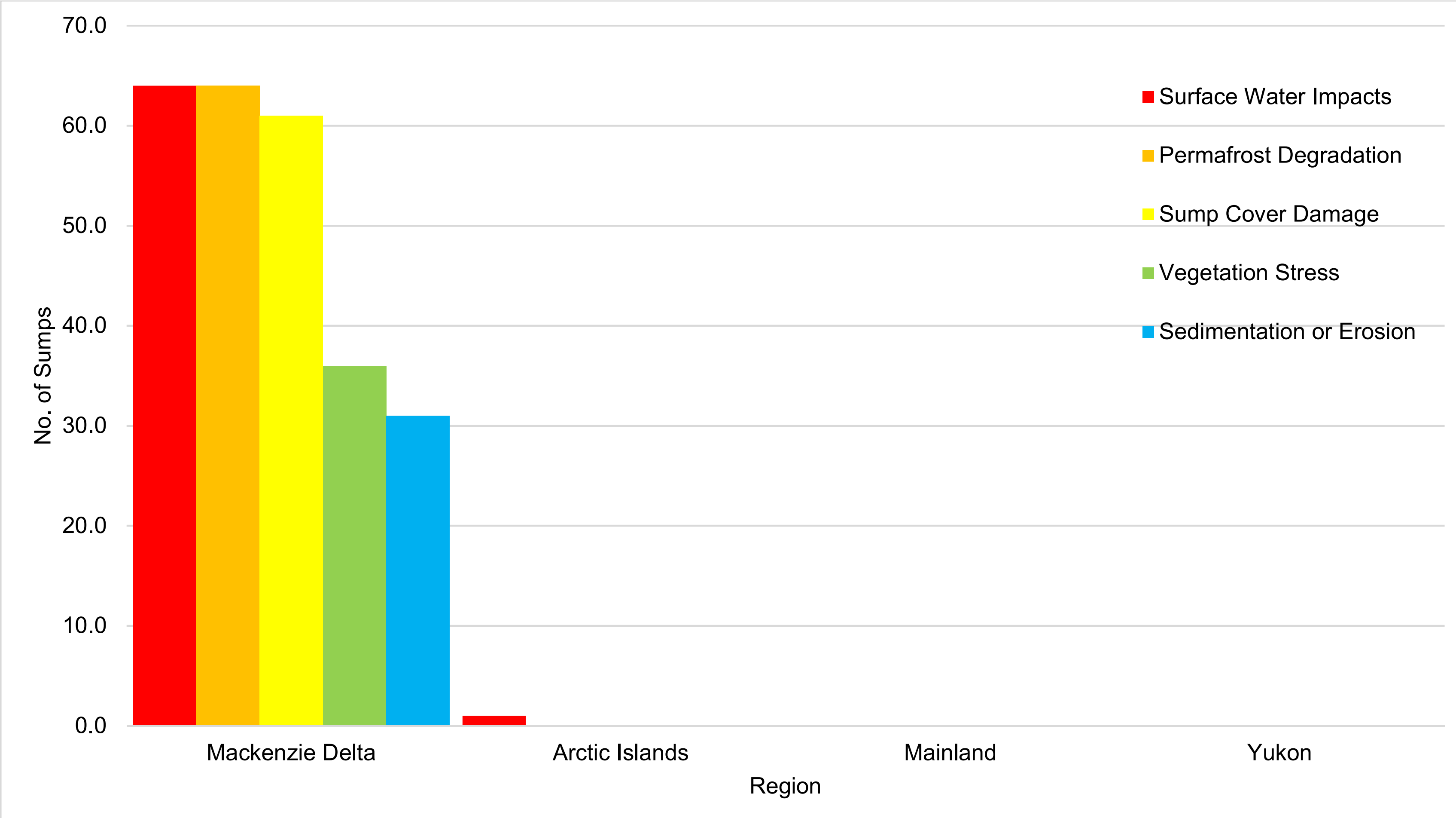


Figure 8. Regional distribution of sumps with identified potential and/or actual environmental impacts.

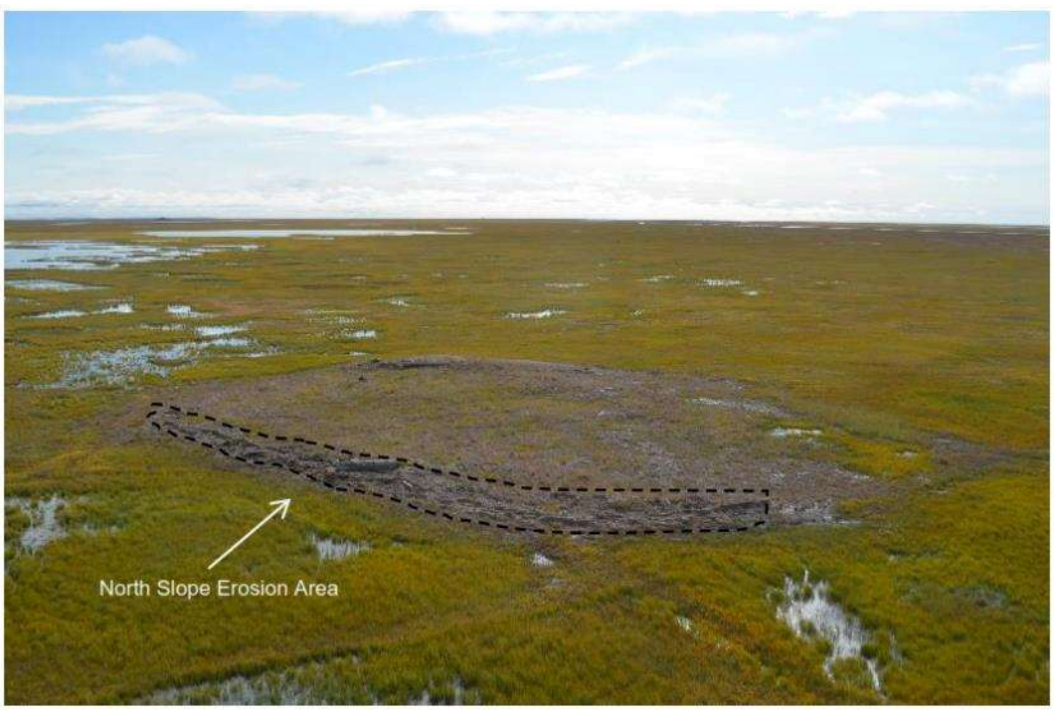
For a select subset of sumps with sufficient documentation (i.e. in general more than one sump report available over several years), an evaluation of the potential and/or actual environmental impacts that have occurred over time was completed to assess the rate at which sump degradation appears to occur, as well as, the change in extent and magnitude of the potential and/or actual environmental impact. Table 8 provides a summary of the assessment below.

As noted in Table 8, potential and/or actual environmental impacts generally appear to manifest approximately 10 years following sump closure or reclamation, although exceptions are common. In general, early impacts at first appear in response to initial settling of the sump cover, with some contaminant migration potentially occurring beyond the sump and possible impacts to surface water. After several years additional subsidence and ponding can occur, with corresponding permafrost degradation, escape of drilling waste to the surface and impact to surface water and vegetation. At this point in its history, the sump cap may approach a state of failure.

Shown below are photographs and examples of the various sump failure mechanisms (e.g. subsidence, ponding, cracking, vegetation stress).

Photograph 1. Example of sump cap subsidence and surface water ponding over half of the sump area, Kugpik L-46 sump. Taken July 2013.

Photograph 2. Example of subsidence of 30 to 50 cm along corner of sump cap, Itiginkpac F-29 sump. Taken August 2013.



Photograph 3. Example of sump cap erosion along sump perimeter, Langley K-30 sump. Taken August 2018.

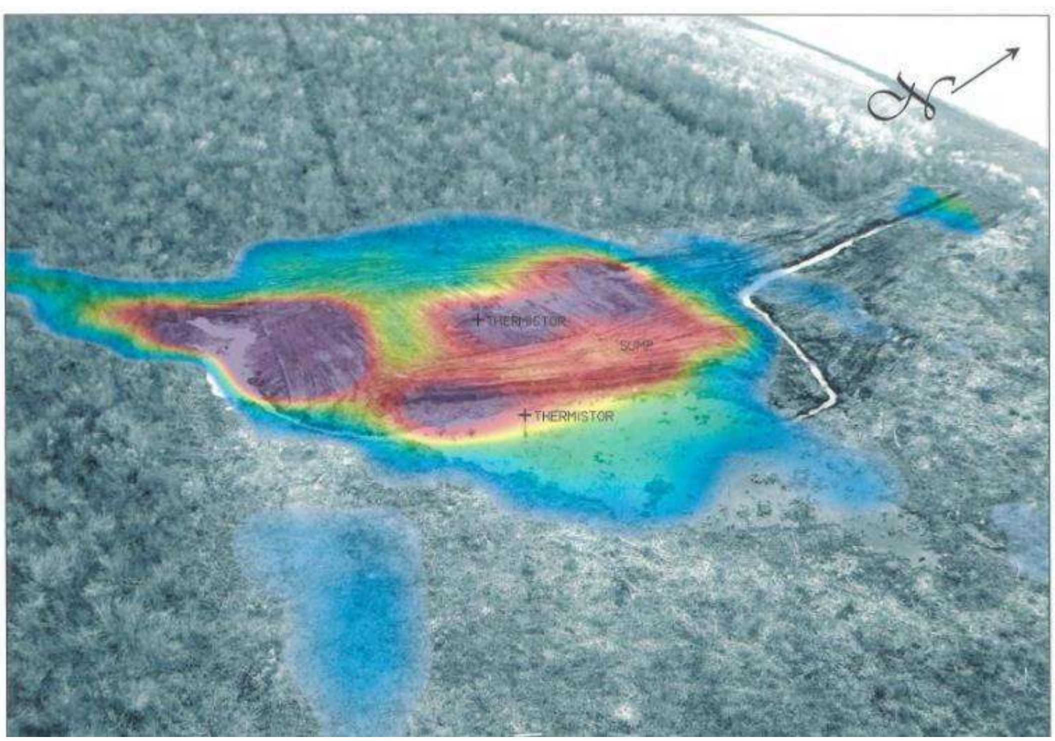
Photograph 4. Close-up view of sump cap erosion along sump perimeter, Langley K-30 sump. Taken August 2018.

Photograph 5. Example of shoreline erosion of sump area, Unipkat I-22 sump. Sump was peviously excavated of all drilling waste and backfilled with clean material. Taken July 2013.

Photograph 6. Example of tension cracking along perimeter of sump cap, Umiak N-05 sump. Taken August 2016.

Photograph 7. Example of vegetation stress from potentially impacted water adjacent to sump, Tuk B-02/M-18 sump. Taken Augsut 2013.

Photograph 8. Example of hydrocarbon sheen on surface water indicating potential leaching from sump, Umiak N-05 sump. Taken August 2016.



Photograph 9. Example of electromagnetic (EM) survey showing contaminant migration beyond sump boundaries, Itiginkpac F-29 sump. Completed September 2005.

Continuing degradation of sumps could lead to instability and failure of the sump to contain waste material, with contaminants potentially released into the environment. The potential for future degradation of the sumps was assessed, which considered:

- Increasing trends in air/ground temperatures due to climate change;
- Changes in vegetative species and locations of growth about the sump;
- Sump settlement and instability; and,
- Local environmental setting.

Sumps were classified as having the potential for future degradation if there was:

- Increasing trends in ground temperatures or active layer depth;
- Increasing trends in sump settlement and instability (e.g., subsidence, cracking, sloughing, erosion); or,
- Significant ponding on surface of sump.

The assessment of future sump degradation is summarized in Table 8. These sumps were assessed because there were multiple years of site data to complete an assessment over time. All sumps assessed have the potential for continued or future degradation.

Table 8. Summary of changes in potential and/or actual environmental impacts over time.

Well Name	Years After Sump Closure / Remediation	Potential and/or Actual Environmental Impact	Details	Potential for Future Degradation
Ikhil I-37	37	Sump cover damage Surface water impacts Permafrost degradation	50% of sump subsided with ponding. Escape of drilling mud. Hydrocarbon sheen. Elevated hydrocarbons and metals in water	Yes – continued escape of drilling mud will occur into surrounding environment. Potential for further subsidence.
Itiginpak F-29	1	None	Contaminant migration beyond sump.	Yes – potential for further subsidence and contaminant migration.
	2	None	Further migration away from sump. Drilling waste potentially unfrozen.	
	10	Sump cover damage	Subsidence of 30-50 cm.	
Kugpik L-46	11	Sump cover damage	Major subsidence with ponding.	Yes - potential for further subsidence.
Kurk M-15	3	None	None	Yes - potential for further cracking/erosion and contaminant migration.
	13	Sump cover damage Erosion.	Contaminant migration beyond sump. Surface cracking and erosion.	
Langley K-30	2	None	Slumping.	Yes - potential for further permafrost degradation, subsidence and erosion.
	11	Sump cover damage Surface water impact	Hydrocarbon sheen. Subsidence.	
	13	Sump cover damage Surface water impact Permafrost degradation	Increase in active layer thickness. No other change.	
	14	Sump cover damage Surface water impact Permafrost degradation Erosion	Increase in subsidence and erosion.	
	16	Sump cover damage Surface water impact Permafrost degradation Erosion	Increase in active layer thickness. No other change.	
Mallik 3L, 4L, 5L-38	9	Sump cover damage	Subsidence with ponding.	Yes- potential for further subsidence from ponding.
	10	Sump cover damage	Increase in ponding. Minimal sump caps remaining.	

Well Name	Years After Sump Closure / Remediation	Potential and/or Actual Environmental Impact	Details	Potential for Future Degradation
			Caps close to surface with minor slumping.	
	11	Sump cover damage	No change.	
	12	Sump cover damage	No change.	
	15	Sump cover damage	No change.	
Nuna I-30	1	None	None	Yes - potential for further cracking.
	3	Surface water impacts Vegetation stress	Ponding, surface cracking, restricted vegetation growth.	
Parsons F-09	32	Sump cover damage	Sump had subsided with water ponding on the subsided portion of the sump.	Yes - continued escape of drilling mud will occur into surrounding environment. Potential for further subsidence, cracking and slumping.
	38	Sump cover damage Surface water impacts	Sump cap has subsided. Drilling mud seeping from sump.	
	40	Sump cover damage Surface water impacts Erosion	Slumping, subsidence, cracking and ponding. Drilling mud seeping from sump.	
Tuk B-02 and M-18	11	Sump cover damage Vegetation stress	Subsidence, cracking and ponding. Vegetation showing impacts.	Yes - potential for further subsidence and cracking.
Umiak N-05	0	None	Minor subsidence. Contaminant migration beyond sump.	Yes - potential for further permafrost degradation, subsidence, cracking and contaminant migration.
	1	Surface water impacts Sump cover damage Permafrost degradation	Further contaminant migration beyond sump. Slumping, subsidence and ponding. Remediation completed. Permafrost depth at sump greater than adjacent areas.	
	2	Surface water impacts Sump cover damage Permafrost degradation	Continued contaminant migration beyond sump. Cracking and slumping. Active layer deeper at sump than adjacent areas.	
	4	Surface water impacts Sump cover damage Permafrost degradation	Continued migration beyond sump. Active layer deeper at sump than adjacent areas.	
	5	Surface water impacts	Healing of cracks. Active layer stable at depth deeper than adjacent areas. No further migration from sump. Migration area similar in size during past 4 years.	

Well Name	Years After Sump Closure / Remediation	Potential and/or Actual Environmental Impact	Details	Potential for Future Degradation
	6	Surface water impacts	Continued healing of cracks. Contaminant migration very slow or no longer active.	
	8	Surface water impacts Vegetation stress	Some elevated salinities in surface water and localized impacts on vegetation	
	9	Surface water impacts Vegetation stress	No changes.	
	10	Surface water impacts Vegetation stress	Some thawing and subsidence at perimeter. No other changes.	
	11	Surface water impacts Vegetation stress Permafrost degradation	Cracking and subsidence at perimeter. Increase in active layer thickness over time. Areas of impacted vegetation. Hydrocarbon sheen. Potential new contaminant migration beyond sump.	
	12	Surface water impacts Vegetation stress Permafrost degradation	Cracking on surface. Hydrocarbon sheen. Dead vegetation. Potential continued contaminant migration beyond sump.	
Umiak N-16	2	None	Contaminant migration beyond sump.	Yes - potential for further subsidence, cracking and contaminant migration.
	8	None	Subsidence and ponding.	
	9	None	Subsidence and ponding.	
	10	None	No change.	
	11	None	Subsidence, ponding and cracking.	
	12	None.	No change.	
	13	Surface water impacts Vegetation stress	Potential leaching. Hydrocarbon sheen. Dead vegetation. Cracking.	
Unipkat I-22	1	Sump cover damage Erosion	Subsidence, cracking, erosion.	Yes - potential for further subsidence, cracking and erosion.
	2	Sump cover damage Erosion	Further subsidence, cracking, erosion. Ground at equilibrium with general thermal regime.	

Well Name	Years After Sump Closure / Remediation	Potential and/or Actual Environmental Impact	Details	Potential for Future Degradation
	3	Sump cover damage Erosion	Further erosion.	
	4	Sump cover damage Erosion	Further erosion but appears to be stabilizing.	
Unipkat M-45 and Kumak I-25	0	Permafrost degradation Vegetation stress	Increasing active layer depth. Subsidence and ponding. Vegetation slightly stressed.	Yes - potential for further permafrost degradation, subsidence, cracking and contaminant migration.
	1	Permafrost degradation Vegetation stress	Remediation occurred. Some subsidence and ponding.	
	2	Permafrost degradation Vegetation stress	Remediation occurred.	
	3	Permafrost degradation	Minor ponding Vegetation coverage increasing.	
	4	Permafrost degradation	Minor subsidence and ponding, cracking.	
	5	Permafrost degradation	Minor subsidence and ponding. Cracking.	
	6	Permafrost degradation	Minor subsidence and ponding. Cracking.	
	9	Permafrost degradation	Subsidence and ponding. Increase in ground temperature. Contaminant migration beyond sump.	
	10	Permafrost degradation	Subsidence and ponding. Permafrost thaw.	
	11	Permafrost degradation	Subsidence and ponding. Rising ground temperatures. Increase in active layer along perimeter.	

3.4 Conclusions and Key Findings

Subject to data availability, a summary of the potential and/or actual environmental impact for each site was summarized based on a review of relevant studies and reports. The following potential and/or actual environmental impacts were addressed: surface water impacts, permafrost degradation, sump cover damage, vegetation stress, and sedimentation or erosion issues. The selection of these impacts for evaluation was driven by the factors typically visually observed and/or evaluated through completion of site inspections.

53% of the sumps had insufficient information available to allow further assessments of potential environmental impacts. Sumps with sufficient information were all located within the Mackenzie Delta (with the exception of one site located in the Arctic Islands). Information gaps on specific sump sites may be related to the costs required to access distant sites (more costly at sites further from Inuvik), locations where there was only potential concerns or degradation or locations in close proximity to on-site activities still in progress.

For sumps with available information, surface water impacts, permafrost degradation and sump damage represented the most commonly observed potential and/or actual environmental impacts. From an analysis of the data, no apparent trend existed between the ages of the sumps and potential and/or environmental impacts. No apparent trend of impacts appears to exist between the predominant geological and/or environmental setting. This result is unexpected and may reflect the limited amount of inspection data that could otherwise indicate trends associated with progressive degradation.

A more detailed evaluation of the progressive degradation of sumps was completed for sites where multiple years of inspection records existed. These allowed for a documentation of the potential and actual environmental impacts. For the sites evaluated, sump performance appears to be acceptable in the initial years after construction but may be followed by a progressive degradation of the sump cover, with signs of erosion, permafrost degradation, surface water impacts, and stressed vegetation. No identifiable rate of degradation was observable from the data.

The interviews of Inuvialuit hunters and trappers with intimate knowledge of the region were completed by the ISR-CBMP to collect information pertaining to sumps that were considered potentially problematic, to collect input into sump performance and potential environmental impacts, and to collect input on areas considered special or sensitive in nature. These findings were added to the overall study and an overview of the key findings is provided below:

- 104 sumps in the ISR have environmental impacts, 119 (53%) remain undefined.
- The most abundant potential and/or actual environmental impact is surface water, followed by permafrost degradation, sump cover damage, vegetation stress and sedimentation/erosion.
- No discernable temporal or spatial trends in environmental impacts with relation to sump age, geologic setting or region were observed, with the exception of the following temporal trend below.
- Of 12 sumps with sufficient information for the assessment, all are considered to have the potential for future degradation.
- Inspector reports identify 5 sumps of potential concern for additional characterization or remediation efforts (see Section 2.4).
- Based on the Inuvialuit engagement study done by the CBMP, 58 well site locations were noted as being a concern. In general, concerns identified were reflective of the site a whole and not necessarily specific to the drilling waste sump.

4.0 EVALUATION OF SUMP INFORMATION GAPS

The following three tasks are presented in this section of the report.

- **Task 1** – Consolidate the sump information collected into a standardized format and database.
- **Task 2** – Identification of sump information gaps.
- **Task 3** – Recommend methods to fill critical information gaps to inform remediation/removal plans.

4.1 Consolidation of Sump Information

The information on sumps collected in Section 2.0 was organized to follow methodologies developed in the Inuvialuit Water Board's 2006 Protocol for the Monitoring of Drilling-waste Disposal Sumps (herein referred to as "Sump Protocol; Northwest Territories Water Board, 2005) to allow for a standardized approach for identifying the presence/absence of information. The Protocol was developed to guide proponents with the collection of environmental information at closed sites that contained sumps. It was recognized that information is necessary to evaluate the design, construction and abandonment practices and to evaluate the environmental impacts of drilling waste disposal to sumps. The Sump Protocol aims to document the following attributes of the sumps:

- Site identification and location
- Site history and local environmental conditions
    - Site background
        - Project background
        - Site development
        - Drilling operations
    - Sump details – sump construction and contents
    - Environmental setting
        - Surface conditions
        - Soils and ground-ice conditions
        - Groundwater
- Site conditions after closure
    - Infrastructure and sump morphology
        - Photographs
        - Sump characteristics
    - Surface water quality results
- Active-layer and ground temperature monitoring
    - Active-layer depths
    - Thermal monitoring
- Electromagnetic survey and soil sampling
    - Surveys (map and results)
    - Soil quality results

Appendix B contains the presence/absence database of each attribute for each sump.

4.2 Identification of Information Gaps

The presence/absence evaluation for each sump attribute (described in Section 4.1) was used to identify information gaps for the sumps. If the attribute information was not available, it was considered to be an "information gap". The information gaps have been categorized to define the current state of available information for each site:

- **Category 1** - Are the key sump characteristics at time of construction known?
    - These characteristics will help to understand the source of contamination and requirements for remediation/removal plans, if necessary.
- **Category 2** - Has the local environment and/or background conditions been characterized?
    - These characteristics will help to assess risk of exposure and/or actual exposure of a contaminant to environmental receptors.
- **Category 3** - Are conditions of the sump known after its closure?
    - These characteristics will help to understand current site conditions that have resulted in, or are at risk of, release of a contaminant.
- **Category 4** - Has environmental monitoring of the closed sump occurred?
    - These characteristics will help to understand pathways and mobility of the contaminant from its source and current site impacts to the environment, as well as, risk of release of a contaminant.

The information categories and their associated attributes for the sumps are identified in Table 9, along with a summary count of well sites with available information on each. The detailed presence/absence assessment table for the attributes of each sump is provided in Appendix B.

Table 9. ISR sump count by available sump attribute information.

Category	Attribute	Description of Attribute	No. of Sumps	Percent of Total Sumps
Category 1 - Are the key sump characteristics at time of construction known?	Location	Latitude/longitude of sump and/or well.	219	98.2
	Sump Area[1]	Length, width, or total area.	7	3.1
	Sump Depth[1]	Depth of excavation.	6	2.7
	Cover Thickness[1]	Thickness of overlying material placed above drill waste.	6	2.7
	Drill Waste Characteristics	Chemical and physical properties of drilling mud and/or waste.	15	6.7
	Date of Sump Operation and Closure	Sump construction and reclamation dates, or well spud and rig release dates.	218	97.8
Category 2 - Has the local environment and/or background conditions been characterized?	Surface Condition – topography[2]	General ground relief of site.	99	44.4
	Surface Condition – vegetation[2]	General coverage and/or characteristics of surrounding background vegetation.	99	44.4
	Active Layer Depth[2]	Maximum depth of ground thaw in background areas surrounding sump.	102	45.7
	Soil Conditions[2]	General physical and/or chemical properties of background soil.	97	43.5
	Ground Ice Conditions[2]	General characteristics of frozen ground features in local area.	13	5.8
	Groundwater[2]	Chemical and/or physical properties of background groundwater.	2	0.9
	Background Surface Water Quality[2]	Chemical and/or physical properties of background surface water.	83	37.2

Category	Attribute	Description of Attribute	No. of Sumps	Percent of Total Sumps
Category 3 - Are conditions of sump known after its closure?	Inspection Records	Government water licence inspection reports with information and date on sump conditions after closure.	9	4.0
	Sump Area[3]	Length, width, or total area.	92	41.3
	Sump Depth[3]	Depth of excavation.	7	3.1
	Cover Thickness[3]	Thickness of overlying material placed above drill waste.	2	0.9
	Drill Waste Characteristics[3]	Chemical and physical properties of drilling mud and/or waste.	2	0.9
	Sump Stability	Condition of cover, evidence of subsidence, sloughing, cracking, erosion, water ponding.	108	48.4
	Status of Known Environmental Impact(s)	Conclusion based on environmental site monitoring regarding sump impact on local environment.	9	4.0
Category 4 - Has environmental monitoring of the closed sump occurred?	Ground Temperatures	Sub-surface temperatures within and above drilling waste.	30	13.5
	Vegetation	General coverage and/or characteristics of vegetation on and around sump.	108	48.4
	EM Surveys	Electromagnetic scan (EM) for elevated conductivities on and around sump.	97	43.5
	Soil Quality	Chemical properties of soil on and/or around sump.	94	42.2
	Water Quality	Chemical properties of surface water on and/or around sump.	94	42.2

Note:
[1] Sump as-built characteristics may be based on project description plans rather than actual field documentation.
[2] Background environmental conditions can be documented several or more years after sump closure during follow-up studies/monitoring.
[3] A proportion of sump as-built characteristics are only documented several or more years after sump closure during follow-up studies/monitoring.

Certain information gaps (i.e., attributes with no information) were tallied and classified as follows:

- **Low** – Information available for 76 to 100% of attributes.
- **Moderate** – Information available for 51 to 75% of attributes.
- **High** – Information available for 26 to 50% of attributes.
- **Severe** – Information available for 0 to 25% of attributes.

Table 10 indicates the sump count for each information gap category and class. Most sumps are classified with 'severe' information gaps, where little or no information available for most of the specified attributes. The distribution of classes of information gaps within each information category is shown on Figure 9.

Table 10. Information gap assessment.

Category	Information Gap Class No. of Sumps				
	Low (76-100% Attributes Available)	**Moderate (51-75% Attributes Available)**	**High (26-50% Attributes Available)**	**Severe (0-25% Attributes Available)**	**Total**
Category 1	6	2	210	5	223
Category 2	7	89	9	118	223
Category 3	0	3	95	125	223
Category 4	85	17	3	118	223
All Attributes	6	85	17	115	223

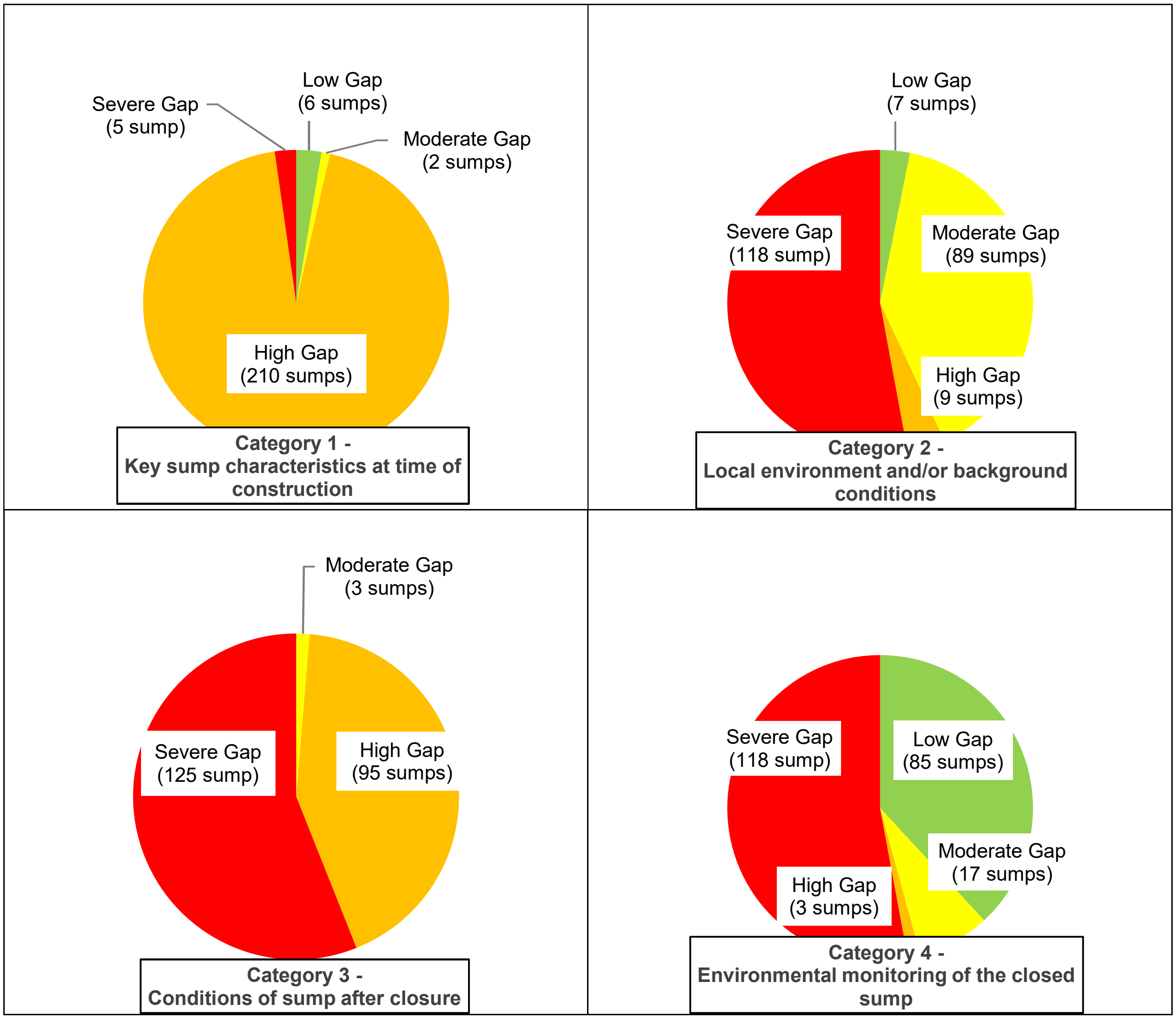


Figure 9. Distribution of information gap classes within each information category.

Table 11 provides a breakdown of information gaps by region and time period (i.e., closure date of sump). As observed from Table 11, attribute information is primarily available for sumps located within the Mackenzie Delta region. Attribute information is generally most abundant for well sites drilled during the 1970's and 1980's, followed by those drilled in the 2000's. A number of new wells drilled after 2000 have significant information gaps that result from a lack of documentation available from public sources.

Table 11. Information gap summary by region and sump closure period.

Region / Sump Closure Period	Information Gap Class No. of Sumps				
	Low (76-100% Attributes Available)	Moderate (51-75% Attributes Available)	High (26-50% Attributes Available)	Severe (0-25% Attributes Available)	Total
CER Region					
Mackenzie Delta	6	84	17	65	172
Arctic Islands	0	1	0	40	41
NWT Mainland	0	0	0	7	7
Yukon	0	0	0	3	3
Time Period					
1962-1969	0	1	2	8	11
1970-1979	1	56	12	86	155
1980-1989	0	20	0	9	29
1990-1999	0	4	2	5	11
2000-2009	5	3	1	3	12
2010-2019	0	0	0	0	0

4.3 Key Information Gaps

To further understand the key information gaps that are criterial to inform remediation/removal plans and/or risk management and monitoring plans, key sump attributes were consolidated into the following seven groups.

- Contaminant source characteristics (in this case the sump extent, volume and waste composition).
- The environmental characteristics which may give rise contaminant exposure to receptors.
- The pathways and mobility of the contaminant from the source.
- The current site conditions that have resulted in release of the contaminant.
- The current site impacts to vegetation and the sump stability (e.g., condition of cover, evidence of slumping, cracking, erosion, and water ponding).
- Current vegetation community types that may contribute to snow accumulation and permafrost degradation potential.

These groupings were developed to characterize the source of contamination, the environmental setting, the pathways and mobility of contamination, and the current status of sump degradation. Table 12 presents the seven information groups, the sump attributes within each group, and the evaluation of information availability. The majority of the sumps have relatively large information gaps (i.e., available information for less than 25% of attributes) for all the groupings. Documentation containing relevant information on sump conditions is not available for more than half the sumps in the ISR. Recommended methods to address the information gaps so as to inform future reclamation planning are also presented in Section 5.0.

Table 12. Information gap by key information group.

Key Information Group	Attributes	Key Information Gap No. of Sumps			
		0-25% Attributes Available	26-50% Attributes Available	51-75% Attributes Available	76-100% Attributes Available
Contaminant source characteristics	Sump area Sump depth Drill waste characteristics	123	85	7	8
Environmental characteristics	Surface condition - topography Surface condition - vegetation Soil conditions Ground ice conditions Groundwater Background surface water quality Active layer depths	118	9	89	7
Pathways and mobility of contaminant	EM surveys	126	0	0	97
Current site conditions	Active layer depths Ground temperatures Soil quality Water quality	121	14	63	25
Current site impacts to vegetation and sump stability	Vegetation Sump stability (i.e., subsidence, sloughing, cracking, erosion, sedimentation, ponding)	114	2	0	107
Current vegetation community types	Vegetation	115	0	0	108

4.4 Conclusions and Key Findings

The information on well sites and sumps was consolidated into a digital database. Subject to availability, the data were generally organized to follow the IWB's 2006 Sump Protocol that aggregated data into a standardized and acceptable manner. This was done to facilitate future applications.

The Sump Protocol was developed by the IWB, in part, to guide proponents with the collection of environmental information at closed sumps and was used in this study as a tool to assess information gaps at specified sites. Thus, if an attribute identified in the Sump Protocol was not found it was considered to be an information gap.

To further clarify how the types of information gaps were identified, sump attributes were grouped into four categories:

- **Category 1** - Are the key sump characteristics at time of construction known?
- **Category 2** - Has the local environment and/or background conditions been characterized?
- **Category 3** - Are conditions of the sump known after its closure?
- **Category 4** - Has environmental monitoring of the closed sump occurred?

Category 3 was found to present the greatest number of information gaps, followed by categories 1, 2, and 4.

An overview of the key findings of the study is provided below:

- The majority of the sumps have been classified as having a ‘severe’ information gap, meaning that adequate information is available for between 0 to 25% of attributes.
- Sumps located in the Mackenzie Delta region have the highest availability of “attribute information.” For the other regions (i.e., Arctic islands, NWT mainland and Yukon) information is typically limited only to location and operation/closure dates.
- Well sites drilled during the 1970’s and 1980’s, followed by the 2000’s, have the highest levels of available “attribute information”.
- Key information gaps include: Pathways and mobility of contaminants, followed by contaminant source characteristics, current site conditions, environmental characteristics, current vegetation community types and current site impacts to vegetation and sump stability.

5.0 SUMP RANKING AND RECOMMENDED MITIGATION AND REMEDIATION METHODS

The following three tasks are presented in this section of the report.

- **Task 1** – Develop a tool to rank the sumps from high to low priority for management action.
- **Task 2** – Calculate the rank for each sump.
- **Task 3** – Recommend management and reclamation actions for the sumps to mitigate and/or reduce risk and environmental impacts.

The sump rankings and associated recommendations presented here are based on experiences of existing and past observations of the interactions of sumps and climate. The effects of climate change may yet further alter the characteristics of the sumps and require further revisions to the ranking system employed. Other implications of climate change potentially affecting sump degradation are addressed in Section 6.0.

5.1 Sump Class and Ranking

A two-tiered system was developed to rank the priorities for sumps from high to low, as follows:

- First, the sumps were classified based on:
  - a) availability of information and
  - b) observation and/or measurement of sump degradation.

  A four-class system was developed and discussed below. The sump class categorization was developed to provide an understanding of the degree of degradation primarily characterized through site inspections and investigations.
- Second, within each class the sumps were ranked in priority from high to low based on factors that considered the contaminant sources, receptors and potential pathways for exposure.

In summary, the sump classification and ranking tool is an aid used to prioritize the sumps that may require further management attentions or remedial action. It should be noted that this classification system should not be considered as a process for risk assessment or for the assessment of potential or actual environmental impacts.

5.1.1 Sump Classifications

As noted in Sections 3.0 and 4.0, approximately half of the sumps in the ISR have insufficient information available in order to produce definitive assessments. These sumps have been termed as “Class Unknown”. For sumps with available information each was categorized from Class 1 through Class 3 based on degree of degradation: Where Class 1 was designated as the highest degree of degradation and Class 3 as the lowest. A description of each Class is provided below:

- **Class** 1 = Sump is experiencing current or imminent global instability failure, based on noted high levels or combinations of subsidence, ponding, cracking, sloughing, sedimentation or erosion.
- **Class 2** = Degradation is occurring but is not leading to imminent global instability, based on lower levels of the same stability issues noted above.
- **Class 3** = Degradation is less than Class 2.
- **Class Unknown** = No information on sump conditions is available.

The degree of degradation of sumps was based on evidence of:

- Sump failure noted from inspections
- Subsidence
- Ponding of water
- Cracking/sloughing
- Sedimentation/erosion

For each attribute of sump degradation, a score was applied. The cumulative score is utilized to define a Class 1, 2 or 3 sump. Table 13 provides a summary of the attributes for sump degradation, the scoring for each attribute and the criteria for each class of sump. Utilizing the data presented in Section 3.0, a score for each sump was tallied and the class for each sump determined. Table 14 lists the number of sumps assigned to each class as well as their risk rankings as discussed in Section 5.1.2. A map of the sumps and their respective classes is provided in Figure 10 and Figure 11

Table 13. Illustrative sump classification methodology and criteria.

Sump Degradation Attribute	Score	Class Criteria
Noted failure	*Yes* for statement of sump as failed in existing reports. *No* for no statement of sump as failed in existing reports.	Class 1 = average score of >= 0.7 or Yes for noted failure. Class 2 = average score of >=0.3 and <0.7. Class 3 = average score of <0.3. Class Unknown = No information on sump conditions is available
Subsidence	0 for none to minor subsidence. 1 for greater than minor subsidence.	
Ponding	0 for no ponding. 0.33 for minor ponding. 0.66 for moderate ponding. 1 for major ponding.	
Cracking/sloughing	0 for no cracking or sloughing. 1 for observed cracking or sloughing.	
Sedimentation/erosion	0 for no sedimentation or erosion. 1 for observed sedimentation or erosion.	

Table 14. Illustrative summary of sumps by classification with rankings.

Sump Class	No. of Sumps by Class	Sump Rank	No. of Sumps by Rank
Class 1	24	High	0
		Medium	17
		Low	7
Class 2	48	High	0
		Medium	25
		Low	23
Class 3	36	High	0
		Medium	14
		Low	22
Class Unknown	115	Rank Unknown	115
Total	**223**	**Total**	**223**

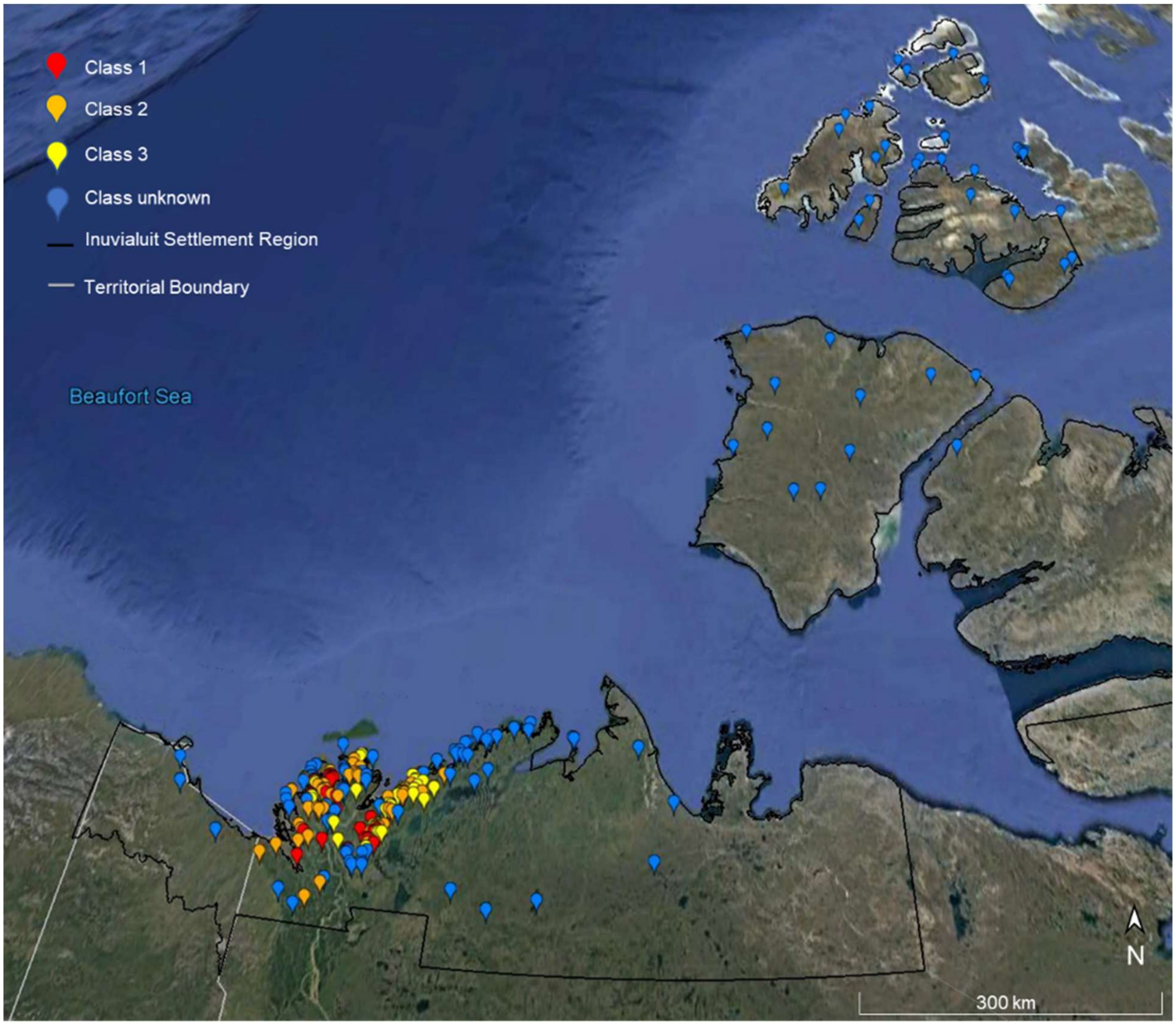


Figure 10. Regional map of sumps and their associated classifications.

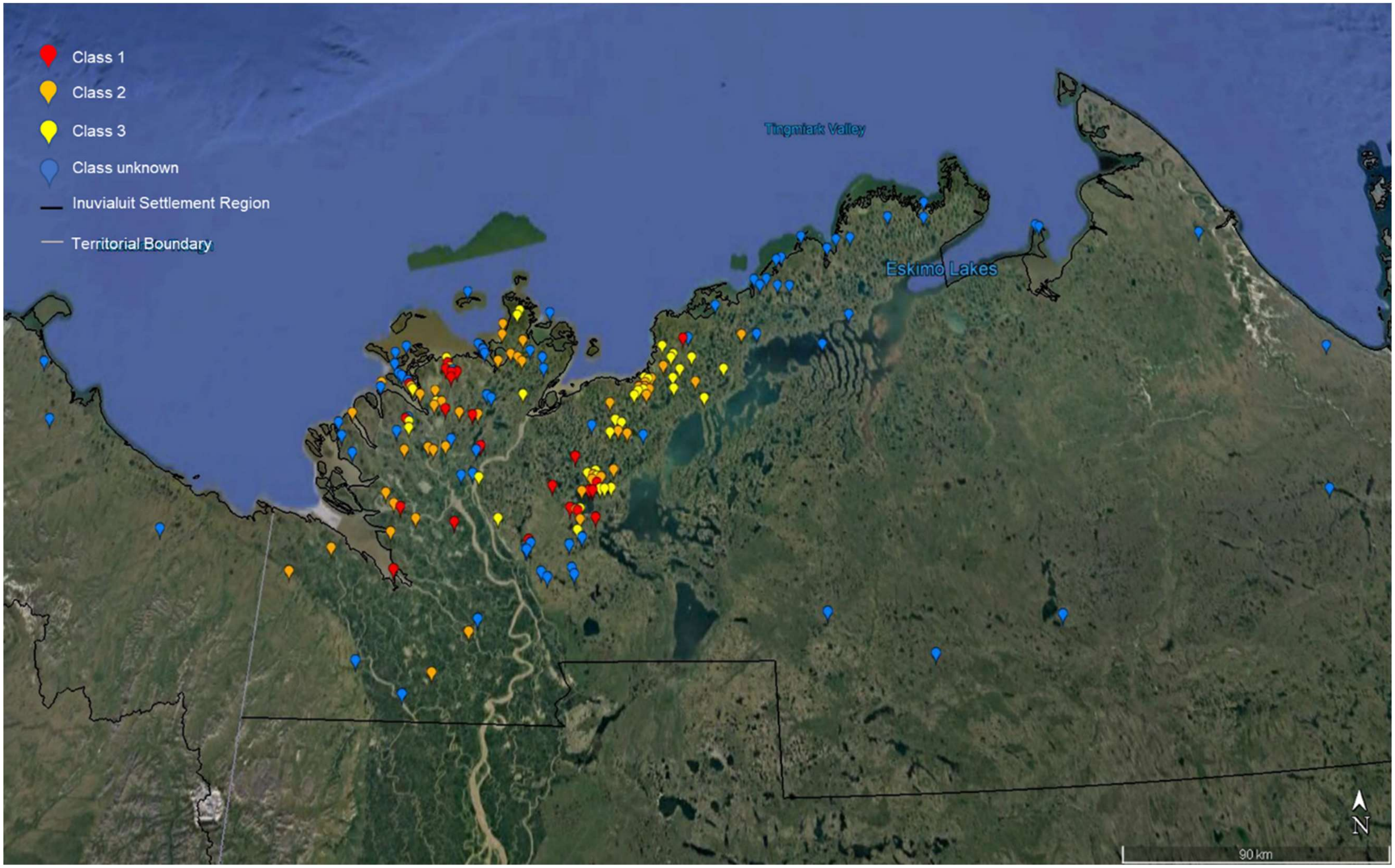


Figure 11. Mackenzie Delta map of sumps and their associated classifications.

5.1.2 Sump Ranking

For sumps classified as Class 1, 2 or 3, each was assigned a ranking of “high, medium or low”. Rankings were based on an evaluation of various factors that took into consideration the contaminant source, receptors and potential pathways for exposure. Figure 12 provides a schematic representation of the conceptual exposure model that was used a guide to select the hazards. The selected factors are not all those required to complete a full risk assessment but considered data that were potentially available for the sump locations. Although the ranking system was informed by the conceptual exposure model, the availability and types of data collected were used to inform assessments of sump/site conditions. In short, the ranking system was developed in accordance with the availability of data. Further discussion on additional considerations is provided in Section 5.1.2.1.

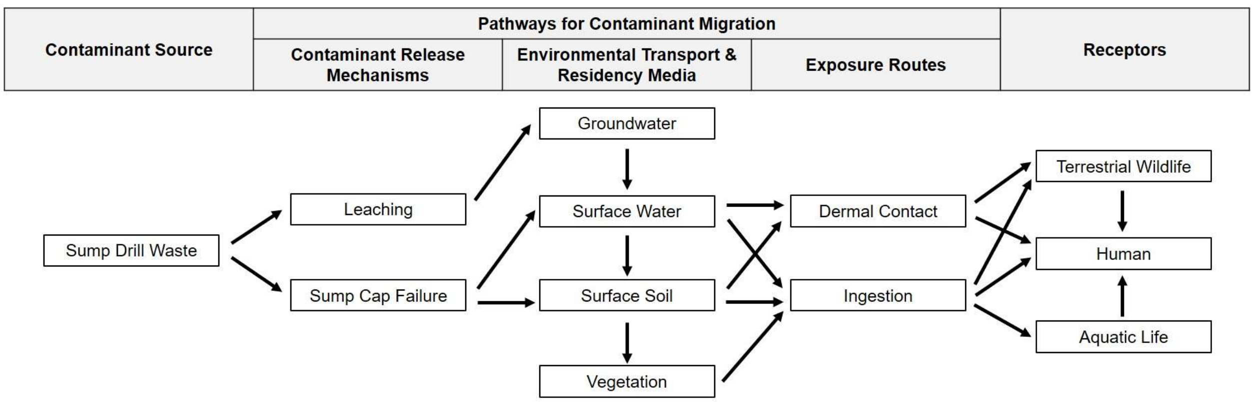


Figure 12. Schematic representation of human and environmental health conceptual exposure model for the movement of contaminant(s) bound to drilling waste to a person, wildlife or aquatic life.

The factors considered to determine the rank of the sump are as follows:

- Hazard factors:
  - Soil:
    - Soil contamination
    - Salt staining
  - Water:
    - Surface water contamination
    - Contaminant migration beyond sump
- Receptor factors:
  - Human:
    - Distance to surface water
  - Ecological:
    - Distance to protected areas
- Exposure pathway factors:
  - Stability:
    - Cap vegetation layer deficiency

        - Cap subsidence
        - Surface water ponding
        - Cap cracking, sloughing, sedimentation or erosion
        - Seasonality of sump operation
    - Environmental settings:
        - Site soil characteristics conducive to runoff
        - Active layer depths with potential for release of contaminants

Utilizing the data presented in Section 3.0, a score for each factor was assigned. Table 16 provides a summary of the factors and the scoring for each factor. In cases where no information was available to score a factor, it was assigned a value of zero. Thus, sumps for which there was limited information were assessed a total factor score lower than a sump with a more complete dataset. As a result, there is an unavoidable bias in the scoring system attributable to the availability of data.

For each sump, the score for each factor was tallied. This cumulative factor score was utilized to define a "high, medium or low" ranking as shown in Table 15. Table 14 summarizes the results of the ranking system derived for each class of sump.

Table 15. Risk rank criteria.

Risk Rank	Criteria
High	Total factor score of 10 to 13.
Medium	Total factor score of 5 to 9.
Low	Total factor score of <5.

Table 16. Summary of hazard, receptor and pathway factors and associated score.

Factor	ID	Indicators with Existing Measured Data	Attributes	Score Explanation	Rationale
Hazard Factors					
Soil	H1	Soil contamination	Based on laboratory results. One or more sump related soil chemical parameter concentrations exceed CCME criteria or background concentrations, including: - acidity/alkalinity (pH) - metals and major ions	Scores assigned as follows: • 0 = No exceedances of background concentrations over 30%. • 0.5 = Exceedances of background metal/major ion concentrations with over 30% difference and/or pH exceeds CCME but background does not. • 1 = Exceedances of both CCME and background metal/major ion concentrations. • If no background data is available, a score of 1 is assigned for CCME exceedances of metals/major ions.	Elevated soil chemical parameters relative to CCME criteria or background concentrations may indicate failure of the sump to contain drill waste. Three score tiers are used to differentiate between no indication of soil impacts (0), indicated impacts (0.5), and indicated impacts that pose a potential health risk based on CCME (1). A 30% difference from background values was selected as the threshold for indicated impacts to account for natural variability in the data and discount minor exceedances. Assuming a high risk score to compensate for data gaps (e.g., missing background data) is a precautionary approach that may result in a higher risk than actually present and should be filled in future work.
	H2	Salt staining	Based on visual observations in historical reports or interviews. Presence of salt staining across the site.	Scores assigned as follows: • 0 = No staining. • 1 = Staining present.	Salt staining can be an indicator of waste impacted water escaping from the drilling sump with the potential to further impact the environment. The two score tiers differentiate between no indication of soil impacts (0), indicated impacts (1).
Water	H3	Surface water contamination	Based on laboratory results. One or more sump related water chemical parameter concentrations exceed CCME criteria or background concentrations, including: - acidity/alkalinity (pH) - metals and major ions	Scores assigned as follows: • 0 = No exceedances of background concentrations over 30%. • 0.5 = Exceedances of background metal/major ion concentrations with over 30% difference and/or pH exceeds CCME but background does not. • 1 = Exceedances of both CCME and background metal/major ion concentrations. • If no background data is available, a score of 1 is assigned for CCME exceedances of metals/major ions.	Elevated surface water chemical parameters relative to CCME criteria or background concentrations may indicate failure of the sump to contain drill waste. Three score tiers are used to differentiate between no indication of water impacts (0), indicated impacts (0.5), and indicated impacts that pose a potential health risk based on CCME (1). A 30% difference from background values was selected as the threshold for indicated impacts to account for natural variability in the data and discount minor exceedances. Assuming a high risk score to compensate for data gaps (e.g., missing background data) is a precautionary approach that may result in a higher risk than actually present and should be filled in future work.
	H4	Contaminant migration beyond sump	Based on electromagnetic surveys for EC. Categorized as: - No noted evidence of contaminant migration away from sump. - Noted evidence of contaminant migration away from sump.	Scores assigned as follows: • 0 = No noted evidence. • 1 = Noted evidence of migration.	EM surveys indicating elevated EC beyond the sump boundaries may indicate contaminated water from drill waste is escaping the sump into the environment. The two score tiers differentiate between no indication of contaminant migration (0), indicated migration (1).
Receptor Factors					
Human	R1	Distance to natural water bodies	Based on visual observations in historical reports or interviews or satellite image review.	Scores assigned as follows: • 0 = 500 m or greater to nearest natural water body. • 0.25 = 100 m to 500 m • 0.75 = 30 m to 100 m. • 1 = Less 30 m to nearest water body.	Greater proximity to surface water increases the potential for impacts to the aquatic environment and subsequent exposure to receptors through ingestion or contact. In addition, there may be increased risk to erosion by the water bodies. Three score tiers are used to differentiate between low risk for impacts and/or erosion due to low proximity (0), moderate risk (0.5), and high risk due to near proximity.
Ecological	R2	Distance to protected areas	Based on location within recognized protected areas, including: • Banks Island Bird Sanctuary; • Kendall Island Bird Sanctuary; • Aulavik National Park; and, • Ivvavik National Park.	Scores assigned as follows: • 0 = Outside protected area. • 1 = Within protected area.	Location within protected areas has greater risk for sensitive habitat and/or species, resulting in disproportionate impacts to the environment relative to non-protected areas. The two score tiers differentiate between a location outside protected areas and thus at lower risk for impacts to sensitive habitat/species (0) and location within protected areas and thus at higher risk for impacts to sensitive habitat/species (1).
Exposure Pathway Factors					
Stability	E1	Cap vegetation layer deficiency	Based on visual observations in historical reports or interviews.Vegetation layer attributes on the sump include percent cover, noted stressed vegetation.	Scores assigned as follows: • 0 = Percent cover of >25%, and low stressed vegetation (<=100 m2). • 0.5 = Percent cover of >25%, with a high level of stressed vegetation (>100 m^2) or noted but undefined stress. • 1 = Percent cover of <25%. • Unknown percent cover but high vegetation stress is given a score of 1.	Limited vegetation cover or significant areas of stressed vegetation may negatively impact sump stability through increased erosion, increasing active layer depth leading to destabilization of waste materials. Three score tiers are used to differentiate between low risk for erosion due to high vegetation cover and low levels of stress (0), moderate risk for erosion due to high but stressed vegetation cover (0.5), and high erosion risk due to low vegetation cover.

Factor	ID	Indicators with Existing Measured Data	Attributes	Score Explanation	Rationale
				• Unknown percent cover with low vegetation stress is given a score of 0.5.	Assuming a higher risk score to compensate for data gaps (e.g., missing cover data) is a precautionary approach that may result in a higher risk than actually present and should be filled in future work.
	E2	Cap subsidence	Based on visual observations in historical reports or interviews. Subsidence of sump cap is categorized as none, minor, or collapsed. Subsidence may also be noted as present, but its severity is undefined.	Scores assigned as follows: • 0 = None. • 0.5 = Minor. • 1 = Collapsed, or subsidence is noted but undefined.	Subsidence of the sump cap could lead to decreased stability of the sump, either through increases in active layer thickness and thawing of waste material or cracking and failure of the cap to effectively contain the waste. Three score tiers are used to differentiate between low risk for cap failure from no noted subsidence (0), moderate risk for failure from minor subsidence (0.5), and high risk from noted collapse of the sump cap (1). Assuming a high risk score to compensate for data gaps (e.g., noted but undefined subsidence) is a precautionary approach that may result in a higher risk than actually present, and should be filled in future work.
	E3	Surface water ponding	Based on visual observations in historical reports or interviews or aerial photographs review. Ponding is categorized as: - None; - Minor, which includes surface water covering <20% of sump area and/or is present adjacent to sump boundaries; - Moderate, which includes surface water covering 20 to 50% of sump area; and, - Major, which includes surface water over 50% of sump area.	Scores assigned as follows: 0 = None. 0.33 = Minor. 0.66 = Moderate. 1= Major.	Ponding adjacent to or over the sump area can lead to increases in active layer thickness and destabilization of the waste material. Four score tiers are used to differentiate between no risk for sump failure from ponding induced thaw (0), minor risk from minor amounts of ponding occurring on or adjacent to the sump (0.33), moderate risk from moderate ponding (0.66), and high risk from noted major ponding on the sump cap (1).
	E4	Cap cracking, sloughing, sedimentation or erosion	Based on noted presence/absence from visual observations in historical reports or interviews.	Scores assigned as follows: • 0 = No noted presence. • 0.5 = Noted presence of cracking/sloughing or sedimentation/erosion. • 1 = Noted presence of both cracking/sloughing and sedimentation/erosion. • Noted presence of one but not available (n/a) for the other is given a score of 0.5. • No noted presence of one and n/a for the other is given a score of 0.	Cracking, sloughing, sedimentation or erosion of the sump cap can reduce the cover thickness over the waste, leading to increased active layer thickness and destabilization of the waste, as well as open pathways for water to enter/exit and waste to escape. Three score tiers are used to differentiate between low risk for cap failure from no noted cap failure mechanisms (0), moderate risk for failure from presence of some failure mechanisms (0.5), and high risk from noted presence of all mechanisms (1). When information is available for some indicators but not for others it is assumed that the missing indicators do not occur, otherwise they would have been noted.
Environmental Settings	E5	Seasonality of sump operation	Based on timeframe sump was in operation.	Scores assigned as follows: • 0 = Sump in operation during winter months only. • 1 = Sump in operation during summer months (May-Sep).	Sumps that were open and/or in operation during summer months may have contributed to additional permafrost degradation of the area and have reduced effectiveness for permafrost recovery, thus increasing risk for thaw, destabilization and release of waste materials or contaminants. The two score tiers differentiate between sumps open only during winter and thus at lower risk for impacts to permafrost (0) and sumps open during part or all of summer and thus at higher risk for impacts to permafrost (1).
	E6	Site soil characteristics conducive to runoff of contaminated surface water away from sump	Based on visual observations in historical reports or interviews. Includes soil grain size and composition (i.e., mineral, organic).	Scores assigned as follows: • 0 = Coarse grained soil, primarily organic composition. • 1 = Fine grained soil, primarily mineral composition. • Soils in between these two ranges are given a score of 0.75, 0.5 or 0.25 depending on the relative proportions of fine to coarse to organic to mineral.	Soil characteristics that will enhance or at least not impede movement of surface water runoff, including fine grain sizes and low organic content provide increased potential for impacted water to enter the surrounding environment. Five score tiers are used to differentiate between low to high risk for runoff of contaminated surface water based on relative grain size and organic content of soil descriptions. Soil descriptors for finer grain sizes and less organic content are score as higher risk (>0.5), while coarser grain sizes and more organic content are lower risk (<0.5).
	E7	Active layer depths with potential for release of contaminants	Based on ground temperature measurements. Measure of the maximum depth of ground thaw within and adjacent to the sump in summer.	Scores assigned as follows: • 0 = Active layer depth within and/or adjacent to sump is within 30% of background. • 1 = Active layer depth within and/or adjacent to sump is greater than background by 30% or more.	Active layer depths that are significantly deeper than natural background depths may indicate thaw has reached the drilling waste, proving a pathway for release of waste or impacted water into the environment. The two score tiers differentiate between sumps with indicated impacts to active layer depths relative to background (1), and sumps with no indicated impacts to active layer depth (0). A 30% difference from background values was selected as the threshold for indicated impacts to account for natural variability in the data and discount minor differences.

5.1.2.1 Further considerations

Due to the limitations in available data for certain sumps, not all relevant factors could be included in the rankings. Other factors that would be ideal to consider, without limitation, include:

- Vegetation types – Certain species such as high growing shrubs can increase snow accumulation, insulating the ground and leading to further thawing and destabilization of buried waste material. Including a risk factor based on species types would aid in assessing risk presented by shrubby species, however, vegetation data on species types is limited and thus excluded.
- Groundwater contamination – Deep groundwater data is not available. Shallow/near surface groundwater, and/or water within the active zone likely has a high potential to influence surface water and therefore surface water contamination would likely include contributions from shallow groundwater.
- Distance to well - Proximity to a wellhead that is active or suspended and thus assumed to be uncapped increases the potential for contaminants to enter the well and impact the deep groundwater. The locations and therefore distance between the sump and the well are not well documented.
- Cultural receptors - Proximity to sites of cultural significance or areas of human use tend to increase the likelihood of human receptors being present with attendant risks of exposure to contaminants. Additionally, such effects would tend to decrease the aesthetic value of the region.
- Sensitive habitat and/or species - Location within sensitive habitat or territories of species at risk has greater potential to impact said habitat and species, resulting in disproportionate impacts to the environment and wildlife relative to non-sensitive habitat/species.
- Slope - Topography with some form of relief and slopes will increase the potential for surface water flow to occur and for impacted water to enter the surrounding environment.
- Ocean shoreline and sea level rise - Sumps near to shore and within the zone of future sea level rise are at risk of flooding, erosion and release of their contaminants into the environment.

The above factors could be considered in future analysis if data becomes available.

5.1.3 Sump Classification by Interest Group

5.1.3.1 Company/Consortium Ownership

Based on the well ownership analysis in Section 2.2, the sump classification for each company/consortium was consolidated and presented in Table 17. For each well owner, the well names associated with the Class 1 sumps is presented in Table 18. The location of Class 1 sumps for all well owners is provided in Figure 13 and Figure 14.

Table 17. Company/consortium responsible for the sump and the associated sump classification.

Company	Total Sumps	Class 1	Class 2	Class 3	Class Unknown
Imperial[18]	75	6	17	21	31
ConocoPhillips	37	9	9	10	9
Shell	22	5	9	5	3
Suncor	22	0	3	0	19

[18] Refer to Appendix B for the corporate names of each company listed in the table

Company	Total Sumps	Class 1	Class 2	Class 3	Class Unknown
Husky	15	0	0	0	15
Chevron	11	0	2	0	9
BP	5	0	0	0	5
MGM Energy Corp.	4	0	4	0	0
Inuvialuit Petroleum	3	0	0	0	3
Japex	3	1	0	0	2
Canadian Natural Resources Ltd.	2	0	2	0	0
Encana	2	0	0	0	2
Deminex	1	0	0	0	1
Murphy Oil Company Ltd.	1	0	0	0	1
Repsol Oil and Gas Canada Inc.	1	0	0	0	1
Utility Group Facilities Inc.	0	0	0	0	0
Uncertain	19	3	2	0	14
Total	**223**	**24**	**48**	**36**	**115**

Table 18. The well site names associated with Class 1 sumps.

Company	Total Class 1 Sumps	Well Site Name
Imperial	6	• ATERTAK E-41 • TAGLU C-42 • TAGLU D-43 • TAGLU D-55 • TAGLU G-33 • TAGLU WEST P-03
ConocoPhillips	9	• ATIGI G-04 • ATIGI O-48 • PARSONS E-02 • PARSONS F-09 • PARSONS L-43 • PARSONS N-17 • PARSONS O-27 • SIKU C-55 • TOAPOLOK O-54
Shell	5	• KIPNIK O-20 • KUGPIK O-13 • NIGLINTGAK H-30 • UNAK B-11 UNIPKAT I-22
Japex	1	• MALLIK 3L,4L,5L-38
Uncertain	3	• IKHIL I-37 • REINDEER D-27 • YA-YA P-53

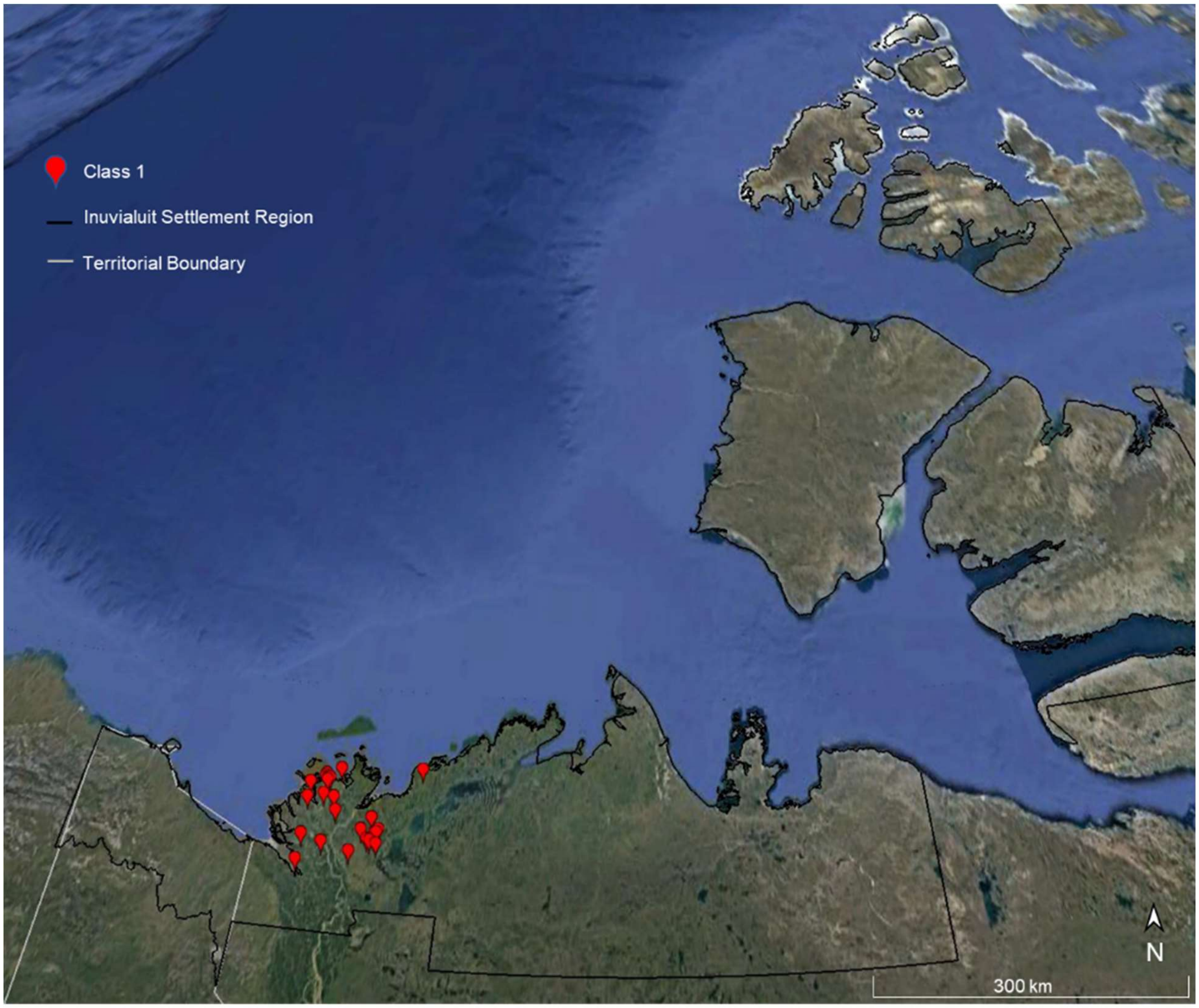


Figure 13. Regional map of Class 1 sumps for all well owners.

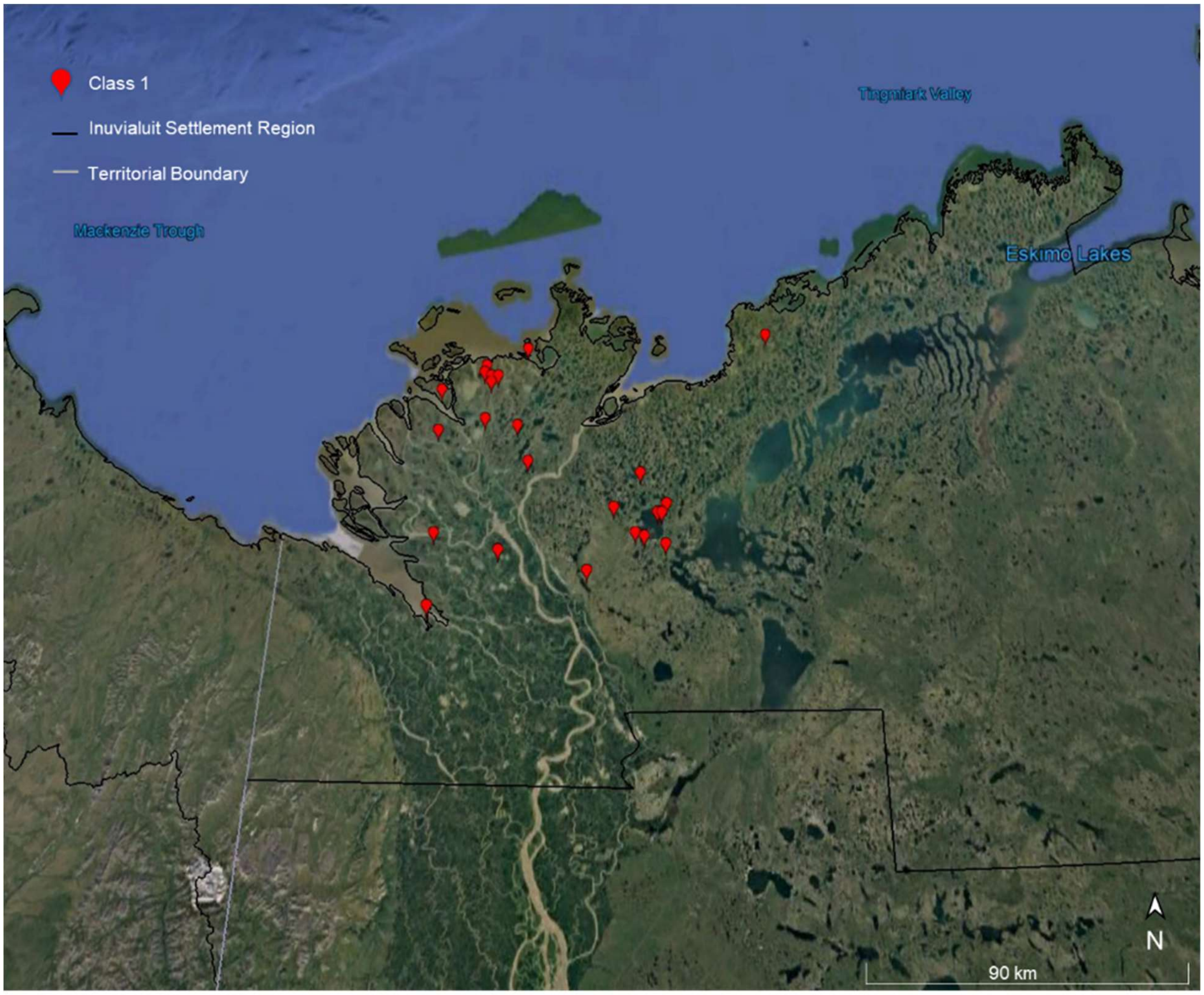


Figure 14. Mackenzie Delta map of Class 1 sumps for all well owners.

The majority (20 of 24) of Class 1 sumps have indicated ownership that is attributable to ConocoPhillips, Imperial and Shell. These three companies appear to have responsibilities for 83% of the sumps in the ISR. A map of sumps with ownership assigned to ConocoPhillips, Imperial and Shell is provided in Figure 15, Figure 16 and Figure 17, respectively.

5.1.3.2 ISR-CBMP Sites

As described in Section 3.2, the Inuvialuit engagement done with assistance of the CBMP identified 58 sites of concern. The well names and associated classifications are summarized and shown in Table 19 and Figure 18, respectively. As noted in the table and figure, some sites identified as being of concern include wells with no sump.

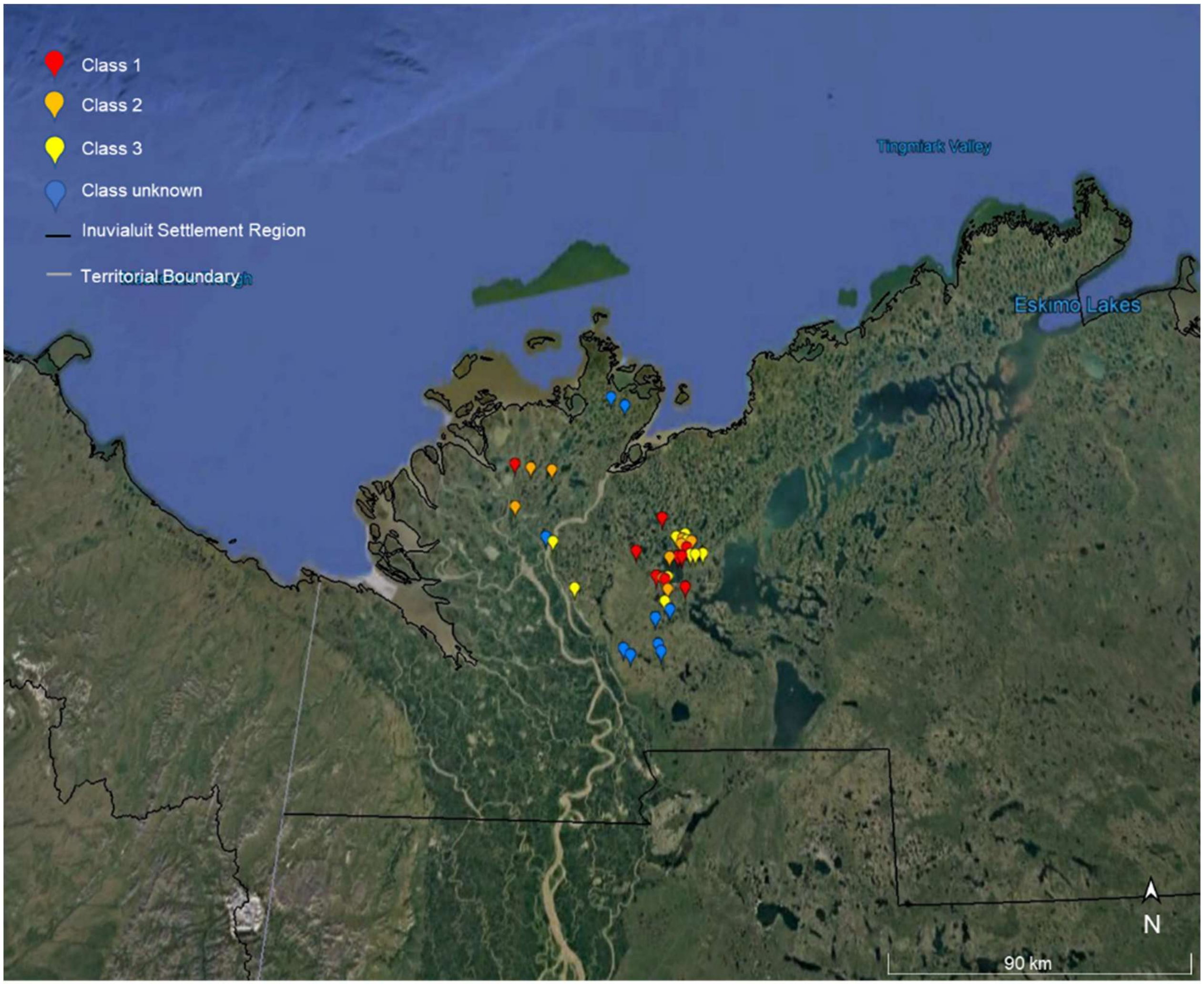


Figure 15. Regional map of ConocoPhillips sumps and their associated classification.

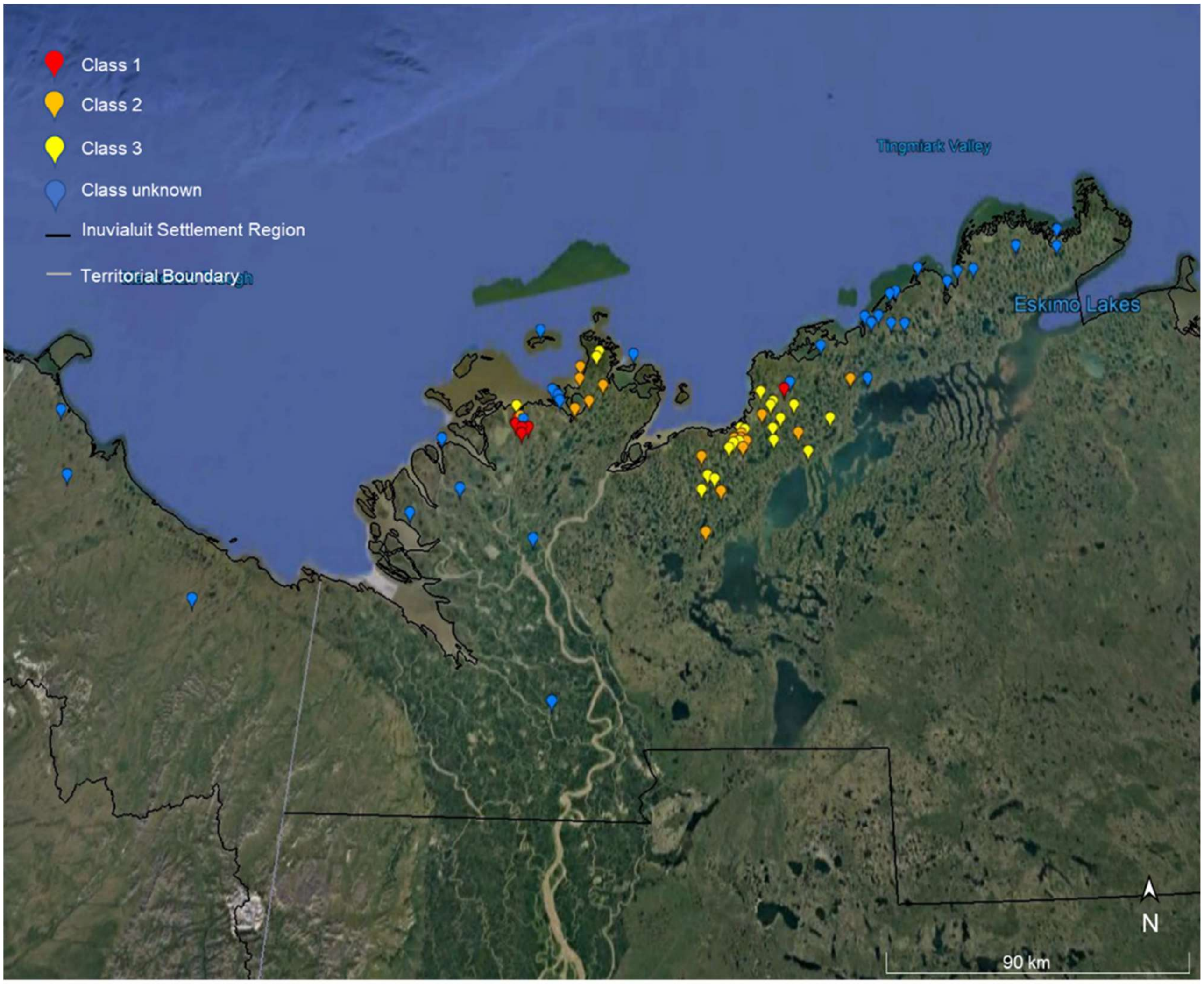


Figure 16. Regional map of Imperial sumps and their associated classification.

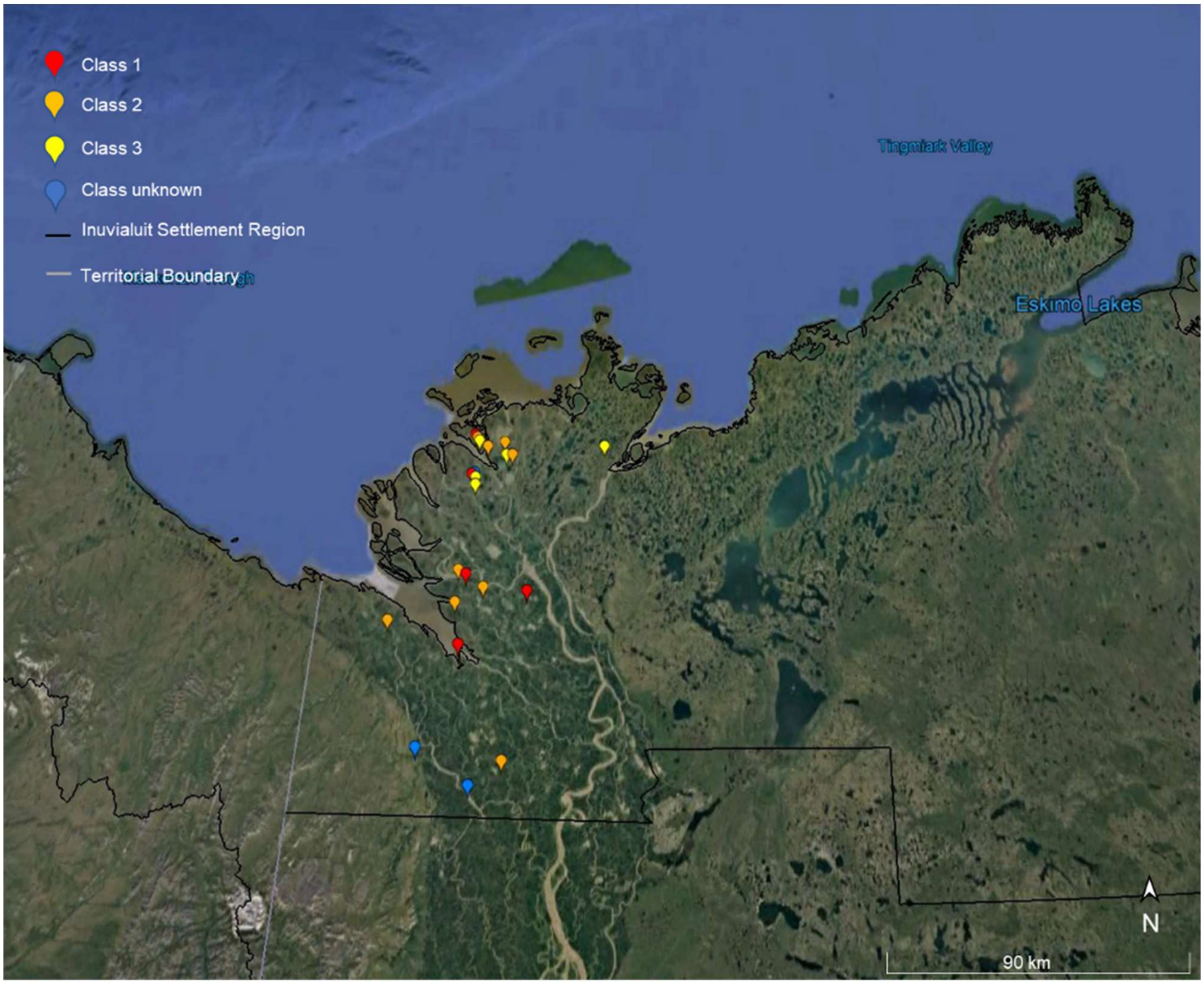


Figure 17. Regional map of Shell sumps and their associated classification.

Table 19. Well sites and associated sump class identified through Inuvialuit engagement as a concern and the associated Class defined in this study.

Company	Total Sumps	Class 1	Class 2	Class 3	Class Unknown	Well Sites with No Sump
Imperial	19	• ATERTAK E-41 • TAGLU C-42 • TAGLU D-43 • TAGLU D-55 • TAGLU G-33 • TAGLU WEST P-03	• TAGLU H-54 • TUK F-18 • UMIAK J-37	• TUK G-39 • TUK G-48	• AMAROK N-44 • KANGUK I-24 • KIMIK D-29 • LANGLEY E-29 • MALLIK L-38 • NAPARTOK M-01 • TAGLU N-43 • TUNUNUK K-10	-
ConocoPhillips	6	• PARSONS F-09	• PARSONS L-37 • KIKORALOK N-46 • YA-YA- M-33	• PARSONS A-44 • TUNUNUK F-30	-	-
Shell	12	• KUGPIK O-13 • UNAK B-11	• KUGPIK L-24 • KUMAK C-58 • KUMAK J-06 • NAPOIAK F-31 • TULLUGAK K-31 • ULU A-35	• KUMAK E-58	• AKLAVIK A-37 • BEAVER HOUSE CREEK H-13 • UNIPKAT N-12	-
Suncor	1	-	• KUGPIK L-46	-	-	-
Chevron	2	-	• FISH RIVER B-60	-	• UPLUK M-38	-
MGM Energy Corp.	4	-	• UMIAK N-05 • KUMAK I-25/UNIPKAT M-45 • LANGLEY K-30 • UMIAK N-16	-	-	• APUT D-43 • NORTH ELLICE J-17
Japex	3	• MALLIK 3L,4L,5L-38		-	• MALLIK 2L-38 • MALLIK 6L-38	-
Canadian Natural Resources Ltd.	2	-	• ITIGINKPAK F-29 • TUK B-02/TUK M-18	-	-	-
Uncertain	7	• IKHIL I-37 • YA-YA P-53	• TITALIK K-26	-	• GARRY G-07 • GARRY P-04 • YA-YA A-28 • YA-YA I-17	-
Total	**56**	**12**	**21**	**5**	**18**	**2**

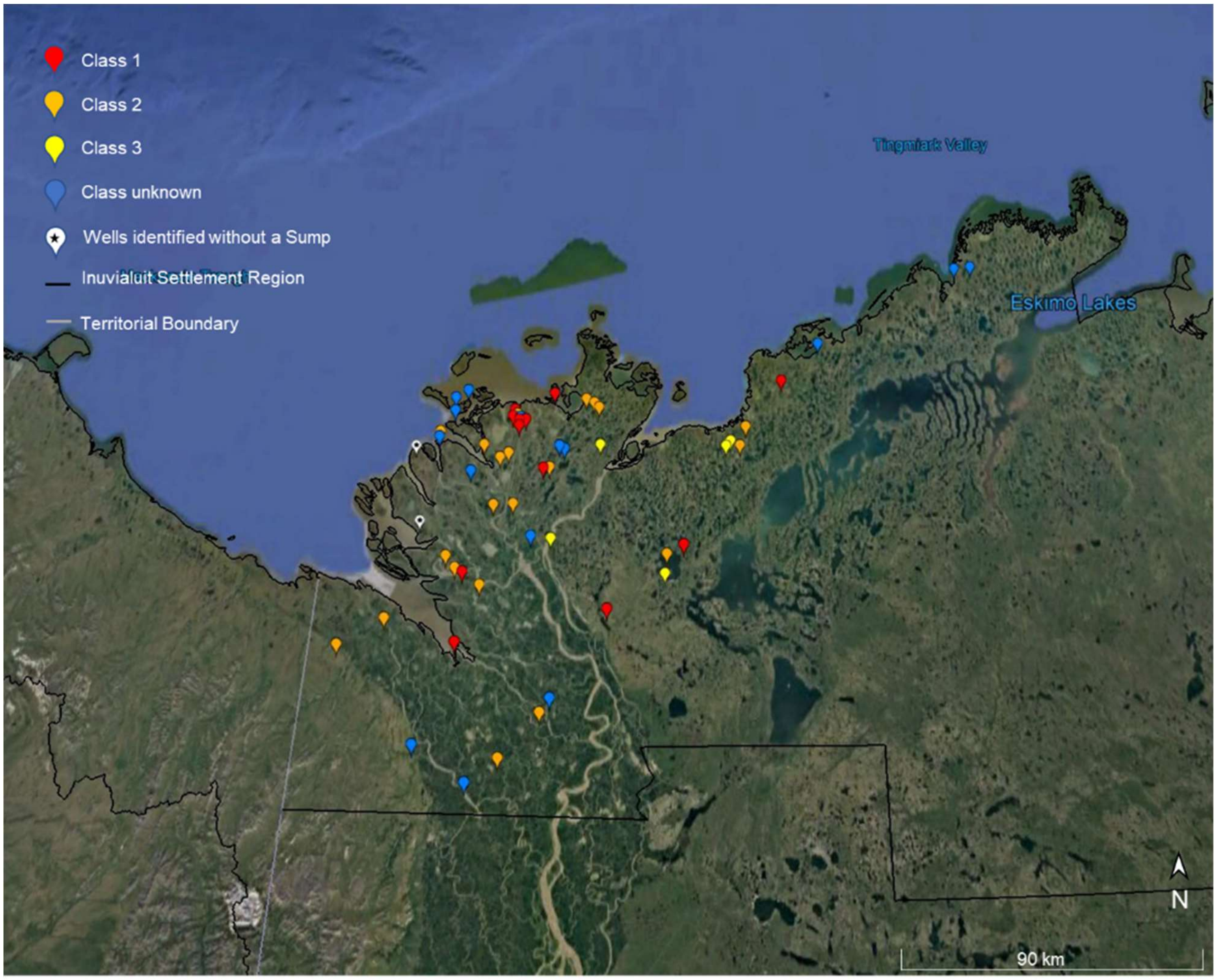


Figure 18. Mackenzie Delta map showing sites of concern identified through Inuvialuit engagement and their respective sump classification.

5.1.3.3 GNWT Priority Sites

As part of the study, ARKTIS requested that the GNWT provide a list of the higher priority sites based on their ranking system (which may differ from that used in this study). A comparison of the GNWT priority sites to the classification system developed in this study is provided in Table 20 and depicted on a map in Figure 19. The GNWT noted 19 sumps that this study did not have information to classify (Class unknown); thus, it is likely the GNWT has additional information for these sites.

Table 20. Comparison of GNWT higher priority sites to the sump Class derived in this study.

Sump Class	GNWT Priority Sumps	
	No. of Sumps	**Well Site Name**
Class 1	2	• TAGLU D-43 • TAGLU G-33
Class 2	5	• ITIGINKPAK F-29 • LANGLEY K-30 • KUGPIK L-46 • KURK M-15 • NUNA I-30
Class 3	0	-
Class Unknown	19	• MUSKOX D-87 • PARKER RIVER J-72 • ANDREASEN L-32 • DYER BAY L-49 • INTREPID INLET H-49 • KUSRHAAK D-16 • TIRITCHIK M-48 • WILKIE POINT J-51 • MALLIK L-38 • SATELLITE F-68 • DUNDAS C-80 • EGLINTON P-24 • KITSON R. C-71 • MARIE BAY D-02 • ZEUS F-11 • BURNT LK • ELLICE I-48 • N2006A0029 • OH1 SUMP
Total	**26**	

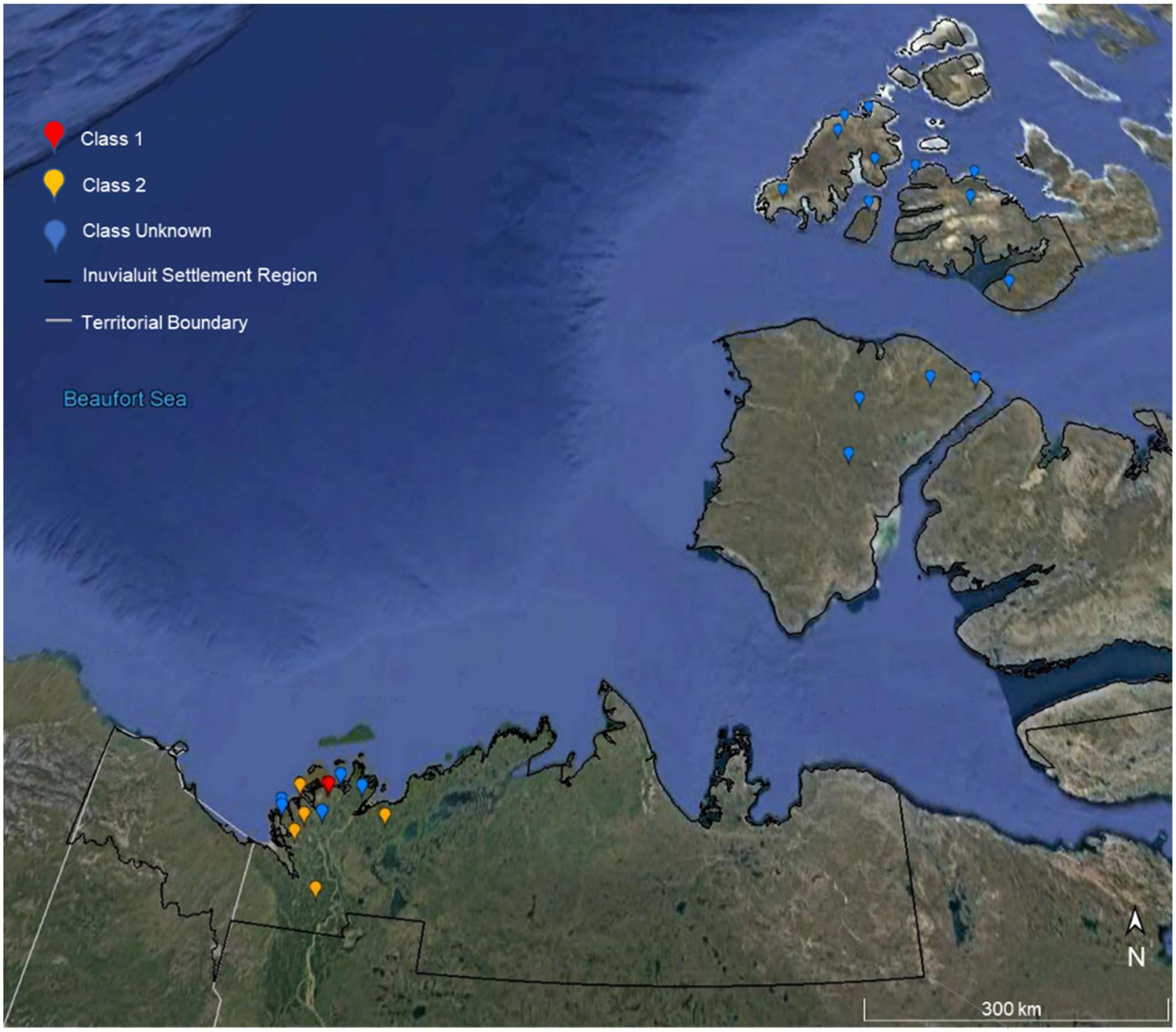


Figure 19. Mackenzie Delta map showing GNWT higher priority sites and the associated sump classification derived in this study.

5.1.3.4 Corporate Engagement

Early in the study, the Inuvialuit Regional Corporation (IRC) notified a number of companies of the initiation of the study and requested their co-operation with the study team. Accordingly, an assessment of the corporations of the highest relevance to the study (i.e. those with the highest number of wells) was made. A total of 19 firms were identified with interests in the ISR. Limitations of time and budget for the study did not permit the study team to approach all 19 companies. However, four were chosen, approached and agreements were secured for them to participate in the engagement process and be interviewed (Imperial Oil Canada, Shell Canada Limited, ConocoPhillips Canada and Paramount Resources Limited (MGM Energy limited). These firms represented approximately 69% of the 223 identified well sites.

The study team presented, and requested comments upon, the approaches and criteria used for the classification of the sumps along with specific questions as to ownership interests, past histories of the sites and relevant information that could assist in the completion of the study. Each of the selected companies provided valuable advice and information regarding their interests in the ISR, advice which is gratefully acknowledged.

5.2 Recommend Mitigations and Remediation Actions to Reduce Risk and Environmental Impacts

Of the Class 1 sumps, 8 of 24 sumps were noted to have failed in a report or by an inspector. These sumps are highlighted in red within Table 21 and Table 22. Efforts to mitigate against environmental impacts should be undertaken in the short-term and in accordance with any inspector direction. The records collected in this study do not indicate if any mitigative or remedial actions have been completed at these sites in response. One sump (Unipkat I-22) was noted as having been previously reclaimed with all drilling waste excavated and removed from site and the sump backfilled with clean fill; however, the adjacent river is eroding into the former sump area and any potential residual contamination remain.

For Class 1 sumps, a summary of the available information is presented in Table 21. A summary of the sump ranking information is presented in Table 22. In general, the Class 1 sumps have a reasonable amount of known information. However, most of the sumps have data that was collected in 2004, and therefore the data used in the sump rankings is at least 15 years old. It is recommended that the Class 1 sumps undergo environmental monitoring in accordance with the IWB Sump Protocol to collect updated information.

Long-term mitigations and remedial methods would generally involve development and implementation of a risk management or remediation plan for the site. The process steps for reclamation planning of an industrial site that may complete is presented in Figure 20, and further detailed in Canadian Council of Ministers of the Environment (CCME) National Guidelines for Decommissioning Industrial Sites (CCME, 1991) and the Government of the Northwest Territories, Environmental Guideline for Contaminated Site Remediation (GNWT, 2003). The guideline's phased decommissioning and cleanup process has been adapted and adjusted for use at the sump sites considered in this study.

In general, site information is collected (e.g., completion of Phase 1, 2 or 3 environmental site assessment (ESA) that informs development of a risk management or reclamation plan. Implementation of the risk management or reclamation plan occurs to mitigate the potential for environmental impacts. Post-implementation monitoring is conducted to demonstrate performance of the remedial efforts are successful.

A risk management plan may be needed when remediation cannot (or will not) be completed. A risk management approach involves removing or mitigating an exposure pathway or receptor, which is a form of exposure control. This could involve controlling a contaminant source rather than remediating it. Risk managed sites typically have conditions or restrictions on land and/or water use or have site management activities to maintain or achieve the acceptable exposure control.

It is critical that the risk management or reclamation plans are developed with criteria that are agreed to by the various stakeholders and that any restriction on land or water use are defined. Any remedial action for the sites must be completed in accordance with applicable laws and the Inuvialuit Final Agreement. Risk management and reclamation plans must also consider the sensitive and culturally significant areas within the ISR as outlined in the Husky Lakes Special Cultural Area Criteria[19] and the various ISR Community Conservation Plans[20].

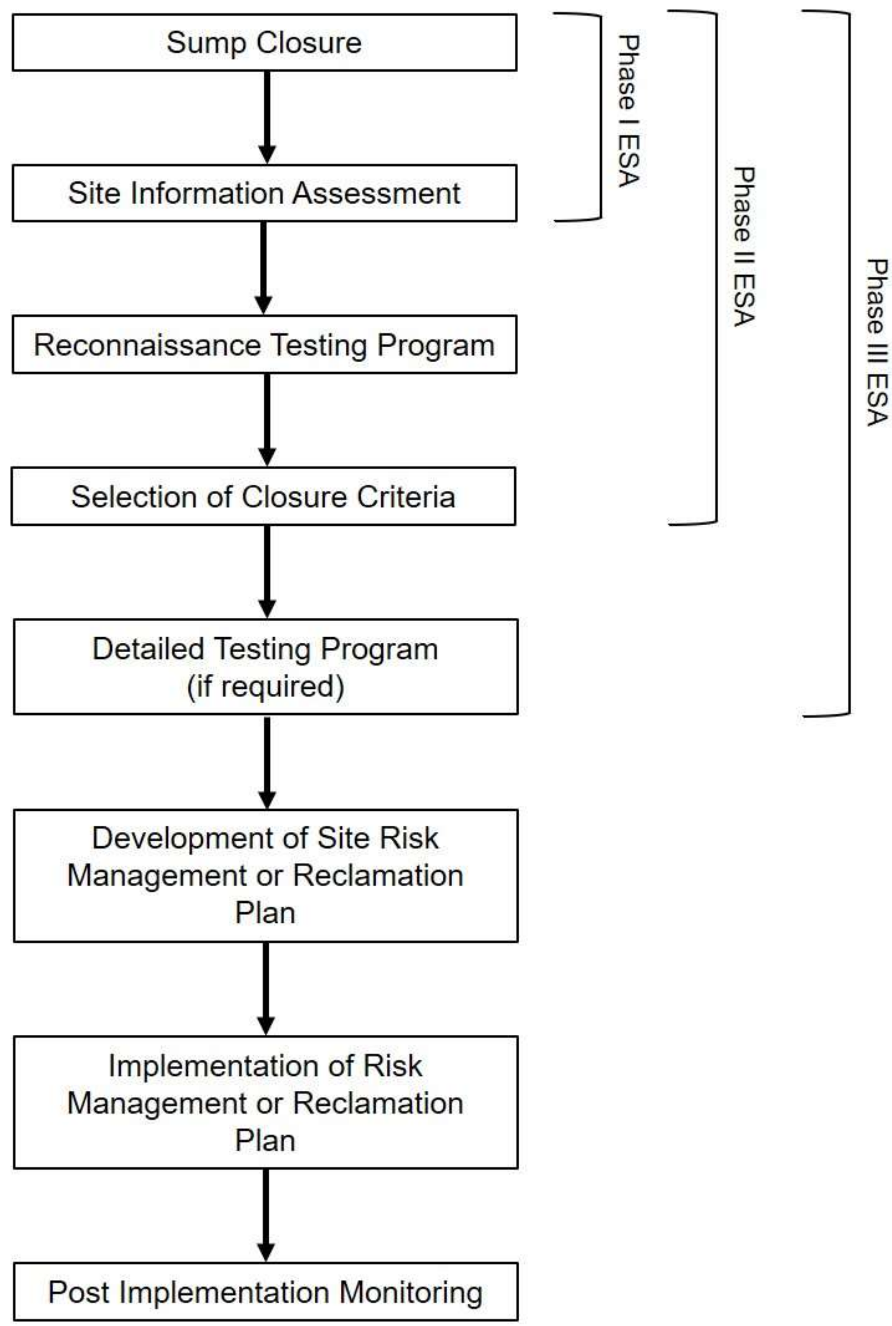


Figure 20. Adjusted guidelines process steps to sump site mitigation and remediation.

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[19] https://www.irc.inuvialuit.com/sites/default/files/Husky_Lakes_Special_Cultural_Area_Criteria.pdf
[20] https://eirb.ca/resources/reports-and-documents/

Table 21. Class 1 sump attribute information availability.

Attribute	No. of Class 1 Sumps	Percent of Attributes Available for Class 1 Sumps	ATERTAK E-41	ATIGI G-04	ATIGI O-48	IKHIL I-37	KIPNIK O-20	KUGPIK O-13	MALLIK 3L,4L,5L-38	NIGLINTGAK H-30	PARSONS E-02	PARSONS F-09	PARSONS L-43	PARSONS N-17	PARSONS O-27	REINDEER D-27	SIKU C-55	TAGLU C-42	TAGLU D-43	TAGLU D-55	TAGLU G-33	TAGLU WEST P-03	TOAPOLOK O-54	UNAK B-11	UNIPKAT I-22	YA-YA P-53
Category 1 - Are the key sump characteristics at time of construction known?																										
Location	24	100.0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sump Area	0	0.0	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sump Depth	0	0.0	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cover Thickness	0	0.0	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Drill Waste Characteristics	5	20.8	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Date of Sump Operation and Closure	24	100.0	1972	1971	1974	1973	1974	1973	2002	1973	1986	1972	1976	1976	1974	1966	1972	1972	1973	1972	1971	1972	1974	1974	1973	1973
		Percent Available	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	50.0	50.0	50.0	50.0	50.0	33.3	33.3	33.3	33.3
Category 2 - Has the local environment and/or background conditions been characterized?																										
Surface Condition – topography	20	83.3	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Surface Condition – vegetation	20	83.3	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Active Layer Depth	23	95.8	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soil Conditions	20	83.3	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Ground Ice Conditions	3	12.5	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
Groundwater	1	4.2	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
Background Surface Water Quality	19	79.2	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Percent Available	57.1	71.4	28.6	71.4	71.4	71.4	57.1	71.4	57.1	71.4	71.4	71.4	71.4	28.6	28.6	57.1	71.4	71.4	71.4	71.4	71.4	71.4	100	28.6
Category 3 - Are conditions of sump known after its closure?																										
Inspection Records	2	8.3	No	No	No	No	No	No	2017	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	2014	No
Sump Area	20	83.3	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Sump Depth	0	0.0	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Cover Thickness	1	4.2	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Drill Waste Characteristics	2	8.3	No	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Sump Stability	24	100.0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Status of Known Environmental Impact(s)	2	8.3	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No
		Percent Available	28.6	14.3	28.6	28.6	28.6	28.6	28.6	28.6	28.6	71.4	28.6	28.6	28.6	28.6	28.6	28.6	42.9	28.6	28.6	28.6	14.3	28.6	42.9	28.6
Category 4 - Has environmental monitoring of the closed sump occurred?																										
Latest Year Sump Information was Available			2004	2004	2004	2010	2019	2019	2017	2019	2004	2012	2004	2004	2004	2004	2010	2004	2004	2004	2007	2004	2004	2006	2019	2004
Ground Temperatures	6	25.0	No	No	No	No	No	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	Yes	No
Vegetation	24	100.0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
EM Surveys	21	87.5	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Soil Quality	22	91.7	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Water Quality	23	95.8	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Percent Available	60.0	80.0	80.0	60.0	80.0	100	20.0	100	80.0	80.0	100	100	100	80.0	80.0	80.0	80.0	80.0	80.0	80.0	60.0	80.0	100	80.0
		Percent Total	44.0	48.0	40.0	48.0	52.0	56.0	36.0	56.0	48.0	64.0	56.0	56.0	56.0	40.0	40.0	52.0	60.0	56.0	56.0	56.0	44.0	52.0	68.0	40.0

Note: Sumps marked red are noted as having failed from available documentation and thus considered higher priority for mitigation or remediation.

Table 22. Class 1 sump ranking and scores.

Factors	Indicators	No. of Class 1 Sumps	Percent of Indicators Available for Class 1 Sumps	ATERTAK E-41	ATIGI G-04	ATIGI O-48	IKHIL I-37	KIPNIK O-20	KUGPIK O-13	MALLIK 3L,4L,5L-38	NIGLINTGAK H-30	PARSONS E-02	PARSONS F-09	PARSONS L-43	PARSONS N-17	PARSONS O-27	REINDEER D-27	SIKU C-55	TAGLU C-42	TAGLU D-43	TAGLU D-55	TAGLU G-33	TAGLU WEST P-03	TOAPOLOK O-54	UNAK B-11	UNIPKAT I-22	YA-YA P-53
Hazard Factors																											
Soil	Soil contamination	19	79.2	n/a	n/a	0.5	1	0.5	1	n/a	0.5	0.5	1	0.5	1	1	n/a	1	0.5	1	n/a	0	0.5	1	0.5	1	0.5
	Salt staining	18	75.0	0	1	n/a	n/a	1	1	n/a	1	0	1	0	0	0	n/a	n/a	1	1	1	1	1	0	1	0	n/a
Water	Surface water contamination	18	75.0	1	0.5	n/a	1	1	1	n/a	0.5	n/a	1	0.5	1	1	n/a	n/a	1	0.5	0.5	0.5	1	0.5	0.5	1	n/a
	Contaminant migration beyond sump	22	91.7	0	1	1	1	0	1	n/a	1	0	1	0	1	1	0	0	0	0	n/a	0	1	1	1	1	0
Receptor Factors																											
Human	Distance to natural water bodies	24	100	0.25	0.75	0	0.25	0.25	0.25	0.75	0.25	0.25	0.25	0.25	0.25	1	0.75	0.25	0.75	0.75	0	0.75	0	0	0.25	0.75	0.25
Ecological	Distance to protected areas	24	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0
Exposure Pathway Factors																											
Stability	Cap vegetation layer deficiency	24	100	1	0.5	0.5	0	1	0.5	1	0.5	0	0	1	0	0	1	0.5	0	0	1	0	0	1	0	0	1
	Cap subsidence	24	100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Surface water ponding	16	66.7	n/a	0.33	1	n/a	n/a	1	n/a	0.66	0.66	0.33	0	0.66	0.33	n/a	0	1	1	1	0	n/a	0.66	1	n/a	n/a
	Cap cracking, sloughing, sedimentation or erosion	24	100	0.5	0.5	0.5	0	0.5	0.5	0	0.5	1	1	0.5	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	1	0.5
Environmental Settings	Seasonality of sump operation	24	100	1	0	0	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	0
	Site soil characteristics conducive to runoff of contaminated surface water away from sump	18	75.0	0.25	0.25	n/a	n/a	1	1	n/a	1	0.75	0	0	0.75	0.75	n/a	n/a	1	0.5	0.5	0.5	0.5	0.5	1	0.75	n/a
	Active layer depths with potential for release of contaminants	17	70.8	1	1	n/a	n/a	1	0	n/a	0	0	1	1	0	0	n/a	n/a	n/a	1	1	1	1	0	0	0	n/a
			Total Risk Score	5	6.83	4.5	5.25	8.25	9.25	2.75	6.91	4.16	7.58	4.75	6.66	8.08	4.25	4.25	7.75	9.25	8.5	6.25	7.5	6.66	6.75	7.5	3.25
			Risk Rank	Med	Med	Low	Med	Med	Med	Low	Med	Low	Med	Low	Med	Med	Low	Low	Med	Med	Med	Med	Med	Med	Med	Med	Low
			Percent of Indicators Available	76.9	92.3	69.2	69.2	92.3	100	46.2	100	92.3	100	100	100	100	53.8	69.2	92.3	100	84.6	100	92.3	100	100	92.3	61.5

Note: Sumps marked red are noted as having failed from available documentation and thus considered higher priority for mitigation or remediation.

5.3 Conclusions and Key Findings

A management tool was developed to rank the sumps from “high to low” priority. Sumps were first classified based on available information and the observed degree of degradation. Four classes were defined, Class 1 through 3, with Class 1 having the highest degree of sump degradation and also with an “unknown” Class that represents sump sites where there was insufficient information. Within each sump classification, each was assigned a “high, medium or low” ranking based on various factors that considered the contaminant source, receptors and pathways for exposure.

Each sump was classified and ranked using the tool. 52% (115 of 223) of the sumps had limited information and received a rating Classification as “Unknown”. The 48% (108 of 223) of the remaining sumps received Class 1 (22%, 24 of 108), Class 2 (44%, 48 of 108) and Class 3 (33%, 36 of 108) ratings. The classifications of sumps were organized by company/consortium ownership as compared with sumps identified by the GNWT as having a higher priority ranking.

Mitigation and remedial actions to reduce risk and environmental impacts associated with the sumps was presented and included:

- Short term actions to implement corrective actions for Class 1 sites that were noted to have failed.
- Short term actions to update the Class 1 site environmental information since the current data is more than 15 years old.
- Development of risk management or remedial action plans for Class 1 sites.

An overview of study key findings is provided below:

- Sumps were categorized into four classes based on potential for global instability and information availability.
- The majority of sumps are classified as “Unknown” due to limited available data.
- 24 sumps are classified as “Class 1”: Those showing current or imminent global instability failure and considered to be of high priority for potential management action.
- Sumps identified as a potential concern through the CBMP Inuvialuit engagement survey that consisted primarily of sumps Classified as “Class 2” or “Class Unknown”, followed by classes 1 and 3.
- A ranking tool was developed based on various hazard, receptor and exposure pathway factors that contribute to the overall risk presented by a sump (Table 16). The total risk score for a given sump was used to rank the sumps to prioritize future work either for additional testing and/or remediation/removal plans and/or risk management and monitoring.
- Recommendations were made for possible methods to mitigate and/or remediate sites to an acceptable risk level for each risk ranking.

6.0 ASSESSMENT OF CLIMATE CHANGE AND POTENTIAL IMPACTS TO SUMP PERFORMANCE

The following three tasks are presented in this section of the report.

- **Task 1** – To collect historical climate data and process the data to estimate the future effects of climate change within the ISR.
- **Task 2** – To summarize the potential short term (10 year) and long term (up to 2095) changes in climate throughout the region.
- **Task 3** – To use the long term climate predictions for the prediction of sub-surface temperatures potentially affecting typical sumps and to assess the potential implications of a warming climate on sump performance.

6.1 Historical and Future Climate in the ISR

Two different climate models were applied to assess the future climate in the ISR:

- Short-term projections - The short-term climate projections utilized past climate data to project the short-term future climate using the North American Regional Reanalysis (NARR) dataset. NARR is a back-casting long-term historical regional climate dataset collected over the past 40 years (1979-2018) at a resolution of 32 km^2 over the ISR. A 10-year projection was calculated. The methodology and projections of future air and soil temperatures is provided in Appendix C.
- Long-term predictions – The long-term climate predictions were based on the results of global climate models and the associated green-house-gas (GHG) emissions scenario using the Pacific Climate Impact Consortium (PCIC) dataset[21]. The PCIC dataset provides daily temperatures and total precipitation at a 10 km^2 resolution for all of Canada for the period of 1950 – 2095. For each emissions scenario (RCP4.5 and RCP8.5) the simulations for 1950-2005 are the same, and the divergent emissions scenarios used by the models start in 2006. The GHG emissions scenarios presented included:
    - RCP4.5 emission scenario represents an emission peak mid-century approximately 50% higher than 2000 levels. It then declines rapidly over 30 years followed by stabilization at approximately half of the observed 2000 levels
    - RCP 8.5 emission scenario represents a “business as usual” scenario and assumes that world GHG emissions continue to increase at current rates through the end of the 21st century.

In general, short-term projections are intended to provide a more reasonable approach to near future climate conditions as compared with global climate change models: However, certainty in the projection decreases with longer time frames.

The historical climate data from the years 1976 to 2005 (measured and/or simulated from weather stations and the NARR and PCIC datasets) for the following locations in the ISR is summarized in Table 23.

- Southern reach of ISR – Inuvik
- Mid of ISR – Tuktoyaktuk
- Northern reach of ISR – Mould Bay on Prince Patrick Island

Historical weather data was collected from Type A weather stations. Inuvik weather data was obtained from Inuvik A weather station operated by NAVCAN with climate ID 2202571, Tuktoyaktuk weather data

[21] Climate data accessed in December 2019 from https://climateatlas.ca/

was obtained from Tuktoyaktuk A weather station operated by NAVCAN with climate ID 2203913, and Mould Bay weather data was obtained from Mould Bay A and Mould Bay CS weather stations operated by ECCC-MSC and have Climate ID 2502700 and 250M001, respectively. Inuvik and Tuktoyaktuk were chosen based on their proximity to most of the sumps, as well as their Type A weather stations and available historical data. Mould Bay was chosen to represent the more northern sumps, due to the availability of weather data and the current weather station located there. In comparing the historical measured climate to the two climate models, there is generally good agreement.

Predictions of the future climate from the two climate models were compared with the three ISR locations (Table 23) for the following time periods:

- Near future period (2019 – 2028) for NARR projections and PCIC predictions
- Short-term future period (2021 – 2050) for PCIC predictions only
- Long-term future period (2051 – 2080) for PCIC predictions only

NARR projections were completed for a 10 year near future period. Therefore, there is no short-term or long-term future projection available from the NARR dataset. For the near future period, the NARR projections were observed as being reasonably similar to the PCIC predictions.

Using the PCIC dataset, the monthly temperature and precipitation for the historical, short-term future and long-term future periods is presented in Figure 21. For the RCP4.5 and RCP8.5 emissions scenario, the air temperature and precipitation are predicted to increase for each month of the year. The increases in temperature and precipitation are greater for the RCP8.5 emission scenario as compared with the RCP4.5 emission scenario. Seasonally, the increase in air temperature is predicted to be greater in the winter months as compared with the summer months, which results in a longer period of time annually when temperatures are predicted to be above 0 ^{o}C. Within the ISR, the long-term predictions show an increase in air temperature ranging from approximately +3 ^{o}C to +7.5 ^{o}C with a predicted increase in precipitation ranging from approximately +45 mm to +64 mm (see Table 24).

Table 23: Historical and future predicted temperature and precipitation within the ISR.

Location	1976 - 2005 (Historical)				2019 - 2028 (Near Future)			2021 - 2050 (Short-Term)		2051 - 2080 (Long-Term)	
	Weather Station	NARR	PCIC RCP4.5	PCIC RCP8.5	NARR	PCIC RCP4.5	PCIC RCP8.5	PCIC RCP4.5	PCIC RCP8.5	PCIC RCP4.5	PCIC RCP8.5
	Mean Annual Temperature (°C)										
Inuvik	-8.4	-7.93	-8.5	-8.5	-6.2	-6.7	-6.4	-5.9	-4.5	-5.5	-2.6
Tuktoyaktuk	-10.0	-10.9	-10.0	-10.0	-5.5	-8.0	-7.7	-7.1	-5.6	-6.7	-3.6
Mould Bay	-17.0	-14.8	-17.2	-17.2	-12.1	-15.1	-14.9	-14.2	-12.4	-13.7	-9.9
	Mean Annual Precipitation (mm)										
Inuvik	225.5	292.7	251.5	251.5	-	271.4	266.6	278.8	281.7	297.4	314.0
Tuktoyaktuk	139.1	261.3	177.2	177.2	-	193.2	189.6	197.9	201.4	212.5	227.2
Mould Bay	118.9	215.5	168.2	168.2	-	184.7	189.4	193.0	200.7	213.0	232.3

Table 24: Predicted change in future temperature and precipitation within the ISR.

Location	2019 - 2028 (Near Future)		2021 - 2050 (Short-Term)		2051 - 2080 (Long-Term)	
	PCIC RCP4.5 Predicted change	PCIC RCP8.5 Predicted change	PCIC RCP4.5 Predicted change	PCIC RCP8.5 Predicted change	PCIC RCP4.5 Predicted change	PCIC RCP8.5 Predicted change
	Mean Annual Temperature (°C)					
Inuvik	+1.8	+2.1	+2.6	+4.0	+3.0	+5.9
Tuktoyaktuk	+2.0	+2.3	+2.9	+4.4	+3.3	+6.4
Mould Bay	+2.1	+2.3	+3.0	+4.8	+3.5	+7.3
	Mean Annual Precipitation (mm)					
Inuvik	+19.9	+15.1	+27.3	+30.2	+45.9	+62.5
Tuktoyaktuk	+16.0	+12.4	+20.7	+24.2	+35.3	+50.0
Mould Bay	+16.5	+21.2	+24.8	+32.5	+44.8	+64.1

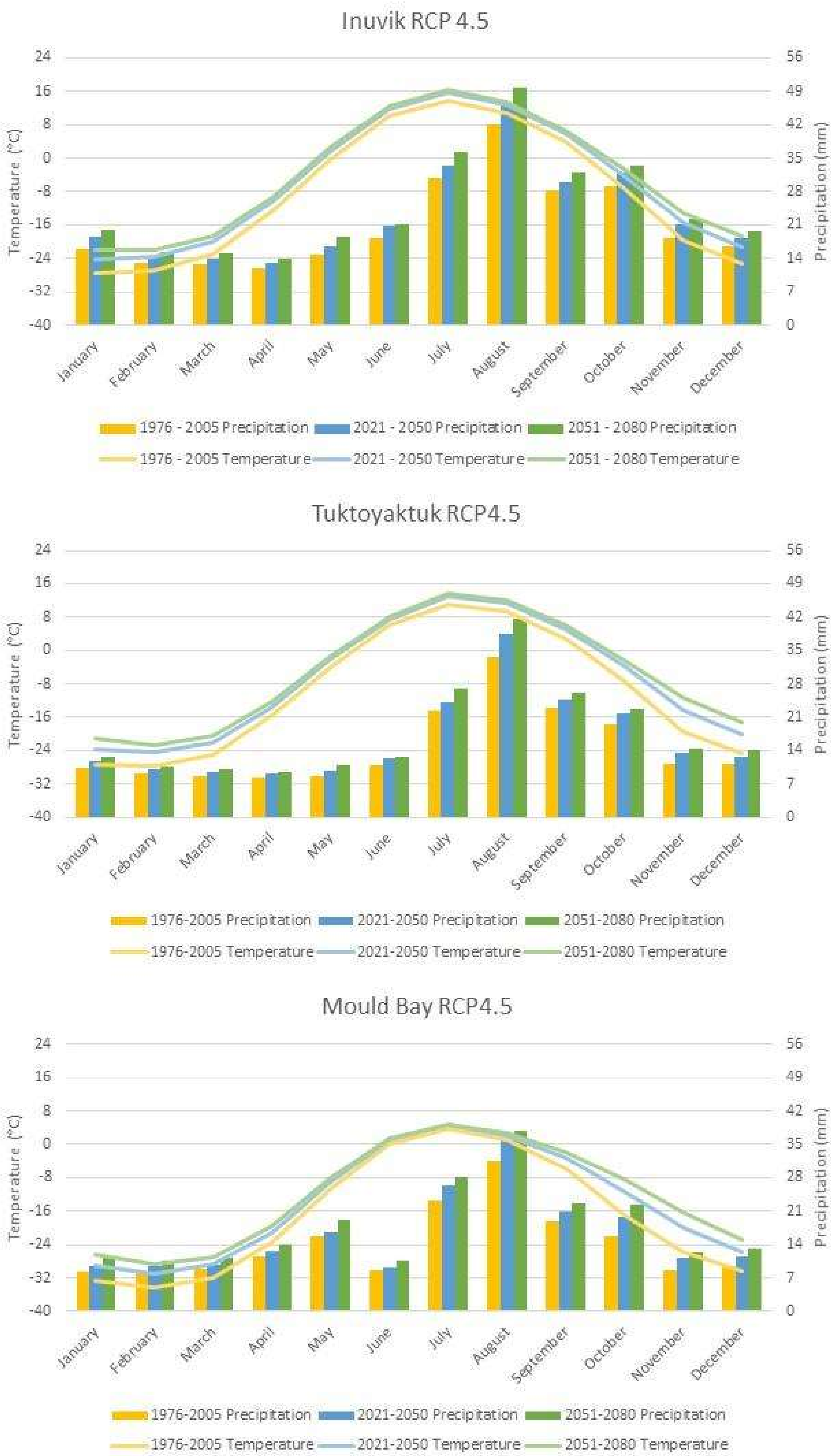

Figure 21. Monthly average temperature and precipitation for the RCP4.5 emission scenario.

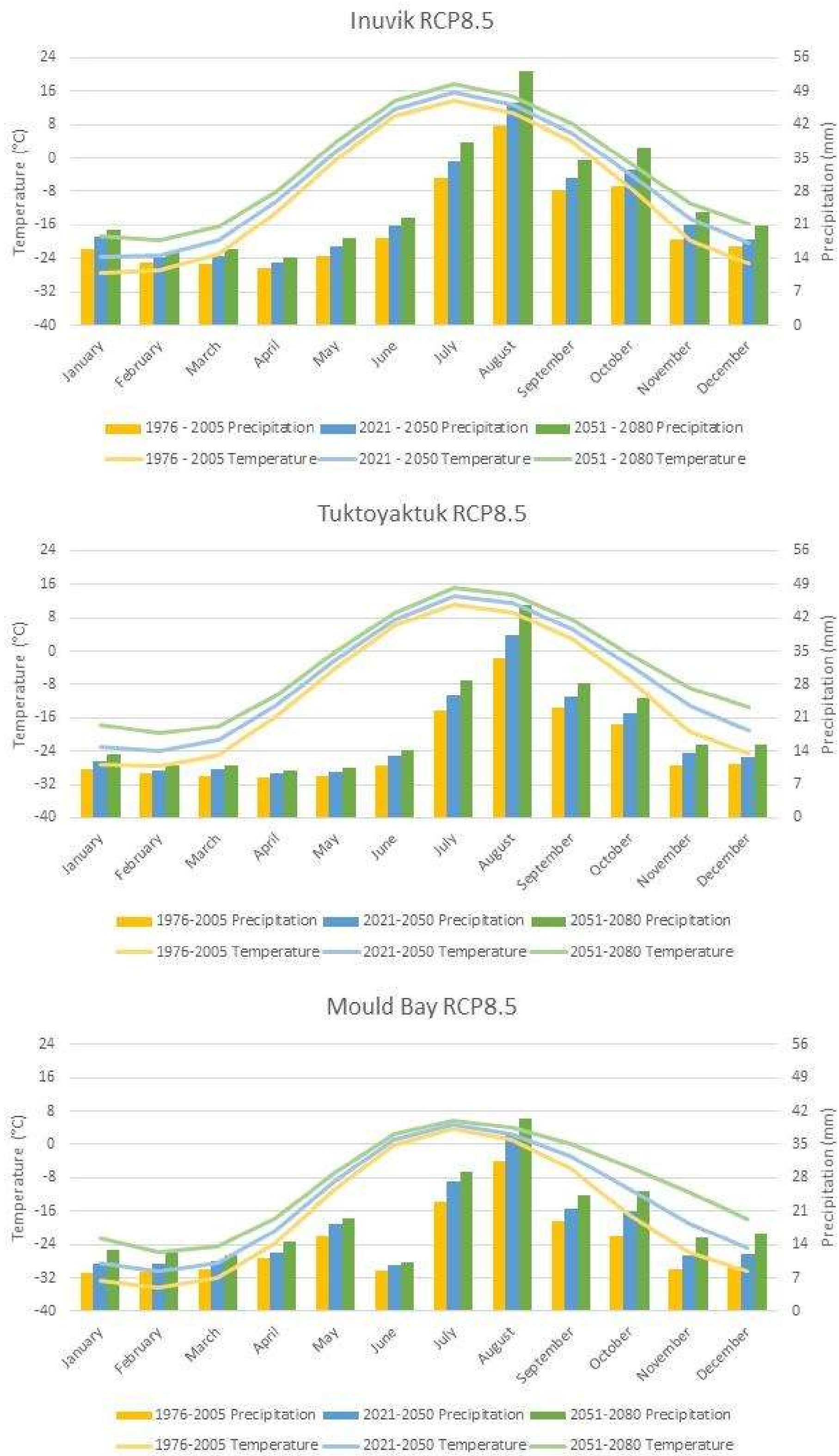

Figure 22. Monthly average temperature and precipitation for the RCP8.5 emission scenario.

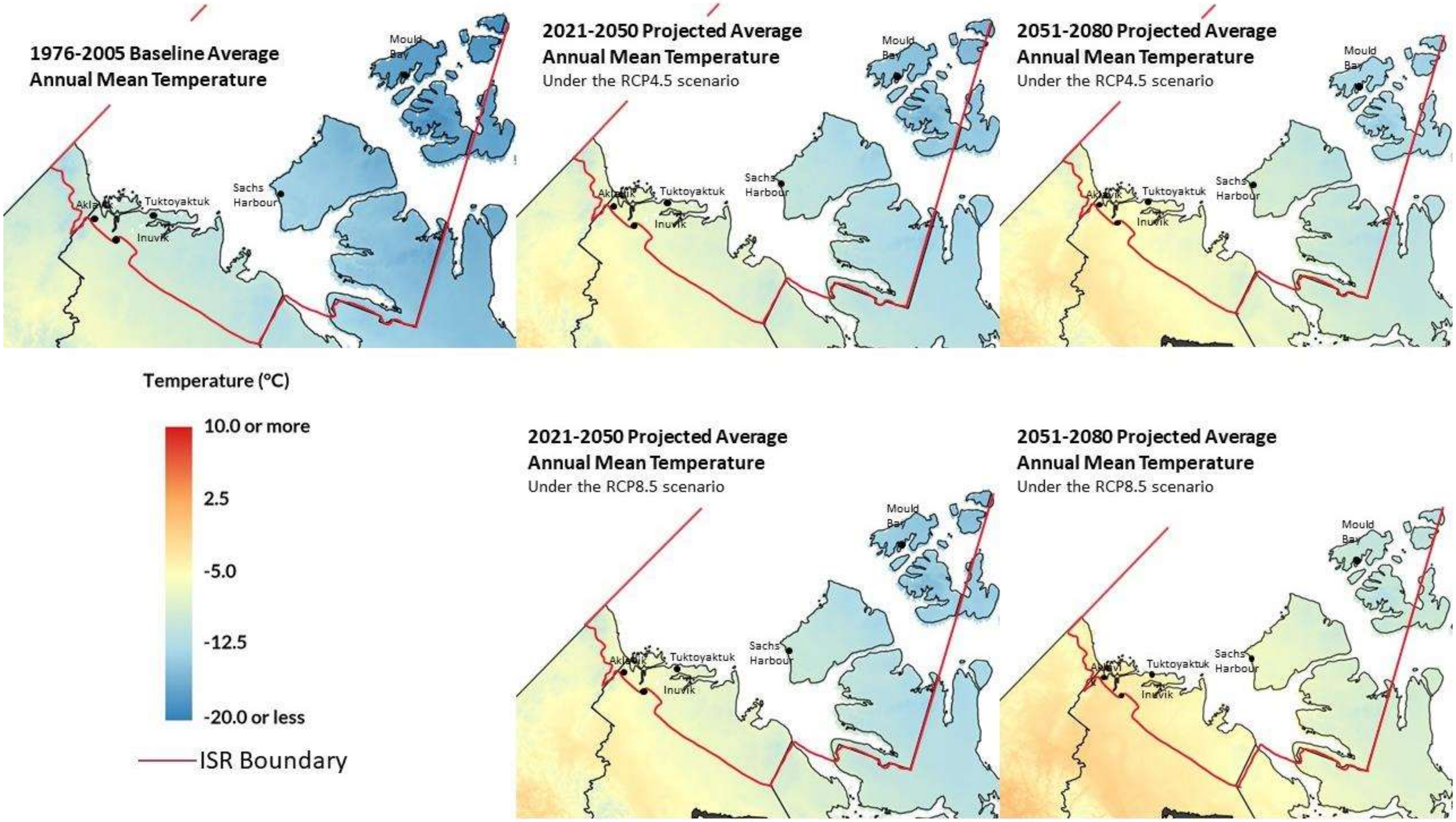

Figure 23. Average annual mean temperature projection for the short- and long-term future compared to the baseline average annual mean temperature.

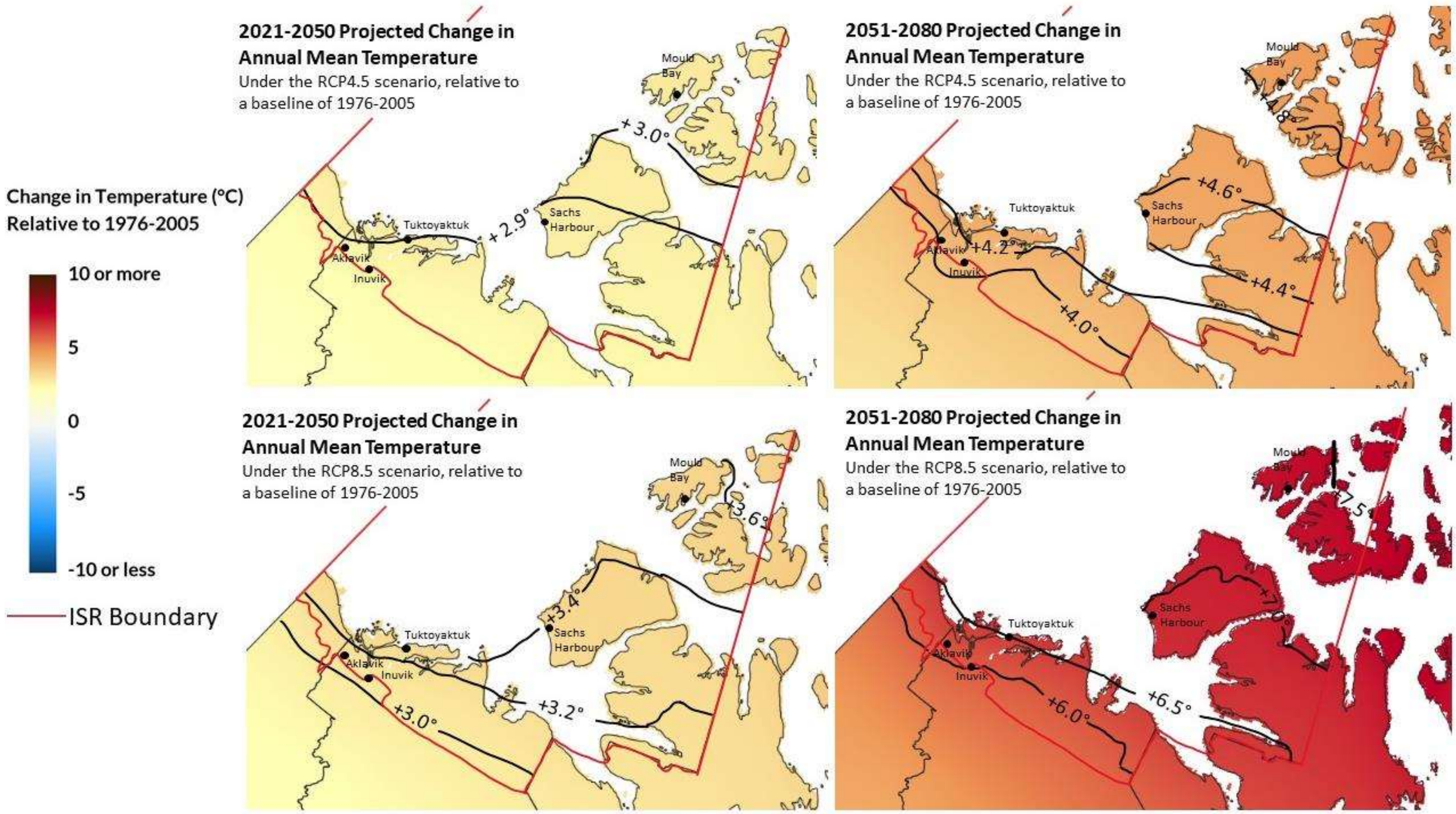

Figure 24. Projected change to mean annual temperature for the short- and long-term future relative to a baseline of 1976 – 2005.

6.2 Ground Temperature Modelling of a Sump Subject to Climate Change

A geothermal modelling analysis was completed to further evaluate the changes in sub-surface soil temperatures within, and adjacent to, a sump as a result of warming climate. Complete details of the model assumptions, inputs and results are presented in Appendix D. Provided herein are key model results that are used to inform how climate change may input future ground temperatures with associated implications for sump performance.

A hypothetical, but representative, sump and surrounding soil and environmental conditions were selected for the analysis. The model was developed to simulate the sub-surface soil and ground temperatures (Figure 25). The model included the drilling waste placed in a sump and capped with mineral soil. The drilling waste was simulated placed at sufficient depth and with a thick cap to encourage freezing in place. The surrounding area consisted of 0.2 m of peat material overlying mineral soil.

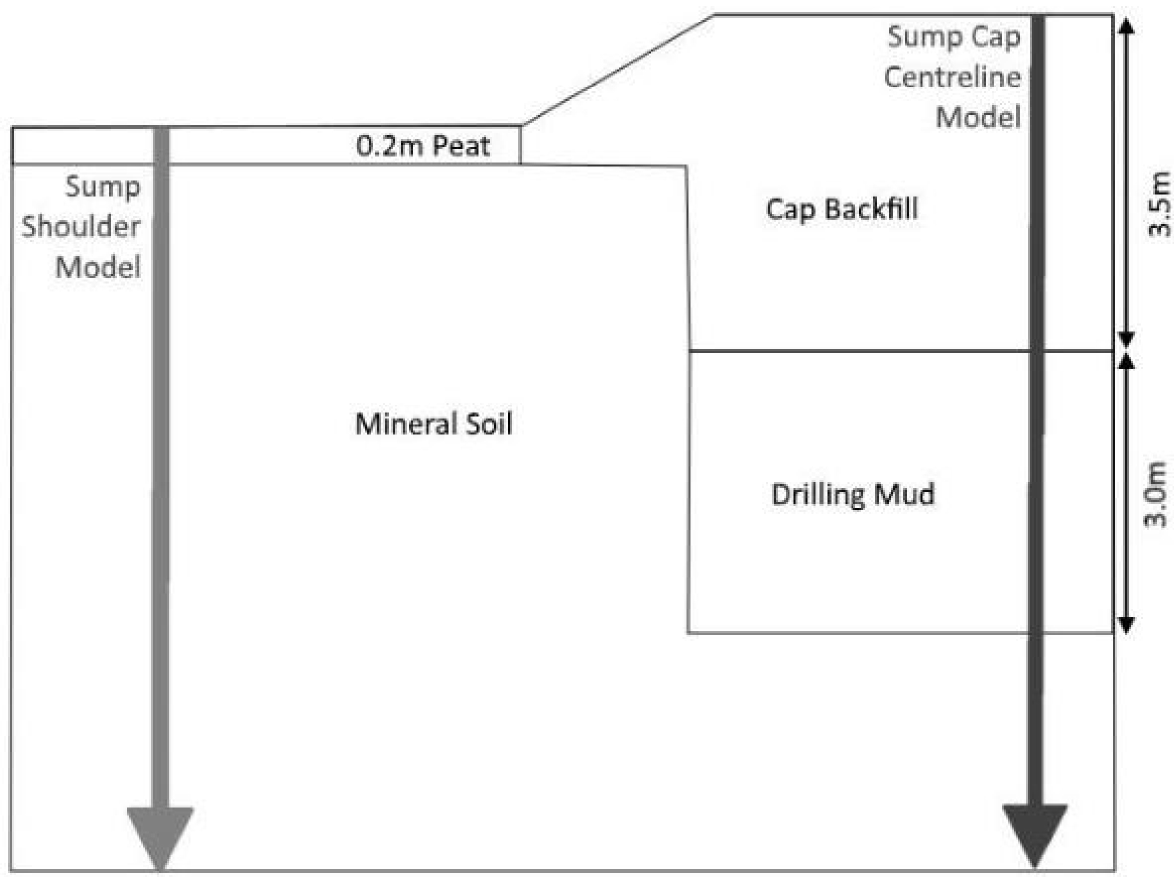

Figure 25. Modelled sub-surface characteristics applied in the ground temperature model. Ground temperatures simulated at sump shoulder and sump cap centreline.

The modelled sump, inputs and analysis generally followed the approach of Kokelj et al., (2010), with the exception that future climate change was assessed. The model applied the projected climate to year 2095 and then simulated the ground conditions at two locations: sump centerline and the shoulder area adjacent to the sump. The future air temperatures were selected to be the projected RCP8.5 climate warming scenario for the Tuktoyaktuk area (Figure 26).

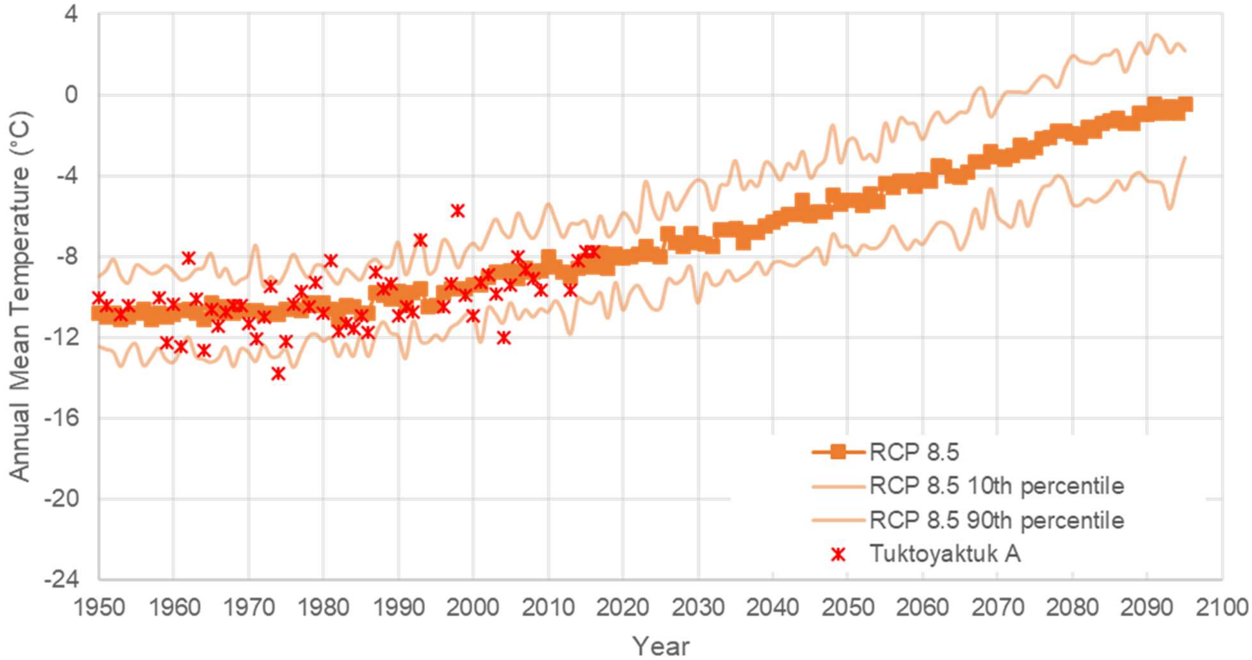

Figure 26.Tuktoyaktuk historical and future mean annual air temperatures for the RCP 8.5 emissions scenario.

Kokelj et al., (2010) indicated that vegetation may influence the snow cover that accumulates on a sump, which in turn influences the ground temperatures. This is because snow may act as an insulator. Thus, a range of snow covers was applied in the model to evaluate the sensitivity of snow cover on the simulated ground temperatures.

The simulated ground temperatures at the sump centerline and adjacent shoulder provide an assessment of the maximum annual thaw depth. Of interest was the maximum annual thaw depth as the air temperature warms due to climate change (Figure 27) and the maximum annual thaw depth over time (Figure 28). For the model that considered the cap centerline, if the annual thaw depth extended beyond 3.5 m, the drilling waste was shown to thaw in the warmer season. This would compromise the intent of freezing the drilling waste in-place.

The maximum annual thaw depth was presented for the range of snow cover conditions to assess the relative influence of the insulating effect of snow. The following key results were noted:

- Maximum annual thaw depth increases with warmer air temperatures. Since air temperatures are predicted to increase with time due to climate change, the maximum annual thaw depth would increase with time.
- Maximum annual thaw depth is greater from the sump centerline as compared with the sump shoulder.
- For the sump centerline, the maximum annual thaw depth is predicted to approach the surface of the drilling waste when the air temperature increases to between -3.0°C (occurs in year 2073) and -1.8°C (occurs in year 2082).

- For the sump centerline in year 2095, the maximum annual air thaw depth ranges between 5.5 m and 7.9. This is predicted to result in thawing of most of the drilling waste material in the warmer season.

The analysis described above are for a cap thickness of 3.5 m. The records of cap thickness for the sumps are limited. If the cap thickness was 1.5 m, the maximum annual thaw depth is predicted to approach the surface of the drilling waste when the air temperature increases to between -6.0°C (occurs in year 2042) and -4.2°C (occurs in year 2065). Therefore, the thinner the cap, the lower the air temperature needs to increase for the thaw depth to reach the top of waste surface.

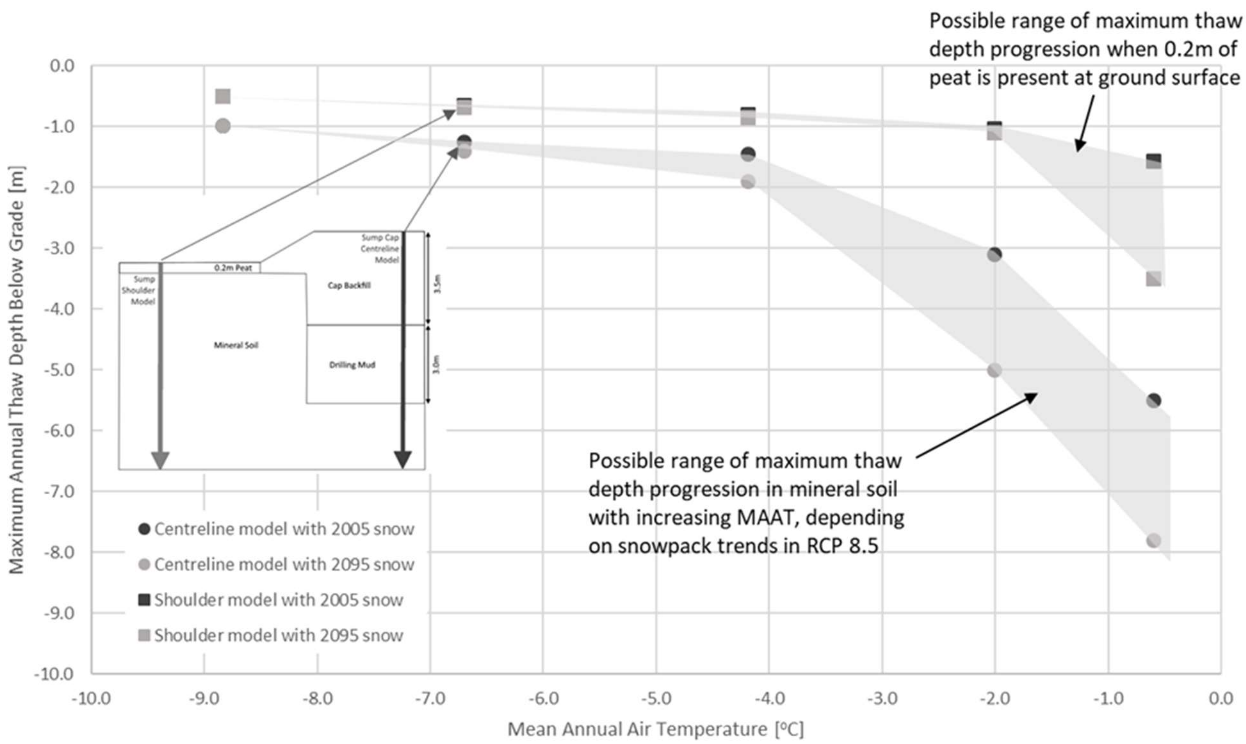

Figure 27. Modelled maximum annual thaw depth as a function of mean annual air temperature.

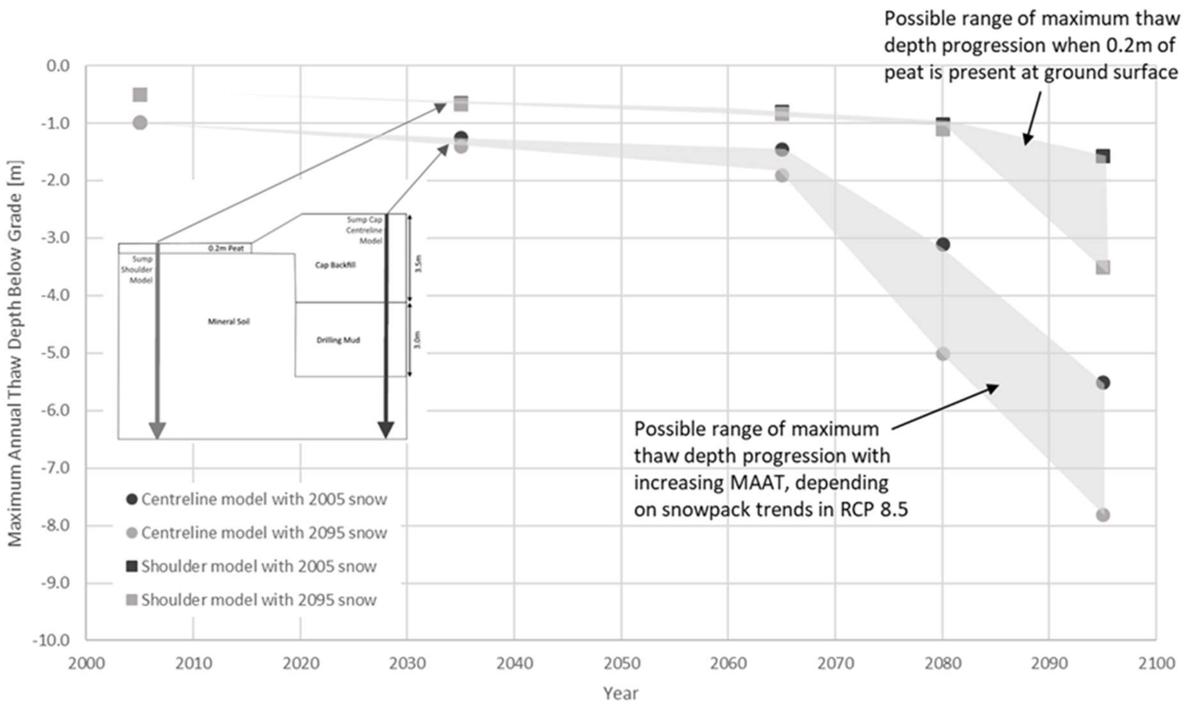

Figure 28. Modelled maximum annual thaw depth by year.

6.3 Implications of Climate Change on Potential for Sump Degradation

The ground temperature modelling completed in Section 6.2 was applied solely to the Tuktoyaktuk location. However, it is predicted that if all the model conditions, except for air temperature, were maintained, and the air temperature changed according to a new ISR location, for locations in the ISR where mean annual air temperatures reach -3°C to -1.8°C, the annual thaw depth is predicted to extend to the frozen drilling waste material when the cover over the drilling waste was 3.5 m. The mean annual air temperature for the RCP4.5 and RCP8.5 emissions scenario in year 2095 are summarized in Table 25.

Table 25. Summary of 2095 mean annual air temperature for the RCP4.5 and RCP8.5 emission scenarios.

Emission Scenario	Inuvik Temperature (°C)	Tuktoyaktuk Temperature (°C)	Mould Bay Temperature (°C)
RCP4.5	-3.8	-4.5	-11.6
RCP8.5	0.3	-0.5	-6.1

Note: Cover thickness of 3.5 m. Red: air temperatures would result in thawing of drilling waste; Orange: air temperatures near conditions to that result in thawing of drill waste; Green: air temperatures below conditions that result in thawing of drill waste.

As noted in Table 25, thawing of drilling waste for the RCP4.5 emissions scenario are nearing conditions that are predicted to occur in the areas near Inuvik, but are not predicted to result in thawing above this latitude. For the RCP8.5 emissions scenario, thawing of the drilling waste is predicted to occur throughout the Mackenzie Delta extending to the Arctic Ocean coast. The higher Arctic islands are not predicted to experience conditions that result in the thawing of drilling wastes. 182 sumps (82%) are located south of the Arctic Ocean and these sumps are projected to be influenced by climate change for the conditions assessed.

Thawing of the drill waste contents could result in the following:

- The once frozen water within the sump has thawed which increases the potential for mobilization away from the sump.
- Since the drilling waste was typically deposited with excess water which would expand during freezing, upon thawing, settlement of the sump contents would occur. This could result in settlement of the cap material and contribute towards damage of the cap (e.g., cracking) and ponding of water on the cap.
- Freeze-thawing processes over the years could result in water infiltrating into the cap and waste materials. When this water freezes, further damage to the cap (e.g., cracking) could occur.

Thus, thawing of the drill waste content can contribute towards further sump degradation.

6.4 Conclusions and Key Findings

The historical and future climate within the ISR was summarized. Two climate change methodologies were used to assess the future climate, which included a short-term projection (future 10 years), and a longer-term prediction (up to 2095) for two GHG emission scenarios.

Within the ISR, the air temperatures and precipitation are predicted to increase over time as a result of climate change. Within the ISR, the long-term predictions show an increase in air temperature ranging from approximately +3 °C to +7.5 °C with an accompanying predicted annual increase in precipitation ranging from approximately +45 mm to +64 mm. Seasonal increases in air temperatures are predicted to be more pronounced in the winter season as compared with summer season. This would result in a longer duration when annual temperatures are above 0°C.

Ground temperature modelling for a hypothetical sump was completed to predict how future increased air temperatures could influence the thaw depth within the sump and at sump shoulder locations. The results indicate that the depth of thaw increases with time as a result of the warmer air temperatures. The depth of thaw could extend into the drilling waste material which could result in annual thaw degradation of the sites. Notably, the sumps were originally constructed and closed with the assumption that the drilling waste materials would remain frozen. If assumptions regarding increasing annual temperatures are confirmed, the original intent of procedures for stable, long-term disposal could be compromised. Thawing of the sump cap and sump materials can give rise to conditions that further lead to sump degradation, such as settlement, cap cracking, and water ponding. As the sump degrades, the potential for environmental impacts increases.

Based on the modelling completed:

- Thawing of drilling waste for the RCP4.5 emissions scenario is nearing conditions that are predicted to occur in the areas near Inuvik but are not predicted to result in thawing above this latitude.
- or the RCP8.5 emissions scenario, thawing of the drilling waste is predicted to occur throughout the Mackenzie Delta extending to the Arctic Ocean coast. The higher Arctic islands are not predicted to experience conditions that result in the thawing of drilling wastes.
- 182 sumps (82%) are located south of the Arctic Ocean and these sumps are projected to be influenced by climate change for the conditions assessed.

7.0 CLOSING

This report has been prepared exclusively for the use of Inuvialuit Regional Corporation for the specific application described within this report. The details provided in this report are for general information purposes only. The information and recommendations contained in this report should not be used for any other purpose, at another location, or by any other parties. Any use of, or reliance on this report by any third party is at that party's sole risk. ARKTIS assumes no responsibly for inappropriate use of the contents of this report, and disclaims all liability arising from negligence or otherwise. General terms and conditions are provided in Appendix A.

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APPENDIX A: GENERAL TERMS AND CONDITIONS

USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of ARKTIS Solutions Inc.'s (ARKTIS) client. ARKTIS does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than ARKTIS' client unless otherwise authorized in writing by ARKTIS. Any unauthorized use of the report is at the sole risk of the user.

LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of ARKTIS' investigation. The client, and any other parties using this report with the express written consent of the clients and ARKTIS, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and ARKTIS, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that ARKTIS is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

During the performance of the work and the preparation of this report, ARKTIS may have relied on the information provided by persons other than the client. While ARKTIS endeavors to verify the accuracy of such information when instructed to do so by the client, ARKTIS accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

STANDARD OF CARE

Services performed by ARKTIS for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and financial and physical constraints applicable to the services. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

ALTERNATE REPORT FORMAT

Where ARKTIS submits both electronic file and hard copy versions of reports, drawings and other project related documents and deliverables (collectively termed instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by ARKTIS shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by ARKTIS shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of instruments of professional services shall not, under any circumstances, no matter who owns or uses them, be altered by any party except ARKTIS. The Client warrants that instruments of professional services will be used only and exactly as submitted by ARKTIS.

APPENDIX B: SUPPLEMENTAL TABLES

Table B-1: Wells within the Inuvialuit Settlement Region.

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
761	ESSO CIGOL AKKU F-14	Imperial	ILA	AKKU F-14	300F146930132150	Exploratory Well	Abandoned	69° 23' 14.9"	132° 19' 17.8"	NWT Mackenzie Delta Onshore	09-Dec-72	01-Jan-73		
546	SHELL AKLAVIK A-37	Shell	Territorial	AKLAVIK A-37	300A376820135000	Exploratory Well	Abandoned	68° 16' 14.2"	135° 7' 55.6"	NWT Mackenzie Delta Onshore	02-Aug-70	13-Oct-70		
820	ELF ET AL IMPERIAL	Husky	ILA	AMAGUK H-16	300H166940131000	Exploratory	Plug and abandoned	69° 35' 24.0"	131° 2' 52.1"	NWT Mackenzie Delta Onshore	25-Mar-73	1-May-73	1257.9	
920	IMP CIGOL AMAROK N-44	Imperial	Territorial	AMAROK N-44	300N447000130450	Exploratory Well	Abandoned	69° 53' 59.1"	130° 56' 25.8"	NWT Mackenzie Delta Onshore	11-Apr-74	26-May-74		
829	ELFEX ANDREASEN L-32	Husky	Territorial	ANDREASEN L-32	300L327720118000	Exploratory Well	Abandoned	77° 11' 40.0"	118° 14' 26.4"	NWT Arctic Islands Onshore	09-Apr-73	30-May-73		
843	SUNCOR APOLLO C-73	Suncor	Territorial	APOLLO C-73	300C737540111300	Exploratory Well	Abandoned	75° 32' 2.5"	111° 59' 6.8"	NWT Arctic Islands Onshore	13-May-73	10-Aug-73		
	MGM ET AL APUT D-43	MGM Energy Corp.	Territorial	APUT D-43		Exploratory Well	Suspended	69° 02' 02.5"	135° 41' 48.6"	NWT Mackenzie Delta Onshore	29-Jan-08	7-Mar-08		
728	IMP ATERTAK E-41	Imperial	ILA	ATERTAK E-41	300E416940132300	Exploratory Well	Suspended	69° 30' 26.9"	132° 42' 17.8"	NWT Mackenzie Delta Onshore	01-May-72	13-Jul-72		
1615	ESSO HOME ET AL ATERTAK K-31	Imperial	ILA	ATERTAK K-31	300K316940132300	Exploratory Well	Abandoned	69° 30' 34.3"	132° 39' 17.2"	NWT Mackenzie Delta Onshore	08-Apr-86	12-May-86		
584	GULF MOBIL ATIGI G-04	ConocoPhillips		ATIGI G-04	300G046900133450	Exploratory Well	Abandoned	68° 53' 15.6"	133° 46' 12.9"	NWT Mackenzie Delta Onshore	07-Jan-71	27-Apr-71		
894	GULF MOBIL ATIGI O-48	ConocoPhillips		ATIGI O-48	300O486900133450	Exploratory Well	Suspended	68° 57' 47.7"	133° 56' 16.7"	NWT Mackenzie Delta Onshore	09-Jan-74	28-Feb-74		
2049	MGM ET AL ATIK P-19	MGM Energy Corp.	Territorial	ATIK P-19	300P196900135300	Exploratory Well	Suspended	68° 58' 54.4"	135° 32' 51.9"	NWT Mackenzie Delta Onshore	23-Dec-07	26-Jan-08		
887	IMP CIGOL ATKINSON A-55	Imperial	ILA	ATKINSON A-55	300A556950131450	Delineation Well	Abandoned	69° 44' 9.0"	131° 58' 3.9"	NWT Mackenzie Delta Onshore	15-Dec-73	23-Jan-74		
478	ESSO ATKINSON H-25	Imperial	ILA	ATKINSON H-25	300H256950131450	Exploratory Well	Abandoned	69° 44' 17.6"	131° 50' 31.2"	NWT Mackenzie Delta Onshore	14-Dec-69	26-Feb-70		
534	IOE	Imperial	ILA	ATKINSON M-33	300M336950131450	Exploratory	Plug and abandoned	69° 42' 47.9"	131° 54' 42.8"	NWT Mackenzie Delta Onshore	1-May-70	3-Jun-70	1928.5	
1015	SUNCOR ELF BAR HARBOUR E-76	Suncor	Territorial	BAR HARBOUR E-76	300E767420123300	Exploratory Well	Abandoned	74° 15' 28.8"	123° 54' 2.2"	NWT Arctic Islands Onshore	24-Nov-75	02-Jan-76		
562	SHELL BEAVER HOUSE CREEK H-13	Shell	ILA	BEAVER HOUSE CREEK H-13	300H136830135300	Exploratory Well	Suspended	68° 22' 15.9"	135° 33' 12.2"	NWT Mackenzie Delta Onshore	23-Nov-70	27-Mar-71		
537	IOE	Imperial	YT Reserved	BLOW RIVER YT E-47	300E476850137150	Exploratory	Plug and abandoned	68° 46' 19.9"	137° 27' 13.0"	Yukon Onshore	8-May-70	15-Nov-70	4267.2	
657	SUNCOR BP SKELLY TENNECO ET AL BROCK C-50	Suncor	Territorial	BROCK C-50	300C507750114000	Exploratory Well	Abandoned	77° 49' 2.9"	114° 17' 35.6"	NWT Arctic Islands Onshore	12-Nov-71	22-Mar-72		
719	SUNCOR BROCK I-20	Suncor	Territorial	BROCK I-20	300I207800114300	Exploratory Well	Abandoned	77° 59' 42.9"	114° 34' 2.8"	NWT Arctic Islands Onshore	14-Apr-72	28-Jun-72		
		Uncertain	Territorial	BURNT LK				69° 23' 21.2"	134° 03' 42.2"	NWT Mackenzie Delta Onshore				Identified by GNWT
532	ELF CAPE NOREM A-80	Husky	Territorial	CAPE NOREM A-80	300A807730110000	Exploratory Well	Abandoned	77° 29' 16.1"	110° 27' 14.4"	NWT Arctic Islands Onshore	20-Apr-70	27-Aug-70		
975	SUNCOR TENN ET AL CASTEL BAY C-68	Suncor	Aulavik National Park	CASTEL BAY C-68	300C687410120300	Exploratory Well	Abandoned	74° 7' 13.0"	120° 50' 10.1"	NWT Arctic Islands Onshore	29-Jan-75	05-Apr-75		
407	CPOG CROSSLEY LK S K-60	Encana	ILA	CROSSLEY LK S K-60	300K606830129150	Exploratory Well	Abandoned	68° 29' 39.3"	129° 29' 22.8"	NWT Mainland	28-Aug-68	09-Mar-69		
1073	SUNCOR AIEG ET AL DEPOT ISLAND C-44	Suncor	Territorial	DEPOT ISLAND C-44	300C447630114000	Exploratory Well	Abandoned	76° 23' 17.1"	114° 17' 54.9"	NWT Arctic Islands Onshore	19-Apr-77	10-Jun-77		
744	SUNCOR DOME DUNDAS C-80	Suncor	Territorial	DUNDAS C-80	300C807440113000	Exploratory Well	Abandoned	74° 39' 4.3"	113° 23' 8.6"	NWT Arctic Islands Onshore	14-Oct-72	19-Jan-73		
1012	ELF ET AL DYER BAY L-49	Husky	Territorial	DYER BAY L-49	300L497610121300	Exploratory Well	Abandoned	76° 8' 37.6"	121° 48' 49.2"	NWT Arctic Islands Onshore	01-Nov-75	20-Feb-76		
1013	SUNCOR ET AL E. HECLA C-32	Suncor	ILA	E. HECLA C-32	300C327630110000	Delineation Well	Suspended	76° 21' 12.1"	110° 13' 54.7"	NWT Arctic Islands Onshore	07-Nov-75	16-Dec-75		
754	PANARCTIC TENN ET AL POR	Suncor	ILA	E. HECLA F-62	300F627630110002	Exploratory	Plug and abandoned	76° 21' 15.8"	110° 24' 38.5"	NWT Arctic Islands Onshore	11-Nov-72	11-Dec-72	1219	
934	SUNCOR GULF EGLINTON P-24	Suncor	Territorial	EGLINTON P-24	300P247600118000	Exploratory Well	Abandoned	75° 53' 55.4"	118° 7' 50.1"	NWT Arctic Islands Onshore	06-Jun-74	03-Jul-74		
1969	MGM ET AL ELLICE I-48	Uncertain	Territorial	ELLICE I-48	300I486910135450	Exploratory Well	Suspended	69° 7' 33.6"	135° 55' 43.4"	NWT Mackenzie Delta Onshore	04-Feb-04	16-Apr-04		Ownership uncertain by MGM. Chevron or MGM.
2059	MGM ET AL ELLICE J-27	MGM Energy Corp.	Territorial	ELLICE J-27	300J276910135450	Exploratory Well	Suspended	69° 6' 39.3"	135° 51' 3.5"	NWT Mackenzie Delta Onshore	25-Dec-08	22-Jan-09		
475	IOE ELLICE O-14	Imperial	Territorial	ELLICE O-14	300O146910135450	Exploratory Well	Abandoned	69° 3' 55.6"	135° 48' 25.8"	NWT Mackenzie Delta Onshore	19-Nov-69	17-Feb-70		

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
762	BP ET AL PANARCTIC EMERALD K-33	BP	Territorial	EMERALD K-33	300K337650113300	Exploratory Well	Abandoned	76° 42' 45.7"	113° 43' 31.1"	NWT Arctic Islands Onshore	12-Dec-72	13-Apr-73		
463	IOE ESKIMO J-07	Imperial	ILA	ESKIMO J-07	300J076920132300	Exploratory Well	Abandoned	69° 16' 42.9"	132° 31' 8.8"	NWT Mackenzie Delta Onshore	10-May-69	31-May-69		
1075	CHEVRON CANADA PEX ET AL FISH RIVER B-60	Chevron	ILA	FISH RIVER B-60	300B606840136000	Exploratory Well	Abandoned	68° 39' 2.5"	136° 13' 48.4"	NWT Mackenzie Delta Onshore	21-Jun-77	31-Oct-77		
1088	SUN CCL BVX ET AL GARRY G-07	Uncertain	Territorial	GARRY G-07	300G076930135301	Exploratory Well	Abandoned	69° 43' 95.8"	135° 51' 55.55"	NWT Mackenzie Delta Onshore	10-Feb-78	13-May-78	4021.2	Chevron or Suncor
1006	SUN SOBC BVX ET AL GARRY P-04	Uncertain	Territorial	GARRY P-04	300P046930135300	Exploratory Well	Abandoned	69° 23' 45.5"	135° 30' 29.5"	NWT Mackenzie Delta Onshore	25-Aug-75	05-Jan-76		Chevron or Suncor
1597	ESSO PCI HOME ET AL HANSEN G-07	Imperial	Territorial	HANSEN G-07	300G076940134000	Exploratory Well	Suspended	69° 36' 20.4"	134° 1' 22.0"	NWT Mackenzie Delta Onshore	10-Feb-86	11-Apr-86		
1107	DOME PANARCTIC ET AL HEARNE F-85	BP	Territorial	HEARNE F-85	300F857450110300	Exploratory Well	Abandoned	74° 44' 18.2"	110° 56' 5.9"	NWT Arctic Islands Onshore	25-Oct-78	09-Jan-79		
799	PANARCTIC TENNECO ET AL	Suncor	ILA	HECLA I-69	300I697620110001	Delineation	Plug and abandoned	76° 18' 36.7"	110° 23' 15.4	NWT Arctic Islands Onshore	22-Feb-73	11-Apr-73	1456.6	
540	PANARCTIC HOMESTEAD	Suncor	ILA	HECLA J-60	300J607620110000	Exploratory	Plug and abandoned	76° 19' 37.9"	110° 19' 49.1"	NWT Arctic Islands Onshore	31-May-70	16-Sep-70	3616.5	
473	ELF HORTON RIVER G-02	Husky	ILA	HORTON RIVER G-02	300G027000127150	Exploratory Well	Abandoned	69° 51' 23.1"	127° 16' 5.9"	NWT Mainland	09-Nov-69	22-Jan-70		
639	GULF MOBIL IKHIL A-01	ConocoPhillips	ILA	IKHIL A-01	300A016850134000	Exploratory Well	Abandoned	68° 40' 12.7"	134° 0' 40.4"	NWT Mackenzie Delta Onshore	09-May-71	27-Jun-71		
830	GULF MOBIL IKHIL I-37	Uncertain	ILA	IKHIL I-37	300I376850134000	Exploratory Well	Abandoned	68° 46' 33.7"	134° 7' 59.6"	NWT Mackenzie Delta Onshore	10-Apr-73	03-Dec-73		Sold to Shell by ConocoPhillips. Shell would not confirm.
1839	UGFI et al IKHIL J-35	Inuvialuit Petroleum Corporation	ILA	IKHIL J-35	300J356850134000	Delineation Well	Suspended	68° 44' 35.3"	134° 8' 44.4"	NWT Mackenzie Delta Onshore	27-Feb-98	20-Mar-98		
1606	UGFI et al IKHIL K-35	Inuvialuit Petroleum Corporation	ILA	IKHIL K-35	300K356850134000	Exploratory Well	Suspended	68° 44' 43.4"	134° 9' 25.6"	NWT Mackenzie Delta Onshore	27-Feb-86	25-Mar-86		
1840	IPC IKHIL N-26	Inuvialuit Petroleum Corporation	ILA	IKHIL N-26	300N266850134000	Delineation Well	Abandoned	68° 45' 54.9"	134° 6' 46.8"	NWT Mackenzie Delta Onshore	20-Mar-98	05-Apr-98		
	UGFI et al IKHIL UGFI 02/J-35	Utility Group Facilities Inc.	ILA	IKHIL UGFI 02/J-35				68° 44' 35.582"	134° 8' 34.93"	NWT Mackenzie Delta Onshore	2011	2012		
908	COLUMBIA ET AL AMOCO IKKARIKTOK M-64	Uncertain	Territorial	IKKARIKTOK M-64	300M647230121300	Exploratory Well	Abandoned	72° 23' 49.0"	121° 51' 9.1"	NWT Arctic Islands Onshore	26-Feb-74	16-Apr-74		BP or Canadian Nat Resources
965	DOME IMP IMNAK J-29	BP	ILA	IMNAK J-29	300J296910133000	Exploratory Well	Abandoned	69° 8' 40.8"	133° 6' 14.8"	NWT Mackenzie Delta Onshore	22-Dec-74	12-Mar-75		
780	ELF INTREPID INLET H-49	Husky	Territorial	INTREPID INLET H-49	300H497700118300	Exploratory Well	Abandoned	76° 58' 29.0"	118° 45' 15.7"	NWT Arctic Islands Onshore	10-Jan-73	18-Mar-73		
		Uncertain	Territorial	IOL DRILL SUMP				69° 27' 36.9"	134° 39' 40.5"	NWT Mackenzie Delta Onshore				Identified by GNWT
1984	DEVON ET AL ITIGINKPAK F-29	Canadian Natural Resources	Territorial	ITIGINKPAK F-29 (N2002A0039)	300F296830134300	Exploratory Well	Abandoned	68° 28' 17.9"	134° 36' 41.0"	NWT Mackenzie Delta Onshore	11-Feb-03	16-Mar-03		
1499	ESSO PCI HOME ET AL ITKRILEK B-52	Imperial	Territorial	ITKRILEK B-52	300B526940131450	Exploratory Well	Abandoned	69° 31' 13.8"	131° 58' 41.7"	NWT Mackenzie Delta Onshore	21-Mar-85	04-Apr-85		
767	IMP IVIK C-52	Imperial	Territorial	IVIK C-52	300C526940134150	Exploratory Well	Abandoned	69° 31' 9.8"	134° 29' 2.1"	NWT Mackenzie Delta Onshore	19-Dec-72	13-Feb-73		
716	ESSO IVIK J-26	Imperial	Territorial	IVIK J-26	300J266940134150	Exploratory Well	Suspended	69° 35' 41.8"	134° 20' 48.1"	NWT Mackenzie Delta Onshore	08-Apr-72	30-Sep-72		
825	IMP	Imperial	Territorial	IVIK K-54	300K546940134150	Exploratory	Plug and abandoned	69° 33' 36.0"	134° 29' 1.0"	NWT Mackenzie Delta Onshore	30-Mar-73	8-Jun-73	3151	
779	IMP IVIK N-17	Imperial	Territorial	IVIK N-17	300N176940134150	Delineation Well	Abandoned	69° 36' 50.8"	134° 19' 26.1"	NWT Mackenzie Delta Onshore	10-Jan-73	04-Mar-73		
620	ELF JAMESON BAY C-31	Husky	Territorial	JAMESON BAY C-31	300C317650116300	Exploratory Well	Abandoned	76° 40' 14.6"	116° 43' 56.6"	NWT Arctic Islands Onshore	11-Mar-71	16-May-71		
1018	GULF-MOBIL KAMIK D-48	ConocoPhillips	Territorial	KAMIK D-48	300D486900133150	Delineation Well	Other	68° 57' 12.4"	133° 27' 39.6"	NWT Mackenzie Delta Onshore	23-Dec-75	04-Apr-76		
960	GULF-MOBIL KAMIK D-58	ConocoPhillips	Territorial	KAMIK D-58	300D586900133150	Delineation Well	Abandoned	68° 57' 13.0"	133° 30' 1.1"	NWT Mackenzie Delta Onshore	26-Nov-74	14-Mar-75		
1055	GULF-MOBIL KAMIK F-38	ConocoPhillips	Territorial	KAMIK F-38	300F386900133150	Exploratory Well	Abandoned	68° 57' 22.7"	133° 24' 4.2"	NWT Mackenzie Delta Onshore	13-Dec-76	13-Mar-77		
991	GULF-MOBIL KAMIK L-60	ConocoPhillips	Territorial	KAMIK L-60	300L606900133150	Exploratory Well	Abandoned	68° 59' 40.5"	133° 29' 33.8"	NWT Mackenzie Delta Onshore	29-Mar-75	11-Jun-75		
789	IMP CIGOL KANGUK F-42	Imperial	Territorial	KANGUK F-42	300F427000131000	Exploratory Well	Abandoned	69° 51' 26.1"	131° 11' 30.8"	NWT Mackenzie Delta Onshore	27-Jan-73	15-Feb-73		
603	IOE KANGUK I-24	Imperial	Territorial	KANGUK I-24	300I247000131000	Exploratory Well	Abandoned	69° 53' 40.1"	131° 5' 21.8"	NWT Mackenzie Delta Onshore	13-Feb-71	07-Mar-71		
968	IMP CIGOL KAPIK J-39	Imperial	Territorial	KAPIK J-39	300J397000130000	Exploratory Well	Abandoned	69° 58' 32.2"	130° 8' 19.8"	NWT Mackenzie Delta Onshore	01-Jan-75	30-Jan-75		

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
964	GULF MOBIL KIKORALOK N-46	ConocoPhillips	Territorial	KIKORALOK N-46	300N466910134450	Exploratory Well	Abandoned	69° 5' 45.7"	134° 56' 42.7"	NWT Mackenzie Delta Onshore	20-Dec-74	25-Jan-75		
693	GULF MOBIL KILAGMIOTAK F-48	ConocoPhillips	Territorial	KILAGMIOTAK F-48	300F486930134000	Exploratory Well	Abandoned	69° 27' 28.9"	134° 12' 1.1"	NWT Mackenzie Delta Onshore	04-Feb-72	12-Oct-72		
984	GULF MOBIL KILAGMIOTAK M-16	ConocoPhillips	Territorial	KILAGMIOTAK M-16	300M166930134000	Exploratory Well	Abandoned	69° 25' 51.9"	134° 4' 40.1"	NWT Mackenzie Delta Onshore	25-Feb-75	01-Apr-75		
845	ELF ET AL KILIGVAK I-29	Husky	Territorial	KILIGVAK I-29	300I296930131150	Exploratory Well	Abandoned	69° 28' 38.0"	131° 20' 25.7"	NWT Mackenzie Delta Onshore	16-May-73	08-Aug-73		
670	IMP IOE KIMIK D-29	Imperial	ILA	KIMIK D-29	300D296940132150	Exploratory Well	Abandoned	69° 38' 5.0"	132° 22' 19.8"	NWT Mackenzie Delta Onshore	17-Dec-71	16-Feb-72		
939	SHELL KIPNIK O-20	Shell	ILA	KIPNIK O-20	300O206850134450	Exploratory Well	Abandoned	68° 49' 59.5"	134° 48' 28.4"	NWT Mackenzie Delta Onshore	14-Jul-74	21-Nov-74		
561	SUN KR PANARCTIC KITSON R. C-71	Suncor	Territorial	KITSON R. C-71	300C717620112300	Exploratory Well	Abandoned	76° 10' 15.1"	112° 59' 5.4"	NWT Arctic Islands Onshore	14-Nov-70	06-Feb-71		
458	CPOG KUGALUK N-02	Encana	Territorial	KUGALUK N-02	300N026840131300	Exploratory Well	Abandoned	68° 31' 55.0"	131° 31' 28.1"	NWT Mainland	02-Apr-69	18-Dec-69		
976	SHELL	Shell	Territorial	KUGPIK L-24	300L246900135150	Delineation	Plug and abandoned	68° 89' 20.6"	135° 37' 02.8"	NWT Mackenzie Delta Onshore	3-Feb-75	11-Apr-75	2871	
1942	PC Devon	Suncor	Territorial	KUGPIK L-46	300L466900135150	Exploratory	Plug and suspended	69° 04' 51.315"	135° 19'23.67"	NWT Mackenzie Delta Onshore	11-Mar-02	25-Apr-02	3014	
821	SHELL KUGPIK O-13	Shell	Territorial	KUGPIK O-13	300O136900135150	Exploratory Well	Suspended	68° 52' 49.6"	135° 18' 24.6"	NWT Mackenzie Delta Onshore	26-Mar-73	30-Sep-73		
		Shell	Territorial	KUMAK A-29 (I-29) (N2006A0029)				69° 17' 60.0"	135° 5' 28.0"	NWT Mackenzie Delta Onshore				
838	SHELL	Shell	Territorial	KUMAK C-58	300C586920135000	Exploratory	Plug and abandoned	69° 28' 50.4"	135° 23' 15.3"	NWT Mackenzie Delta Onshore	25-Apr-73	19-Oct-73	3530.2	
1064	SHELL	Shell	Territorial	KUMAK E-58	300E586920135001	Delineation	Plug and abandoned	69° 17' 29.4"	134° 14' 55.3"	NWT Mackenzie Delta Onshore	28-Feb-77	8-Jun-77	1554.5	
2043	MGM ET AL KUMAK I-25	MGM Energy Corp.	Territorial	KUMAK I-25	300I256920135000	Exploratory Well	Suspended	69° 14' 41.9"	135° 5' 14.5"	NWT Mackenzie Delta Onshore	07-Feb-07	07-Mar-07		
879	SHELL KUMAK J-06	Shell	Territorial	KUMAK J-06	300J066920135000	Delineation Well	Abandoned	69° 15' 35.7"	135° 1' 7.7"	NWT Mackenzie Delta Onshore	24-Nov-73	16-May-74		
983	SHELL KUMAK K-16	Shell	Territorial	KUMAK K-16	300K166920135000	Delineation Well	Suspended	69° 15' 32.6"	135° 4' 8.1"	NWT Mackenzie Delta Onshore	24-Feb-75	13-Jul-75		
1901	SUNCOR ANDERSON KURK M-15	Suncor	Territorial	KURK M-15 (N2000A0050)	300M156910135150	Exploratory Well	Suspended	69° 4' 50.9"	135° 19' 33.5"	NWT Mackenzie Delta Onshore	10-Feb-01	17-Apr-01		
1056	IMP DELTA 5 KURK M-39	Imperial	Territorial	KURK M-39	300M396910135150	Exploratory Well	Abandoned	69° 8' 54.7"	135° 25' 3.8"	NWT Mackenzie Delta Onshore	16-Dec-76	09-Mar-77		
962	ELFEX ET AL KUSRHAAK D-16	Husky	Aulavik National Park	KUSRHAAK D-16	300D167330120000	Exploratory Well	Abandoned	73° 25' 5.9"	120° 5' 28.1"	NWT Arctic Islands Onshore	12-Jul-74	04-Apr-75		
2054	MGM ET AL LANGLEY E-07	MGM Energy Corp.	Territorial	LANGLEY E-07	300E076920135300	Exploratory Well	Suspended	69° 16' 23.8"	135° 32' 13.0"	NWT Mackenzie Delta Onshore	17-Mar-08	01-Apr-08		
828	IMP LANGLEY E-29	Imperial	Territorial	LANGLEY E-29	300E296920135300	Exploratory Well	Abandoned	69° 18' 28.7"	135° 37' 6.0"	NWT Mackenzie Delta Onshore	08-Apr-73	19-Jul-73		
1985	MGM ET AL LANGLEY K-30	MGM Energy Corp.	Territorial	LANGLEY K-30	300K306920135300	Exploratory Well	Suspended	69° 19' 30.2"	135° 36' 49.3"	NWT Mackenzie Delta Onshore	19-Mar-03	12-Apr-03		
980	IMP DOME LOUTH K-45	Imperial	Territorial	LOUTH K-45	300K457000131150	Exploratory Well	Abandoned	69° 54' 32.1"	131° 26' 56.9"	NWT Mackenzie Delta Onshore	19-Feb-75	12-Mar-75		
574	IOE MAGAK A-32	Imperial	Territorial	MAGAK A-32	300A326940132000	Exploratory Well	Abandoned	69° 31' 9.0"	132° 7' 41.8"	NWT Mackenzie Delta Onshore	20-Dec-70	22-Jan-71		
1827	AURORA/JOGMEC/NRCAN MALLIK 2L-38	Japex	Territorial	MALLIK 2L-38	302L386930134300	Development Well	Suspended	69° 27' 40.5"	134° 39' 40.5"	NWT Mackenzie Delta Onshore	16-Feb-98	28-Mar-98		
1919	AURORA/JOGMEC/NRCAN MALLIK 3L-38	Japex	Territorial	MALLIK 3L-38	303L386930134300	Test Hole	Suspended	69° 27' 38.1"	134° 39' 51.7"	NWT Mackenzie Delta Onshore	25-Dec-01	08-Jan-02		
1920	AURORA/NRCAN MALLIK 4L-38	Japex	Territorial	MALLIK 4L-38	304L386930134300	Test Hole	Suspended	69° 27' 40.6"	134° 39' 45.0"	NWT Mackenzie Delta Onshore	11-Jan-02	24-Jan-02		
1921	AURORA/NRCAN MALLIK 5L-38	Japex	Territorial	MALLIK 5L-38	305L386930134300	Test Hole	Suspended	69° 27' 39.3"	134° 39' 48.4"	NWT Mackenzie Delta Onshore	25-Jan-02	14-Mar-02		
2046	ARI/JOGMEC/NRCAN MALLIK 6L-38	Japex	Territorial	MALLIK 6L-38	306L386930134300	Test Hole	Abandoned	69° 27' 40.8"	134° 39' 44.4"	NWT Mackenzie Delta Onshore	20-Apr-07	20-Apr-07		
722	ESSO MALLIK A-06	Imperial	Territorial	MALLIK A-06	300A066930134300	Exploratory Well	Abandoned	69° 25' 0.9"	134° 30' 26.1"	NWT Mackenzie Delta Onshore	21-Apr-72	08-Oct-72		
1084	IMP MALLIK J-37	Imperial	Territorial	MALLIK J-37	300J376930134300	Exploratory Well	Abandoned	69° 26' 37.8"	134° 38' 33.1"	NWT Mackenzie Delta Onshore	22-Dec-77	11-Apr-78		
673	ESSO MALLIK L-38	Imperial	Territorial	MALLIK L-38	300L386930134300	Exploratory Well	Suspended	69° 27' 43.8"	134° 39' 35.1"	NWT Mackenzie Delta Onshore	24-Dec-71	05-Apr-72		
773	IMP	Imperial	Territorial	MALLIK P-59	300P596930134300	Delineation	Plug and abandoned	69° 29' 1.7"	134° 43' 15.0"	NWT Mackenzie Delta Onshore	30-Dec-72	2-Mar-73	2633.3	
470	SUNCOR MARIE BAY D-02	Suncor	Territorial	MARIE BAY D-02	300D027630115300	Exploratory Well	Abandoned	76° 21' 3.6"	115° 33' 41.8"	NWT Arctic Islands Onshore	13-Aug-69	24-Sep-69		

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
1603	ESSO HOME ET AL MAYOGIAK G-12	Imperial	ILA	MAYOGIAK G-12	300G126930132450	Exploratory Well	Abandoned	69° 21' 17.0"	132° 48' 48.7"	NWT Mackenzie Delta Onshore	18-Feb-86	28-Mar-86		
631	ESSO MAYOGIAK J-17	Imperial	ILA	MAYOGIAK J-17	300J176930132450	Exploratory Well	Suspended	69° 26' 41.9"	132° 48' 22.2"	NWT Mackenzie Delta Onshore	03-Apr-71	06-Aug-71		
919	IMP MAYOGIAK L-39	Imperial	ILA	MAYOGIAK L-39	300L396930132450	Delineation Well	Abandoned	69° 28' 40.9"	132° 54' 39.9"	NWT Mackenzie Delta Onshore	10-Apr-74	30-Aug-74		
1152	ESSO MAYOGIAK M-16	Imperial	ILA	MAYOGIAK M-16	300M166930132450	Development Well	Abandoned	69° 25' 55.2"	132° 49' 39.8"	NWT Mackenzie Delta Onshore	24-Jan-80	10-Apr-80		
1599	ESSO HOME ET AL MAYOGIAK N-34	Imperial	ILA	MAYOGIAK N-34	300N346930132450	Exploratory Well	Abandoned	69° 23' 59.6"	132° 54' 13.3"	NWT Mackenzie Delta Onshore	14-Feb-86	06-Mar-86		
1197	CHEVRON MUSKOX D-87	Chevron	Territorial	MUSKOX D-87	300D877340117000	Exploratory Well	Abandoned	73° 36' 10.1"	117° 27' 9.5"	NWT Arctic Islands Onshore	30-Oct-81	27-Jan-82		
1132	DOME PANARCTIC N. DUNDAS N-82	BP	Territorial	N. DUNDAS N-82	300N827450113000	Exploratory Well	Abandoned	74° 41' 50.0"	113° 25' 50.0"	NWT Arctic Islands Onshore	11-Jun-79	11-Sep-79		
		Uncertain	Territorial	N2006A0029				69° 07' 26.5"	134° 54' 00.5"	NWT Mackenzie Delta Onshore				Identified by GNWT
686	ELF NANUK D-76	Husky	ILA	NANUK D-76	300D767310123000	Exploratory Well	Abandoned	73° 5' 14.7"	123° 23' 56.0"	NWT Arctic Islands Onshore	17-Jan-72	04-Mar-72		
1116	ESSO PEX NAPARTOK M-01	Imperial	Territorial	NAPARTOK M-01	300M016840134300	Exploratory Well	Abandoned	68° 30' 46.6"	134° 32' 27.3"	NWT Mackenzie Delta Onshore	11-Feb-79	16-Mar-79		
921	SHELL NAPOIAK F-31	Shell	Territorial	NAPOIAK F-31	300F316830134450	Exploratory Well	Abandoned	68° 20' 24.5"	134° 53' 58.2"	NWT Mackenzie Delta Onshore	12-Apr-74	17-May-74		
533	IOE NATAGNAK H-50	Imperial	Territorial	NATAGNAK H-50	300H506950131300	Exploratory Well	Abandoned	69° 49' 27.0"	131° 40' 20.9"	NWT Mackenzie Delta Onshore	30-Apr-70	01-Jun-70		
520	IOE NATAGNAK K-23	Imperial	Territorial	NATAGNAK K-23	300K236950131300	Exploratory Well	Abandoned	69° 42' 31.0"	131° 36' 53.8"	NWT Mackenzie Delta Onshore	13-Mar-70	13-Apr-70		
806	IMP CIGOL NATAGNAK K-53	Imperial	Territorial	NATAGNAK K-53	300K536950131300	Exploratory Well	Abandoned	69° 42' 39.0"	131° 44' 4.9"	NWT Mackenzie Delta Onshore	04-Mar-73	29-Mar-73		
1254	ESSO PEX HOME ET AL NATAGNAK O-59	Imperial	Territorial	NATAGNAK O-59	300O596950131300	Exploratory Well	Abandoned	69° 48' 56.4"	131° 43' 30.0"	NWT Mackenzie Delta Onshore	17-Dec-82	28-Jan-83		
211	TEXCAN C & E	Chevron	ILA	NICHOLSON G-56	300G567000128450	Exploratory	Plug and abandoned	69° 55' 28.9"	128° 58' 34.0"	NWT Mackenzie Delta Onshore	4-Sep-62	19-Sep-62	863.5	
212	TEXCAN C & E NICHOLSON N-45	Chevron	ILA	NICHOLSON N-45	300N457000128450	Exploratory Well	Abandoned	69° 54' 59.3"	128° 56' 28.5"	NWT Mainland	30-Oct-62	07-Nov-62		
1009	SHELL NIGLINTGAK B-19	Shell	Territorial	NIGLINTGAK B-19	300B196920135150	Delineation Well	Suspended	69° 18' 10.7"	135° 18' 29.0"	NWT Mackenzie Delta Onshore	18-Oct-75	22-Feb-76		
753	SHELL NIGLINTGAK H-30	Shell	Territorial	NIGLINTGAK H-30	300H306920135150	Exploratory Well	Suspended	69° 19' 20.9"	135° 20' 45.3"	NWT Mackenzie Delta Onshore	24-Oct-72	07-Apr-73		
933	SHELL NIGLINTGAK M-19	Shell	Territorial	NIGLINTGAK M-19	300M196920135150	Delineation Well	Suspended	69° 18' 48.7"	135° 19' 36.0"	NWT Mackenzie Delta Onshore	01-Jun-74	20-Jan-75		
2058	MGM ET AL NORTH ELLICE J-17	MGM Energy Corp.	Territorial	NORTH ELLICE J-17	300J176920135450	Exploratory Well	Suspended	69° 16' 30.4"	135° 48' 18.8"	NWT Mackenzie Delta Onshore	02-Feb-09	23-Feb-09		
1010	SOBC CAN SUP ET AL NORTH ELLICE J-23	Chevron	Territorial	NORTH ELLICE J-23	300J236920135450	Exploratory Well	Suspended	69° 12' 33.6"	135° 51' 23.9"	NWT Mackenzie Delta Onshore	22-Oct-75	15-Mar-76		
764	IMP	Imperial	Territorial	NUKTAK C-22	300C226950134450	Exploratory	Plug and abandoned	69° 41' 31.7"	134° 51' 50.0"	NWT Mackenzie Delta Onshore	16-Dec-72	8-Mar-73	3856.6	
1350	ESSO PCI HOME ET AL NUNA A-10	Imperial	ILA	NUNA A-10	300A106910133150	Exploratory Well	Abandoned	69° 9' 0.2"	133° 15' 14.1"	NWT Mackenzie Delta Onshore	21-Dec-83	04-Feb-84		
891	IMP NUNA A-32	Imperial	Territorial	NUNA A-32	300A326910133150	Exploratory Well	Abandoned	69° 1' 13.8"	133° 22' 43.8"	NWT Mackenzie Delta Onshore	28-Dec-73	18-Mar-74		
1611	ESSO HOME ET AL NUNA E-40	Imperial	Territorial	NUNA E-40 (D-40)	300E406910133150	Exploratory Well	Abandoned	69° 9' 15.6"	133° 24' 53.8"	NWT Mackenzie Delta Onshore	14-Mar-86	31-Mar-86		
1977	SUNCOR DEVON NUNA I-30	Suncor	ILA	NUNA I-30	300I306910133150	Exploratory Well	Suspended	69° 9' 34.3"	133° 20' 18.8"	NWT Mackenzie Delta Onshore	07-Feb-03	21-Apr-03		
519	IOE NUVORAK O-09	Imperial	Territorial	NUVORAK O-09	300O097000130300	Exploratory Well	Abandoned	69° 58' 55.2"	130° 31' 5.8"	NWT Mackenzie Delta Onshore	12-Mar-70	14-Apr-70		
981	GULF-MOBIL OGEOQEOQ J-06	ConocoPhillips	Territorial	OGEOQEOQ J-06	300J066850133450	Exploratory Well	Abandoned	68° 45' 41.7"	133° 46' 9.5"	NWT Mackenzie Delta Onshore	21-Feb-75	13-Mar-75		
1072	GULF MOBIL OGRUKNANG M-31	ConocoPhillips	ILA	OGRUKNANG M-31	300M316900134150	Exploratory Well	Abandoned	68° 50' 51.8"	134° 25' 0.1"	NWT Mackenzie Delta Onshore	18-Apr-77	01-Aug-77		
		Uncertain	Territorial	OH1 SUMP				69° 10' 22.5"	135° 58' 33.2"	NWT Mackenzie Delta Onshore				Identified by GNWT
536	GULF ONIGAT C-38	ConocoPhillips	Territorial	ONIGAT C-38	300C386850133300	Exploratory Well	Abandoned	68° 47' 9.7"	133° 39' 24.6"	NWT Mackenzie Delta Onshore	02-May-70	25-Jun-70		
1483	GULF ET AL ONIGAT D-52	ConocoPhillips	Territorial	ONIGAT D-52	300D526850133300	Exploratory Well	Abandoned	68° 41' 0.5"	133° 44' 33.4"	NWT Mackenzie Delta Onshore	23-Jan-85	12-Feb-85		
1592	GULF ET AL ONIGAT K-49	ConocoPhillips	Territorial	ONIGAT K-49	300K496850133300	Exploratory Well	Abandoned	68° 48' 40.0"	133° 41' 56.4"	NWT Mackenzie Delta Onshore	02-Feb-86	16-Feb-86		
775	DEMINEX CGDC FOC AMOCO ORKSUT I-44	Deminex	ILA	ORKSUT I-44	300I447230122300	Exploratory Well	Abandoned	72° 23' 46.3"	122° 42' 19.3"	NWT Arctic Islands Onshore	01-Jan-73	28-Mar-73		

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
1113	CHEVRON ET AL PARKER RIVER J-72	Chevron	Territorial	PARKER RIVER J-72	300J727340115300	Exploratory Well	Abandoned	73° 31' 44.2"	115° 52' 34.1"	NWT Arctic Islands Onshore	13-Jan-79	01-Jun-79		
992	GULF MOBIL PARSONS A-44	ConocoPhillips	Territorial	PARSONS A-44	300A446900133300	Delineation Well	Abandoned	68° 53' 4.8"	133° 40' 45.6"	NWT Mackenzie Delta Onshore	09-Apr-75	29-Jul-75		
1032	GULF MOBIL PARSONS D-20	ConocoPhillips	Territorial	PARSONS D-20	300D206900133300	Delineation Well	Other	68° 59' 9.1"	133° 34' 34.5"	NWT Mackenzie Delta Onshore	21-Apr-76	22-Nov-76		
1570	GULF ET AL PARSONS E-02	ConocoPhillips	Territorial	PARSONS E-02	300E026900133300	Exploratory Well	Abandoned	68° 51' 15.5"	133° 32' 19.9"	NWT Mackenzie Delta Onshore	21-Dec-85	23-Jan-86		
671	GULF MOBIL PARSONS F-09	ConocoPhillips	Territorial	PARSONS F-09	300F096900133300	Exploratory Well	Suspended	68° 58' 27.9"	133° 31' 55.3"	NWT Mackenzie Delta Onshore	20-Dec-71	19-Apr-72		
1057	GULF MOBIL PARSONS L-37	ConocoPhillips	Territorial	PARSONS L-37	300L376900133300	Delineation Well	Other	68° 56' 42.5"	133° 40' 4.4"	NWT Mackenzie Delta Onshore	26-Dec-76	02-Apr-77		
1016	GULF MOBIL PARSONS L-43	ConocoPhillips	Territorial	PARSONS L-43	300L436900133300	Delineation Well	Other	68° 52' 38.5"	133° 42' 5.8"	NWT Mackenzie Delta Onshore	10-Dec-75	04-Mar-76		
800	GULF MOBIL PARSONS N-10	ConocoPhillips	Territorial	PARSONS N-10	300N106900133300	Delineation Well	Other	68° 59' 48.3"	133° 31' 59.7"	NWT Mackenzie Delta Onshore	24-Feb-73	29-May-73		
1017	GULF MOBIL PARSONS N-17	ConocoPhillips	Territorial	PARSONS N-17	300N176900133300	Delineation Well	Other	68° 56' 52.8"	133° 34' 8.7"	NWT Mackenzie Delta Onshore	18-Dec-75	13-Apr-76		
917	GULF MOBIL PARSONS O-27	ConocoPhillips	Territorial	PARSONS O-27	300O276900133300	Delineation Well	Suspended	68° 56' 52.8"	133° 36' 5.7"	NWT Mackenzie Delta Onshore	23-Mar-74	30-Aug-74		
1058	GULF MOBIL PARSONS P-41	ConocoPhillips	Territorial	PARSONS P-41	300P416900133300	Exploratory Well	Other	68° 50' 50.6"	133° 40' 37.9"	NWT Mackenzie Delta Onshore	29-Dec-76	05-Apr-77		
889	GULF MOBIL PARSONS P-53	ConocoPhillips	Territorial	PARSONS P-53	300P536900133300	Exploratory Well	Abandoned	68° 52' 49.1"	133° 43' 6.9"	NWT Mackenzie Delta Onshore	22-Dec-73	09-Apr-74		
955	SUNCOR ET AL PEDDER POINT D-49	Suncor	Territorial	PEDDER POINT D-49	300D497540118300	Exploratory Well	Abandoned	75° 38' 11.3"	118° 48' 27.1"	NWT Arctic Islands Onshore	12-Oct-74	10-Nov-74		
666	IMP IOE PIKIOLIK E-54	Imperial	ILA	PIKIOLIK E-54	300E546930132300	Exploratory Well	Abandoned	69° 23' 14.9"	132° 44' 44.8"	NWT Mackenzie Delta Onshore	11-Dec-71	15-Feb-72	3118	
1274	ESSO PEX HOME ET AL PIKIOLIK G-21	Imperial	ILA	PIKIOLIK G-21	300G216930132300	Exploratory Well	Abandoned	69° 20' 23.3"	132° 35' 53.4"	NWT Mackenzie Delta Onshore	16-Feb-83	24-Mar-83	1429.6	
672	IMP IOE PIKIOLIK M-26	Imperial	ILA	PIKIOLIK M-26	300M266930132300	Exploratory Well	Suspended	69° 25' 54.9"	132° 37' 35.8"	NWT Mackenzie Delta Onshore	22-Dec-71	07-Feb-72	1984	
982	GULF MOBIL DOME RED FOX P-21	Uncertain	Territorial	RED FOX P-21	300P216920133300	Exploratory Well	Abandoned	69° 10' 47.9"	133° 35' 10.9"	NWT Mackenzie Delta Onshore	23-Feb-75	03-Jun-75		Ownership under review by ConocoPhillips.
888	GULF IMP SHELL REINDEER A-41	ConocoPhillips	ILA	REINDEER A-41	300A416910134300	Delineation Well	Abandoned	69° 0' 11.7"	134° 40' 28.7"	NWT Mackenzie Delta Onshore	22-Dec-73	07-Feb-74		
814	GULF IMP SHELL REINDEER C-36	Uncertain	ILA	REINDEER C-36 (F-36)	300C366910134300	Exploratory Well	Suspended	69° 5' 9.6"	134° 39' 24.7"	NWT Mackenzie Delta Onshore	13-Mar-73	05-Jun-73		Sold to Shell by ConocoPhillips. Shell would not confirm.
275	B.A. SHELL IOE REINDEER D-27	Uncertain	ILA	REINDEER D-27	300D276910134300	Exploratory Well	Abandoned	69° 6' 4.7"	134° 37' 3.7"	NWT Mackenzie Delta Onshore	08-Jul-65	05-Jan-66		Ownership under review by ConocoPhillips. Shell or ConocoPhillips.
770	PACIFIC IMP ET AL	Imperial	Y.T. ILA	ROLAND BAY Y.T. L-41	300L416930138450	Exploratory	Plug and abandoned	69° 20' 30.8"	138° 56' 55.0"	Yukon Onshore	22-Dec-72	20-Apr-73	2752.3	
906	IMP CIGOL RUSSELL H-23	Imperial	Territorial	RUSSELL H-23	300H237010130000	Exploratory Well	Abandoned	70° 2' 18.2"	130° 6' 37.9"	NWT Mackenzie Delta Onshore	17-Feb-74	01-Apr-74		
1011	SUNCOR ET AL SABINE BAY A-07	Suncor		SABINE BAY A-07	300A077530110000	Exploratory Well	Abandoned	75° 26' 8.5"	110° 0' 58.0"	NWT Arctic Islands Onshore	23-Oct-75	24-Feb-76		
1066	MOBIL GULF SADENE D-02	Uncertain	ILA	SADENE D-02	300D026900126450	Exploratory Well	Abandoned	68° 51' 1.6"	126° 47' 23.6"	NWT Mainland	08-Mar-77	06-May-77		Mobil operates as indicated by Conoco. IOL indicates they do not own this well.
462	SUNCOR SANDY POINT L-46	Suncor	Territorial	SANDY POINT L-46	300L467630115000	Exploratory Well	Abandoned	76° 25' 41.0"	115° 18' 24.7"	NWT Arctic Islands Onshore	09-May-69	02-Aug-69		
651	BP ET AL PANARCTIC SATELLITE F-68	Repsol Oil and Gas Canada Inc.	Territorial	SATELLITE F-68	300F687720116300	Exploratory Well	Abandoned	77° 17' 29.6"	116° 55' 21.7"	NWT Arctic Islands Onshore	17-Sep-71	02-May-72		
1493	GULF ET AL SHAKGATLATACHIG D-50	ConocoPhillips	ILA	SHAKGATLATACHIG D-50	300D506840133450	Exploratory Well	Abandoned	68° 39' 6.9"	133° 57' 17.7"	NWT Mackenzie Delta Onshore	21-Feb-85	22-Mar-85		
1777	SHELL SHAVILIG J-20	Shell	Territorial	SHAVILIG J-20	300J206910135150	Exploratory Well	Abandoned	69° 9' 38.1"	135° 18' 21.7"	NWT Mackenzie Delta Onshore	18-Feb-92	16-Mar-92		

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
523	GULF SHOLOKPAOQAK P-60	ConocoPhillips	Territorial	SHOLOKPAOQAK P-60	300P606840133300	Exploratory Well	Abandoned	68° 39' 44.7"	133° 43' 9.4"	NWT Mackenzie Delta Onshore	17-Mar-70	23-Apr-70		
1031	GULF MOBIL SIKU A-12	ConocoPhillips	Territorial	SIKU A-12	300A126910133300	Delineation Well	Other	69° 1' 0.1"	133° 32' 41.3"	NWT Mackenzie Delta Onshore	14-Apr-76	26-Jul-76		
1019	GULF MOBIL SIKU C-11	ConocoPhillips	Territorial	SIKU C-11	300C116910133300	Delineation Well	Other	69° 0' 4.7"	133° 33' 59.7"	NWT Mackenzie Delta Onshore	26-Dec-75	22-Mar-76		
730	GULF MOBIL SIKU C-55	ConocoPhillips	Territorial	SIKU C-55	300C556910133300	Exploratory Well	Abandoned	69° 4' 3.8"	133° 44' 7.7"	NWT Mackenzie Delta Onshore	02-May-72	08-Nov-72		
1071	GULF MOBIL SIKU E-21	ConocoPhillips	Territorial	SIKU E-21	300E216910133300	Delineation Well	Other	69° 0' 29.1"	133° 37' 4.7"	NWT Mackenzie Delta Onshore	17-Apr-77	21-Jun-77		
943	SUNCOR SMOKING HILLS A-23	Uncertain	ILA	SMOKING HILLS A-23	300A236930126150	Exploratory Well	Abandoned	69° 22' 6.7"	126° 20' 39.0"	NWT Mainland	04-Aug-74	22-Aug-74		BP or Suncor
585	IOE	Imperial	Y.T. ILA	SPRING RIVER YT N-58	300N586910138300	Exploratory	Plug and abandoned	69° 7' 53.0"	138° 44' 4.9"	Yukon Onshore	7-Jan-71	18-Mar-71	2136.3	
654	ELF ET AL STORKERSON BAY A-15	Husky	ILA	STORKERSON BAY A-15	300A157300124300	Exploratory Well	Abandoned	72° 54' 1.6"	124° 33' 40.1"	NWT Arctic Islands Onshore	23-Oct-71	10-Dec-71		
727	IOE TAGLU C-42	Imperial	Territorial	TAGLU C-42	300C426930134450	Delineation Well	Suspended	69° 21' 4.7"	134° 57' 0.0"	NWT Mackenzie Delta Onshore	30-Apr-72	18-Nov-72	4895	
819	IOE TAGLU D-43	Imperial	Territorial	TAGLU D-43	300D436930134450	Delineation Well	Suspended	69° 22' 13.6"	134° 57' 10.4"	NWT Mackenzie Delta Onshore	23-Mar-73	11-Sep-73	4555	
715	IOE TAGLU D-55	Imperial	Territorial	TAGLU D-55	300D556930134450	Exploratory Well	Abandoned	69° 24' 13.7"	134° 59' 44.0"	NWT Mackenzie Delta Onshore	06-Apr-72	21-Aug-72		
622	ESSO TAGLU G-33	Imperial	Territorial	TAGLU G-33	300G336930134450	Exploratory Well	Suspended	69° 22' 17.7"	134° 53' 46.7"	NWT Mackenzie Delta Onshore	13-Apr-71	18-Aug-71	2994	
1054	IOE TAGLU H-54	Imperial	Territorial	TAGLU H-54	300H546930134450	Delineation Well	Suspended	69° 23' 19.8"	134° 58' 16.0"	NWT Mackenzie Delta Onshore	02-Dec-76	11-Jan-77		
1955	IMPERIAL OIL TAGLU N-43	Imperial	Territorial	TAGLU N-43	300N436930134450	Other	Other	69° 22' 44.9"	134° 56' 30.1"	NWT Mackenzie Delta Onshore	09-Apr-77	13-Apr-77		
1501	ESSO HOME ET AL TAGLU WEST H-06	Imperial	Territorial	TAGLU WEST H-06	300H066930135000	Exploratory Well	Abandoned	69° 25' 24.2"	135° 0' 39.6"	NWT Mackenzie Delta Onshore	26-Mar-85	05-Sep-85		
667	ESSO TAGLU WEST P-03	Imperial	Territorial	TAGLU WEST P-03	300P036930135000	Delineation Well	Suspended	69° 22' 54.7"	135° 0' 34.0"	NWT Mackenzie Delta Onshore	12-Dec-71	29-Mar-72	3310	
893	ELF TEXACO TIRITCHIK M-48	Husky	Territorial	TIRITCHIK M-48	300M487250120300	Exploratory Well	Abandoned	72° 47' 52.8"	120° 44' 58.0"	NWT Arctic Islands Onshore	31-Dec-73	06-Apr-74		
751	GULF IMP SHELL TITALIK K-26	Uncertain	Territorial	TITALIK K-26	300K266910135000	Exploratory Well	Abandoned	69° 5' 29.7"	135° 6' 24.8"	NWT Mackenzie Delta Onshore	17-Oct-72	20-Feb-73		Sold to Shell by ConocoPhillips. Shell would not confirm. Previously considered to be owned by Shell.
995	SHELL GULF IMP TITALIK O-15	Uncertain	Territorial	TITALIK O-15	300O156910135000	Delineation Well	Suspended	69° 4' 57.7"	135° 3' 21.7"	NWT Mackenzie Delta Onshore	27-Apr-75	16-Aug-75		Shell operates as indicated by Conoco. Thought to be 50% Shell, 50% Gulf. Shell confirmed ownership in 2004 ESRF.
923	GULF MOBIL TOAPOLOK H-24	ConocoPhillips	Territorial	TOAPOLOK H-24	300H246920134450	Delineation Well	Abandoned	69° 13' 17.7"	134° 50' 34.9"	NWT Mackenzie Delta Onshore	21-Apr-74	15-Jun-74		
882	GULF MOBIL TOAPOLOK O-54	ConocoPhillips	Territorial	TOAPOLOK O-54	300O546920134450	Exploratory Well	Abandoned	69° 13' 57.2"	134° 58' 40.8"	NWT Mackenzie Delta Onshore	27-Nov-73	01-Apr-74		
1941	DEVON PC TUK B-02	Canadian Natural Resources	ILA	TUK B-02	300B026930133000	Exploratory Well	Suspended	69° 21' 11.2"	133° 1' 7.5"	NWT Mackenzie Delta Onshore	17-Feb-02	31-Mar-02		
1563	ESSO PCI HOME ET AL TUK B-40	Imperial	ILA	TUK B-40	300B406920133000	Delineation Well	Suspended	69° 19' 13.6"	133° 8' 29.7"	NWT Mackenzie Delta Onshore	08-Dec-85	09-Jan-86		
1763	ESSO PCI HOME ET AL TUK E-20	Imperial	ILA	TUK E-20	300E206920133000	Exploratory Well	Abandoned	69° 19' 18.6"	133° 5' 9.8"	NWT Mackenzie Delta Onshore	25-Jan-91	08-Apr-91		
419	IOE TUK F-18	Imperial	ILA	TUK F-18	300F186920133000	Exploratory Well	Abandoned	69° 17' 28.9"	133° 4' 10.9"	NWT Mackenzie Delta Onshore	29-Dec-68	27-Apr-69		
1562	ESSO PCI HOME ET AL TUK G-39	Imperial	ILA	TUK G-39	300G396920133000	Delineation Well	Suspended	69° 18' 22.9"	133° 8' 52.8"	NWT Mackenzie Delta Onshore	05-Dec-85	06-Jan-86		
1581	ESSO PCI HOME ET AL TUK G-48	Imperial	ILA	TUK G-48	300G486920133000	Delineation Well	Suspended	69° 17' 23.1"	133° 11' 12.0"	NWT Mackenzie Delta Onshore	14-Jan-86	10-Feb-86		
1508	ESSO PCI HOME ET AL TUK H-30	Imperial	ILA	TUK H-30	300H306920133000	Delineation Well	Suspended	69° 19' 20.6"	133° 5' 23.7"	NWT Mackenzie Delta Onshore	21-Apr-85	06-May-85		
1474	ESSO HOME PCI ET AL TUK J-29	Imperial	ILA	TUK J-29	300J296920133000	Exploratory Well	Abandoned	69° 18' 41.3"	133° 6' 0.2"	NWT Mackenzie Delta Onshore	10-Jan-85	20-Apr-85		

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
1342	ESSO PCI HOME ET AL TUK L-09	Imperial	ILA	TUK L-09	300L096920133000	Exploratory Well	Abandoned	69° 18' 44.5"	133° 2' 22.8"	NWT Mackenzie Delta Onshore	18-Nov-83	06-Mar-84		
1933	DEVON PC TUK M-18	Canadian Natural Resources	ILA	TUK M-18	300M186920133000	Delineation Well	Suspended	69° 17' 50.5"	133° 4' 44.5"	NWT Mackenzie Delta Onshore	24-Dec-01	04-Feb-02		
566	IOE TUKTU O-19	Imperial	ILA	TUKTU O-19	300O196920132450	Exploratory Well	Abandoned	69° 18' 54.9"	132° 48' 26.8"	NWT Mackenzie Delta Onshore	07-Dec-70	06-Feb-71		
1561	ESSO PCI HOME ET AL TUKTUK A-12	Imperial	ILA	TUKTUK A-12	300A126930133000	Delineation Well	Abandoned	69° 21' 1.3"	133° 3' 8.5"	NWT Mackenzie Delta Onshore	02-Dec-85	12-Feb-86		
1594	ESSO PCI HOME ET AL TUKTUK D-11	Imperial	ILA	TUKTUK D-11	300D116930133000	Delineation Well	Suspended	69° 20' 11.5"	133° 4' 50.4"	NWT Mackenzie Delta Onshore	07-Feb-86	02-Mar-86		
1576	ESSO PCI HOME ET AL TUKTUK H-22	Imperial	ILA	TUKTUK H-22	300H226930133000	Delineation Well	Suspended	69° 21' 21.9"	133° 5' 11.9"	NWT Mackenzie Delta Onshore	11-Jan-86	05-Feb-86		
1050	SHELL TULLUGAK K-31	Shell	Territorial	TULLUGAK K-31	300K316900135000	Exploratory Well	Abandoned	68° 50' 29.6"	135° 9' 31.2"	NWT Mackenzie Delta Onshore	18-Oct-76	05-Jan-77		
1029	GULF IMP SHELL TUNUNUK F-30	ConocoPhillips	ILA	TUNUNUK F-30	300F306900134300	Exploratory Well	Abandoned	68° 59' 21.7"	134° 36' 52.7"	NWT Mackenzie Delta Onshore	05-Apr-76	06-Jul-76		
405	IOE BA SHELL TUNUNUK K-10	Imperial	ILA	TUNUNUK K-10	300K106900134450	Exploratory Well	Abandoned	68° 59' 43.7"	134° 46' 43.6"	NWT Mackenzie Delta Onshore	13-Aug-68	29-Jun-69		
1025	SHELL ULU A-35	Shell	ILA	ULU A-35	300A356850135450	Exploratory Well	Suspended	68° 44' 1.5"	135° 53' 6.4"	NWT Mackenzie Delta Onshore	15-Mar-76	22-Sep-76		
766	IMP UMIAK J-37	Imperial	Territorial	UMIAK J-37	300J376930134150	Exploratory Well	Abandoned	69° 26' 35.9"	134° 23' 18.1"	NWT Mackenzie Delta Onshore	17-Dec-72	01-Mar-73		
2018	MGM COP UMIAK N-05	MGM Energy Corp.	Territorial	UMIAK N-05	300N056930134150	Exploratory Well	Suspended	69° 24' 56.5"	134° 16' 30.1"	NWT Mackenzie Delta Onshore	18-Jan-05	23-Apr-05		
1070	IMP. IOE UMIAK N-10	Imperial	Territorial	UMIAK N-10	300N106930134150	Exploratory Well	Abandoned	69° 29' 49.9"	134° 16' 35.1"	NWT Mackenzie Delta Onshore	13-Apr-77	02-Oct-77		
2000	MGM COP UMIAK N-16	MGM Energy Corp.		UMIAK N-16	300N166930134150	Exploratory Well	Suspended	69° 25' 53.0"	134° 19' 5.6"	NWT Mackenzie Delta Onshore	18-Feb-04	23-Apr-04		
713	ELF UMINMAK H-07	Husky	Territorial	UMINMAK H-07	300H077340123000	Exploratory Well	Abandoned	73° 36' 30.8"	123° 0' 41.3"	NWT Arctic Islands Onshore	01-Apr-72	07-May-72		
876	SHELL	Shell	Territorial	UNAK B-11	300B116850135150	Exploratory	Plug and abandoned	68° 66' 69.1"	135° 31' 57.2"	NWT Mackenzie Delta Onshore	7-Nov-73	17-Mar-74	3345.2	
1623	SHELL ET AL UNAK L-28	Shell	Territorial	UNAK L-28	300L286850135150	Exploratory Well	Abandoned	68° 47' 38.0"	135° 22' 15.7"	NWT Mackenzie Delta Onshore	11-Aug-86	13-Dec-86		
1776	SHELL UNIPKAT B-12	Shell	Territorial	UNIPKAT B-12	300B126920135150	Delineation Well	Suspended	69° 11' 0.5"	135° 18' 34.8"	NWT Mackenzie Delta Onshore	08-Jan-92	10-Feb-92		
742	SHELL UNIPKAT I-22	Shell	Territorial	UNIPKAT I-22	300I226920135150	Exploratory Well	Suspended	69° 11' 37.1"	135° 20' 37.3"	NWT Mackenzie Delta Onshore	08-Sep-72	06-Mar-73		
2044	MGM ET AL UNIPKAT M-45	MGM Energy Corp.	Territorial	UNIPKAT M-45	300M456920135150	Exploratory Well	Abandoned	69° 14' 55.5"	135° 27' 30.6"	NWT Mackenzie Delta Onshore	14-Mar-07	22-Mar-07		
1749	SHELL UNIPKAT N-12	Shell	Territorial	UNIPKAT N-12	300N126920135150	Exploratory Well	Suspended	69° 11' 54.5"	135° 19' 17.5"	NWT Mackenzie Delta Onshore	06-Feb-90	04-Apr-90		
1059	CCL UPLUK A-42	Chevron	Territorial	UPLUK A-42	300A426930135150	Exploratory Well	Abandoned	69° 21' 10.7"	135° 25' 44.0"	NWT Mackenzie Delta Onshore	15-Jan-77	02-Apr-77		
797	CHEVRON SOBC UPLUK C-21	Chevron	Territorial	UPLUK C-21	300C216930135150	Exploratory Well	Abandoned	69° 20' 5.7"	135° 21' 35.0"	NWT Mackenzie Delta Onshore	16-Feb-73	19-May-73		
1500	CHEVRON TRILLIUM UPLUK L-42	Chevron	Territorial	UPLUK L-42	300L426930135150	Exploratory Well	Abandoned	69° 21' 37.5"	135° 27' 39.4"	NWT Mackenzie Delta Onshore	22-Mar-85	20-Jul-85		
977	CHEVRON SOBC UPLUK M-38	Chevron	Territorial	UPLUK M-38	300M386930135150	Exploratory Well	Abandoned	69° 46' 55.55"	135° 41' 5"	NWT Mackenzie Delta Onshore	6-Feb-75	4-Mar-75	3764.3	
974	MURPHY ET AL VICTORIA ISLAND F-36	Murphy Oil Company Ltd.	Territorial	VICTORIA ISLAND F-36	300F367250117000	Exploratory Well	Abandoned	72° 45' 19.9"	117° 11' 22.0"	NWT Arctic Islands Onshore	28-Jan-75	27-Apr-75		
1033	PANARCTIC TENN ET AL	Suncor	ILA	W. HECLA C-05	300C057630110300	Delineation	Plug and abandoned	76° 24' 9.0"	110° 31' 54.8"	NWT Arctic Islands Onshore	28-Apr-76	16-May-76	1237.5	
1030	IMP DELTA 5 WAGNARK C-23	Imperial	ILA	WAGNARK C-23	300C236920133150	Exploratory Well	Abandoned	69° 12' 0.9"	133° 21' 54.9"	NWT Mackenzie Delta Onshore	07-Apr-76	05-Oct-76		
833	IMP WAGNARK G-12	Imperial	ILA	WAGNARK G-12	300G126920133150	Exploratory Well	Abandoned	69° 11' 20.9"	133° 18' 23.8"	NWT Mackenzie Delta Onshore	18-Apr-73	05-Aug-73		
1609	ESSO HOME ET AL WAGNARK L-36	Imperial	ILA	WAGNARK L-36	300L366920133150	Exploratory Well	Abandoned	69° 15' 43.4"	133° 25' 3.8"	NWT Mackenzie Delta Onshore	08-Mar-86	25-Apr-86		
990	ELFEX ET AL WILKIE POINT J-51	Husky	Territorial	WILKIE POINT J-51	300J517640117000	Exploratory Well	Abandoned	76° 30' 33.5"	117° 19' 59.3"	NWT Arctic Islands Onshore	17-Mar-75	21-May-75		
554	ELF WILKINS E-60	Husky	Territorial	WILKINS E-60	300E607800111000	Exploratory Well	Abandoned	77° 59' 22.2"	111° 21' 55.6"	NWT Arctic Islands Onshore	11-Oct-70	20-Jan-71		
201	DOME ET AL WINTER HARBOUR NO.1(A-09)	BP	Territorial	WINTER HARBOUR NO.1(A-09)	300A097450110300	Exploratory Well	Abandoned	74° 48' 8.5"	110° 30' 45.1"	NWT Arctic Islands Onshore	10-Sep-61	07-Apr-62		
904	UNION WOLVERINE H-34	Chevron	Territorial	WOLVERINE H-34	300H346830130300	Exploratory Well	Abandoned	68° 23' 19.1"	130° 38' 8.9"	NWT Mainland	05-Feb-74	02-Apr-74		
909	GULF MOBIL YA-YA A-28	Uncertain	Territorial	YA-YA A-28	300A286920134300	Delineation Well	Suspended	69° 17' 10.8"	134° 35' 37.0"	NWT Mackenzie Delta Onshore	28-Feb-74	06-Jul-74		Sold to Shell by ConocoPhillips.

WID	Consortium	Current Owner	Land Owner	Well Name	UWI	Class	Status	Latitude (NAD83) - Well Post	Longitude (NAD83) - Well Post	Region	Original Spud Date	Original Rig Release Date	Depth (m)	Notes
														Shell would not confirm.
959	GULF MOBIL YA-YA I-17	Uncertain	Territorial	YA-YA I-17	300I176920134300	Delineation Well	Abandoned	69° 16' 34.8"	134° 32' 59.0"	NWT Mackenzie Delta Onshore	22-Nov-74	11-Jan-75		Sold to Shell by ConocoPhillips. Shell would not confirm.
958	GULF MOBIL YA-YA M-33	ConocoPhillips	Territorial	YA-YA M-33	300M336920134300	Delineation Well	Abandoned	69° 12' 56.7"	134° 39' 53.9"	NWT Mackenzie Delta Onshore	22-Nov-74	13-Feb-75		
760	GULF MOBIL YA-YA P-53	Uncertain	Territorial	YA-YA P-53	300P536920134300	Exploratory Well	Suspended	69° 12' 45.5"	134° 42' 59.7"	NWT Mackenzie Delta Onshore	08-Dec-72	20-Mar-73		Sold to Shell by ConocoPhillips. Shell would not confirm.
841	SUNCOR TENNECO ET AL ZEUS F-11	Suncor	Territorial	ZEUS F-11	300F117600113300	Exploratory Well	Abandoned	75° 50' 25.1"	113° 36' 34.0"	NWT Arctic Islands Onshore	02-May-73	27-May-73		

Table B-2: Wells in the Inuvialuit Settlement Region and the presence or absence within associated registries and databases.

Well Name	ESRF 2004 Study (Yes/No)	NWT Centre for Geomatics (2009) (Yes/No)	GNWT Database (Yes/No)	CER (Yes/No)	CIRNAC (Yes/No)	IWB Library (Yes/No)	IWB Registry (Yes/No)	ILA (Yes/No)	EISC Registry (Yes/No)	ESRF Website (Yes/No)	ARI Registry (Yes/No)	ASTIS (Yes/No)	ISR Database (Yes/No)	NWT Discovery Portal	Research Study (Yes/No)	Proponent
AKKU F-14	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
AKLAVIK A-37	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
AMAGUK H-16	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
AMAROK N-44	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ANDREASEN L-32	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
APOLLO C-73	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
APUT D-43	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No
ATERTAK E-41	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ATERTAK K-31	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ATIGI G-04	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
ATIGI O-48	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No
ATIK P-19	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No
ATKINSON A-55	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ATKINSON H-25	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ATKINSON M-33	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
BAR HARBOUR E-76	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
BEAVER HOUSE CREEK H-13	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
BLOW RIVER YT E-47	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
BROCK C-50	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
BROCK I-20	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
BURNT LK	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
CAPE NOREM A-80	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
CASTEL BAY C-68	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
CROSSLEY LK S K-60	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
DEPOT ISLAND C-44	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
DUNDAS C-80	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
DYER BAY L-49	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
E. HECLA C-32	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
E. HECLA F-62	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
EGLINTON P-24	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ELLICE I-48	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
ELLICE J-27	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ELLICE O-14	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
EMERALD K-33	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ESKIMO J-07	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
FISH RIVER B-60	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
GARRY G-07	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
GARRY P-04	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
HANSEN G-07	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
HEARNE F-85	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
HECLA I-69	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
HECLA J-60	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
HORTON RIVER G-02	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
IKHIL A-01	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
IKHIL I-37	Yes	No	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
IKHIL J-35	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No
IKHIL K-35	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
IKHIL N-26	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No
IKHIL UGFI 02/J-35	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
IKKARIKTOK M-64	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
IMNAK J-29	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
INTREPID INLET H-49	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
IOL DRILL SUMP	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No

Well Name	ESRF 2004 Study (Yes/No)	NWT Centre for Geomatics (2009) (Yes/No)	GNWT Database (Yes/No)	CER (Yes/No)	CIRNAC (Yes/No)	IWB Library (Yes/No)	IWB Registry (Yes/No)	ILA (Yes/No)	EISC Registry (Yes/No)	ESRF Website (Yes/No)	ARI Registry (Yes/No)	ASTIS (Yes/No)	ISR Database (Yes/No)	NWT Discovery Portal	Research Study (Yes/No)	Proponent
ITIGINKPAK F-29 (N2002A0039)	Yes	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No
ITKRILEK B-52	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
IVIK C-52	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
IVIK J-26	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	Imperial
IVIK K-54	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
IVIK N-17	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
JAMESON BAY C-31	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KAMIK D-48	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KAMIK D-58	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KAMIK F-38	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KAMIK L-60	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KANGUK F-42	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KANGUK I-24	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KAPIK J-39	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KIKORALOK N-46	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
KILAGMIOTAK F-48	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
KILAGMIOTAK M-16	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
KILIGVAK I-29	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KIMIK D-29	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KIPNIK O-20	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KITSON R. C-71	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KUGALUK N-02	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
KUGPIK L-24	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KUGPIK L-46	Yes	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No
KUGPIK O-13	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KUMAK A-29 (I-29)(N2006A0029)	No	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KUMAK C-58	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KUMAK E-58	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KUMAK I-25	No	No	Yes	No	No	Yes	Yes	No	No	No	Yes	No	No	No	No	No
KUMAK J-06	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KUMAK K-16	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
KURK M-15 (N2000A0050)	Yes	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	Yes	No
KURK M-39	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
KUSRHAAK D-16	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
LANGLEY E-07	No	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No
LANGLEY E-29	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
LANGLEY K-30	Yes	No	Yes	No	No	Yes	Yes	No	Yes	No	Yes	No	No	No	No	No
LOUTH K-45	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
MAGAK A-32	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MALLIK 2L-38	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
MALLIK 3L-38	Yes	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No
MALLIK 4L-38	Yes	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No
MALLIK 5L-38	Yes	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No	No	No
MALLIK 6L-38	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MALLIK A-06	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MALLIK J-37	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
MALLIK L-38	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
MALLIK P-59	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
MARIE BAY D-02	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MAYOGIAK G-12	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MAYOGIAK J-17	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MAYOGIAK L-39	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MAYOGIAK M-16	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MAYOGIAK N-34	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
MUSKOX D-87	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No

Well Name	ESRF 2004 Study (Yes/No)	NWT Centre for Geomatics (2009) (Yes/No)	GNWT Database (Yes/No)	CER (Yes/No)	CIRNAC (Yes/No)	IWB Library (Yes/No)	IWB Registry (Yes/No)	ILA (Yes/No)	EISC Registry (Yes/No)	ESRF Website (Yes/No)	ARI Registry (Yes/No)	ASTIS (Yes/No)	ISR Database (Yes/No)	NWT Discovery Portal	Research Study (Yes/No)	Proponent
N. DUNDAS N-82	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
N2006A0029	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NANUK D-76	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NAPARTOK M-01	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
NAPOIAK F-31	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
NATAGNAK H-50	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NATAGNAK K-23	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NATAGNAK K-53	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NATAGNAK O-59	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NICHOLSON G-56	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NICHOLSON N-45	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NIGLINTGAK B-19	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
NIGLINTGAK H-30	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
NIGLINTGAK M-19	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
NORTH ELLICE J-17	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NORTH ELLICE J-23	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NUKTAK C-22	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
NUNA A-10	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NUNA A-32	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NUNA E-40 (D-40)	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
NUNA I-30	Yes	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No
NUVORAK O-09	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
OGEOQEOQ J-06	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
OGRUKNANG M-31	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
OH1 SUMP	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ONIGAT C-38	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
ONIGAT D-52	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
ONIGAT K-49	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
ORKSUT I-44	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARKER RIVER J-72	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
PARSONS A-44	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS D-20	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS E-02	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS F-09	Yes	Yes	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	ConocoPhillips
PARSONS L-37	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS L-43	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS N-10	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS N-17	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS O-27	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS P-41	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PARSONS P-53	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PEDDER POINT D-49	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PIKIOLIK E-54	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PIKIOLIK G-21	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
PIKIOLIK M-26	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
RED FOX P-21	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
REINDEER A-41	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
REINDEER C-36 (F-36)	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
REINDEER D-27	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
ROLAND BAY Y.T. L-41	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
RUSSELL H-23	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SABINE BAY A-07	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SADENE D-02	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SANDY POINT L-46	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SATELLITE F-68	Yes	No	Yes	No	No	No	Yes	No	Yes	No	Yes	No	No	No	No	No

Well Name	ESRF 2004 Study (Yes/No)	NWT Centre for Geomatics (2009) (Yes/No)	GNWT Database (Yes/No)	CER (Yes/No)	CIRNAC (Yes/No)	IWB Library (Yes/No)	IWB Registry (Yes/No)	ILA (Yes/No)	EISC Registry (Yes/No)	ESRF Website (Yes/No)	ARI Registry (Yes/No)	ASTIS (Yes/No)	ISR Database (Yes/No)	NWT Discovery Portal	Research Study (Yes/No)	Proponent
SHAKGATLATACHIG D-50	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
SHAVILIG J-20	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
SHOLOKPAOQAK P-60	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
SIKU A-12	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SIKU C-11	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SIKU C-55	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	Yes	No
SIKU E-21	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SMOKING HILLS A-23	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
SPRING RIVER YT N-58	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
STORKERSON BAY A-15	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TAGLU C-42	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	Imperial
TAGLU D-43	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	Imperial
TAGLU D-55	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Imperial
TAGLU G-33	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	Imperial
TAGLU H-54	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	Imperial
TAGLU N-43	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TAGLU WEST H-06	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Imperial
TAGLU WEST P-03	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Imperial
TIRITCHIK M-48	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TITALIK K-26	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
TITALIK O-15	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
TOAPOLOK H-24	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
TOAPOLOK O-54	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK B-02	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No
TUK B-40	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK E-20	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK F-18	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK G-39	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK G-48	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK H-30	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK J-29	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUK L-09	No	Yes	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
TUK M-18	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No
TUKTU O-19	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUKTUK A-12	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUKTUK D-11	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TUKTUK H-22	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
TULLUGAK K-31	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
TUNUNUK F-30	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
TUNUNUK K-10	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No	No
ULU A-35	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
UMIAK J-37	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
UMIAK N-05	No	No	Yes	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No
UMIAK N-10	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
UMIAK N-16	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No	No	No	No
UMINMAK H-07	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
UNAK B-11	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
UNAK L-28	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
UNIPKAT B-12	Yes	Yes	Yes	No	No	No	No	No	Yes	No	Yes	No	No	No	No	No
UNIPKAT I-22	Yes	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	No	No	No	No	No
UNIPKAT M-45	No	No	Yes	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No
UNIPKAT N-12	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
UPLUK A-42	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
UPLUK C-21	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
UPLUK L-42	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No

Well Name	ESRF 2004 Study (Yes/No)	NWT Centre for Geomatics (2009) (Yes/No)	GNWT Database (Yes/No)	CER (Yes/No)	CIRNAC (Yes/No)	IWB Library (Yes/No)	IWB Registry (Yes/No)	ILA (Yes/No)	EISC Registry (Yes/No)	ESRF Website (Yes/No)	ARI Registry (Yes/No)	ASTIS (Yes/No)	ISR Database (Yes/No)	NWT Discovery Portal	Research Study (Yes/No)	Proponent
UPLUK M-38	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No	No
VICTORIA ISLAND F-36	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
W. HECLA C-05	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WAGNARK C-23	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WAGNARK G-12	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WAGNARK L-36	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WILKIE POINT J-51	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WILKINS E-60	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WINTER HARBOUR NO.1(A-09)	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
WOLVERINE H-34	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
YA-YA A-28	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
YA-YA I-17	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
YA-YA M-33	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
YA-YA P-53	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No
ZEUS F-11	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No

Table B-3: Documentation containing relative information on wells and sumps.

Document Type	Source	Document Title	Year	Relevant Wells
2004 ESRF Study	ESRF	Inuvialuit Settlement Region Drilling Waste Disposal Sumps Study	2005	Reindeer D-27 Siku C-55 Ya-Ya P-53 Atigi O-48 Toapolok H-24 Ya-Ya M-33 Kikoralok N-46 Tununuk F-30 Ogruknang M-31 Kurk M-15
Annual Report	IWB Registry	IWB Water Licence N5L8-1837 2018 Annual Report	2019	Satellite F-68
Annual Report	IWB Registry	IWB Water Licence N5L8-1837 2017 Annual Report	2018	Satellite F-68
Annual Report	IWB Registry	Annual Water Report 2013 for MGM Energy Corp. Burnt Lake (Umiak N-16) Drilling Program	2014	Umiak N-16
Annual Report	IWB Registry	Water Licence N7L1-1815, Annual Water Report 2013, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program (M-45 & I-25): 2006-2008	2014	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	Water Licence N7L1-1815, Annual Water Report 2012, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program (M-45 & I-25): 2006-2008	2013	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	Water Licence N7L1-1815, Annual Water Report 2011, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program (M-45 & I-25): 2006-2008	2012	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	Water Licence N7L1-1815, Annual Water Report 2010, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program: 2006-2008	2011	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	Water Licence N7L1-1815, Annual Water Report 2009, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program: 2006-2008	2010	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	Water Licence N7L1-1815, Annual Water Report 2008, MGM Energy Corp Taktuk, Langley, Farewell Drilling Program	2009	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	2007 Annual Report, Type B Water Licence N7L1-1815, Chevron 2006-2007 Taktuk, Langley and Farewell Drilling Program	2008	Unipkat M-45 Kumak I-25
Annual Report	IWB Registry	2001 Annual Report Kurk M15	2002	Kurk M-15
CER Well List	CER	2019 CER ISR Well List	2019	206 Well Sites
Closure and Reclamation Plan	EISC and IWB Registry	Proposed Unipkat I-22 Sump Remediation Project Description	2010	Unipkat I-22
Closure and Reclamation Plan	IWB Registry	IWB Water Licence N5L8-1837 Reclamation, Closure and Monitoring Plan	2017	Satellite F-68
Closure and Reclamation Plan	IWB Registry	Proposed Interim Closure and Reclamation Plan for Kurk M15, Water Licence N7L1-1759	2014	Kurk M-15
Closure and Reclamation Plan	IWB Registry	Itginkpak F-29 Sump Remediation Plan	2006	Itiginpak F-29
Closure and Reclamation Plan	IWB Registry	Abandonment and Restoration Plan for Water Use Permit N3L-1710	1998	Ikhil J-35 Ikhil N-26
Environmental Site Monitoring Report	EISC	MGM Energy - 2018 Environmental Site Monitoring Report, Site: Langley L-30 Wellsite and Sump	2019	Langley K-30
Environmental Site Monitoring Report	EISC	Unipkat I-22 2016 Site Maintenance and Monitoring Program	2016	Unipkat I-22
Environmental Site Monitoring Report	IWB Library	MGM Energy - 2017 Environmental Site Monitoring Report, Site: Langley L-30 Wellsite and Sump	2017	Langley K-30
Environmental Site Monitoring Report	IWB Library	MGM Energy - 2017 Environmental Site Monitoring Report, Site: Unipkat M-45/Kumak I-25 Wellsite and Sump	2017	Unipkat M-45 Kumak I-25
Environmental Site Monitoring Report	IWB Library	MGM Energy - 2016 Environmental Site Monitoring Report, Site: Langley L-30 Wellsite and Sump	2016	Langley K-30
Environmental Site Monitoring Report	IWB Registry	MGM Energy - 2018 Environmental Site Monitoring Report, Site: Unipkat M-45/Kumak I-25 Wellsite and Sump	2019	Unipkat M-45 Kumak I-25
Environmental Site Monitoring Report	IWB Registry	MGM Energy - 2015 Environmental Site Monitoring Report, Site: Umiak N-05 Wellsite and Sump	2016	Umiak N-05
Environmental Site Monitoring Report	IWB Registry	MGM Energy - 2016 Environmental Site Monitoring Report, Site: Umiak N-05 Wellsite and Sump	2016	Umiak N-05
Environmental Site Monitoring Report	IWB Registry	MGM Energy Corporation - 2015 Environmental Site Monitoring Report, Site Umiak N-16 Sump	2016	Umiak N-16
Environmental Site Monitoring Report	IWB Registry	MGM Energy - 2016 Environmental Site Monitoring Report, Site: Unipkat M-45/Kumak I-25 Wellsite and Sump	2016	Unipkat M-45 Kumak I-25
Letter	IWB Library	N7LI-1787 Chevron Canada Limited - Langley K-30 Drilling Sump	2018	Langley K-30
Letter	IWB Registry	Ikhil Development - Class B Water Permit	1997	Ikhil J-35 Ikhil N-26
Letter	IWB Registry	Ikhil Development - Class B Water Permit	1998	Ikhil J-35 Ikhil N-26
Letter	IWB Registry	MGM Energy Corp. Water Licence - Terms and Conditions, Water Register: N7L1-1822 (Ellice, Langley, and Olivier Drilling)	2007	Aput D-48 Atik P-19 Langley E-07

Document Type	Source	Document Title	Year	Relevant Wells
Project Description	EISC	Langley K-30, Langley E-07 and Kumak I-25 Well Abandonement Program	2019	Langley K-30 Langley E-07 Kumak I-25
Project Description	EISC	Remediation of the Abandoned Panarctic Satellite F-68 Wellsite at Satellite Bay, Prince Patrick Island, Northwest Territitories	2013	Satellite F-68
Project Description	EISC	Detailed Site Description, Remediation Feasibility and Risk Assessment of the Panarctic Satellite F-68 Wellsite, Satellite Bay, Prince Patrick Island, NWT	2011	Satellite F-68
Project Description	EISC	Project Description for Screening Ikhil UGFI 02/J-35 Gas Well 2011/2012 Drilling and Facilities Tie-In Program Ikhil, NWT	2011	UGFI 02/J-35
Project Description	EISC	Abdandoned Panarctic Satellite F-68 Wellsite Contamination Delineation Program	2010	Satellite F-68
Project Description	EISC	Project Description for the Proposed Anderson Resources Ltd. Tuk 2 Winter 2001/2002 Drilling Program Water Licence Application	2001	Tuk M-18 Tuk B-02
Project Description	IWB Registry	Unipkat I-22 2019 Pile Removal Program	2019	Unipkat I-22
Project Description	IWB Registry	2016 Site Remediation Program, Satellite Bay, Prince Patrick Island, Northwest Territories	2016	Satellite F-68
Project Description	IWB Registry	Unipkat I-22 Soil Disposal Plan	2011	Unipkat I-22
Project Description	IWB Registry	Ellice, Langley and Olivier Drilling, Completion and Testing Project, Winters 2007-2008, 2008-2009, and 2009-2010	2007	Atik P-19
Project Description	IWB Registry	Chevron Canada Limited Taktuk, Langley and Farewell Drilling Program Winter 2006-2008	2006	Unipkat M-45 Kumak I-25
Project Description	IWB Registry	Project Description for the Proposed EnCana Corporation Burnt Lake Drilling Program, Winter 2004	2004	Umiak N-16
Project Description	IWB Registry	Project Description for the Proposed Petro-Canada Nuna Winter 2002/2003 Drilling Program	2002	Nuna I-30
Project Description	IWB Registry	Project Description for the Proposed Petro-Canada Kurk/Napartok Winter 2001/2002 Drilling Program	2001	Itiginpak F-29
Project Description	IWB Registry	Mackenzie Delta Gas Hydrate Research and Development Project	2001	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Research Licence	ARI	Remediation of the Abandoned Panarctic Satellite F-68 Wellsite at Satellite Bay, Prince Patrick Island, Northwest Territories	2019, 2018, 2017, 2016, 2015, 2013, 2011, 2010,	Satellite F-68
Research Licence	ARI	Examining the impacts of climate change on aquatic and terrestrial ecosystems of the Mackenzie region, NWT	2018, 2017, 2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009	na
Research Licence	ARI	Environmental Studies Across Treeline	2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005,	na
Research Licence	ARI	Gas Hydrate Research studies related to drilling of a Gas Hydrate Exploration Well at Mallik L-38, Mackenzie Delta, N.W.T.	2008, 2007, 2002, 1998,	Mallik L-38
Research Licence	ARI	Environmental Conditions at Abandoned Drilling Mud-Sumps and Surrounding Terrain in the Outer Mackenzie Delta (Kendall Island Bird Sanctuary)	2006, 2005	Taglu D-43 Taglu H-54 Taglu C-42 Niglintgak B-19 Kumak K-16 Kumak E-58 Kumak J-06
Research Licence	ARI	Environmental Soil Chemistry at Abandoned Drilling Mud-Sumps in the Kendall Island Bird Sanctuary, Mackenzie Delta Region	2006, 2005	Taglu D-43 Taglu H-54 Taglu C-42 Niglintgak B-19 Kumak K-16 Kumak E-58 Kumak J-06
Research Licence	ARI	Pemafrost and Sump Investigations in the Mackenzie Delta Region	2004, 2003, 2002, 2001, 2000, 2000, 1999,	Taglu Island area
Research Licence	ARI	Using Drilling Mud Sumps to Determine how well Permafrost Contains Contaminants	1998, 1997	Mallik L-38 Niglintgak Parsons Lake
Research Licence	ARI	Northern Phase 1 Environmental Assessment Program - Remote Sensing Pilot Project	2009	77 drill sites
Research Licence	ARI	Aurora Research Institute Mallik 2L-38 and 3L/4L/5L-38 Sump Monitoring and Retrofit Program	2008	Mallik 2L-38 Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Research Licence	ARI	Taglu D-43 Well Site Surficial Clean Up and Sump Assessment; 2007 Taglu G-33 Well Site Surface Clean Up and Sump Assessment; and 2007 Debris Clean Up at Ivik J-26 Well Site	2007	Taglu D-43 Taglu G-33 Ivik J-26
Research Licence	ARI	Proposed Unipkat I-22 Phase II Environmental Site Assessment	2007	Unipkat I-22

Document Type	Source	Document Title	Year	Relevant Wells
Research Licence	ARI	Shell Canada Limited Summer 2006 Historic Well Site Investigations	2006	Napoiak F-31 Niglintgak M-19 Kipnik J-06 Beaverhouse Creek H-13 Kumak C-58 Kumak J-06 Unak L-28 Unak B-11 Ulu A-35 Tullugak K-31 Kugpik O-13 Kugpik L-24 Titalik O-15 Titalik K-26 Shavilig J-20 Unipkat B-12 Unipkat I-22 Kumak E-58 Niglintgak B-19 Niglintgak H-30 Kumak A-29 Kumak K-16
Research Licence	ARI	Inventory and assessment of drilling waste sumps in the Mackenzie Delta of the Inuvialuit Settlement Region	2005	Arnak L-30 W. Atkinson L-17 Hanson G-07 Itrilek B-52 Louth K-45 Mallik L-38 Mallik J-37 Ellice O-14 Itiyok I-27 Kugmallit H-59 Kurk M-39 Langley E-29 Mallik P-59 Napartok M-01 Nuktak C-22 Tununuk K-10
Research Licence	ARI	Inventory and assessment of drilling waste sumps in the Mackenzie Delta of the Inuvialuit Settlement Region	2005	Ikhil A-01 Ikhil I-37 Kilagmiotak M-16 Kilagmiotak F-48 Ogeoqeoq J-06 Onigat C-38 Onigat D-52 Reindeer C-36 Reindeer A-41 Sholokpaoqak P-60 Shakgatlatachig D-50
Research Licence	ARI	Historic Sump Site Assessment	2005	Muskox D-87 Parker River J-72
Research Licence	ARI	ChevronTexaco 2005 Drilling Operations - Project Description Data Collection	2004	Ellice I-48 Tuktoyatuk West Ellice Island
Research Licence	ARI	Chevron North Langley Sump Revegetation Project	2004	Langley K-30
Research Licence	ARI	Environmental Studies Research Funds Regional Sump Study Project	2004	na
Research Licence	ARI	ChevronTexaco Drilling Operations - Project Description Data Collection	2004	West Ellice Island
Research Licence	ARI	Ground-thermal Conditions at Abandoned Drilling Mud Sumps, Mackenzie Delta Region, N.W.T.	2003	na
Research Licence	ARI	Licence #2169	1977	na
Research Study	ASTIS	Review of current research on drilling-mud sumps in permafrost terrain, Mackenzie Delta region, NWT, Canada		na
Research Study	ASTIS	Exploratory Hydrocarbon Drilling Impacts to Arctic Lake Ecosystem		na
Research Study	ASTIS	Recovery of Tundra Vegetation Three Decades after Hydrocarbon Drillingwith and without Seeding of Non-Native Grasses		na

Document Type	Source	Document Title	Year	Relevant Wells
Research Study	ASTIS	Factors Contributing to the Long-Term Integrity of Drilling-Mud Sump Caps in Permafrost Terrain, Mackenzie Delta Region, Northwest Territories, Canada - pg 81		na
Research Study	ASTIS	Environmental Review of Gulf Canada Operations in the Mackenzie Delta		na
Research Study	ASTIS	Contaminant Movement in Frost-Affected Soils		na
Research Study	ESRF	Monitoring a Sump Containing Drilling Mud with a High Salt Content		na
Research Study	ESRF	Handling and Disposal of Waste Drilling Fluids from On-Land Sumps in the Northwest Territories and Yukon		na
Research Study	ESRF	Drilling Waste Management - Recommended Best Practices		na
Research Study	ESRF	Assessment of Drilling Waste Disposal Options in the Inuvialuit Settlement Region		na
Research Study	ESRF	Environmental Persistence of Drilling Mud and Fluid Discharges and Potential Impacts		na
Research Study	ISR Database	Field report on environmental conditions of abandoned oil and gas drilling pads and sumps situated in sporadic and continuous permafrost	1998	na
Research Study	ISR Database	Arctic land use research, sump studies V : ecological changes adjacent to sumps at exploratory wellsites in the Mackenzie Delta and northern Yukon : a summary report	1985	na
Research Study	ISR Database	Arctic land use research, sump studies III : Ecological changes adjacent to sumps at exploratory wellsites in the Mackenzie Delta	1984	na
Research Study	ISR Database	Sump studies II - Geothermal disturbances in permafrost terrain adjacent to Arctic oil and gas wellsites	1981	na
Research Study	ISR Database	Drilling fluid disposal : drilling fluids and disposal methods employed by Esso Resources Canada Limited to drill in the Canadian Arctic	1980	na
Research Study	NWT Discovery Portal	Permafrost and Terrain Conditions at Northern Drilling-Mud Sumps: Impacts of Vegetation and Climate Change and the Management Implications		na
Research Study	Web	Environmental Conditions and Vegetation Recovery at Abandoned Drilling Mud Sumps in the Mackenzie Delta Region, Northwest Territories, Canada		na
Research Study	Web	Surface Disposal of Waste Drilling Fluids, Ellef Ringnes Island, N.W.T.: Short-Term Observations		na
Research Study	Web	Terrain, Land Use and Waste Drilling Fluid Disposal Problems, Arctic Canada		na
Research Study	Web	Drilling Mud Sumps in the Mackenzie Delta Region: Construction, Abandonment and Past Performance		na
Research Study	Web	Drilling Wastes		na
Research Study	Web	Increasing rates of retrogressive thaw slump activity in the Mackenzie Delta region, N.W.T., Canada		na
Research Study	Web	Contaminant migration through the permafrost active layer, Mackenzie Delta area, Northwest Territories, Canada		na
Summary Report	ConocoPhillips	Taglu G-33 Well Site Surficial Clean Up and Sump Assessment	2008	Taglu G-33
Summary Report	ConocoPhillips	Subsurface Site Assessment, Parsons F-09	2013	Parsons F-09
Summary Report	EISC	Mackenzie Delta Wellsite Inspection Program	2019	Aklavik A-37 Napoiak F-31 Niglintgak M-19 Kipnik O-20 Beaverhouse Creek H-13 Kumak C-58 Kumak J-06 Unak L-28 Unak B-11 Ulu A-35 Tullugak K-31 Kugpik O-13 Kugpik L-24 Titalik O-15 Titalik K-26 Shavilig J-20 Unipkat B-12 Unipkat I-22 Unipkat N-12 Kumak E-58 Niglintgak B-19 Niglintgak H-30 Kumak A-29 Kumak K-16
Summary Report	EISC	Parsons F-09 Environmental Site Assessment and vegetation survey	2012	Parsons F-09
Summary Report	EISC	2011 Summary Report of the Detailed Site Description Program Conducted in 2011 at the Panarctic Satellite F-68 Wellsite, Satellite Bay, Prince Patrick Island, NWT	2012	Satellite F-68
Summary Report	EISC	ConocoPhillips Canada Ikhil I-37 Well Environmental Site Assessment and Ikhil I-37 and Siku C-55 Well Sites Vegetation Reconnaissance Surveys	2011	Ikhil I-37 Siku C-55
Summary Report	EISC	Phase I and Limited Phase II Environmental Site Assessment, Panarctic Satellite F-68 Wellsite	2009	Satellite F-68

Document Type	Source	Document Title	Year	Relevant Wells
Summary Report	Imperial	Environmental Assessment of the Taglu Drilling Sumps	2006	Taglu West H-06 Taglu D-55 Taglu H-54 Taglue West P-03 Taglu D-43 Taglu G-33 Taglu C-42
Summary Report	Imperial	Taglu D-43 Well Site Surficial Clean Up and Sump Assessment	2008	Taglu D-43
Summary Report	Imperial	2007 Debris Clean Up at Ivik J-26 Well Site	2008	Ivik J-26
Summary Report	IWB Library	Chevron Langley K-30 Downloading of Temperature Information and Site Investigation	2005	Langley K-30
Summary Report	IWB Registry	Unipkat I-22 Shell Canada Energy 2014 Monitoring and Maintenance Program Summary Report	2015	Unipkat I-22
Summary Report	IWB Registry	Environmental Inspection Report: Umiak N-05 Sump, 2014 Delta Program	2014	Umiak N-05
Summary Report	IWB Registry	Environmental Inspection Report: Umiak N-16 Sump, 2014 Delta Program	2014	Umiak N-16
Summary Report	IWB Registry	Umiak N-05 Sump Monitoring Data Interpretation Report	2013	Umiak N-05
Summary Report	IWB Registry	Unipkat I-22 Shell Canada Energy 2013 Monitoring and Sampling Program Report	2013	Unipkat I-22
Summary Report	IWB Registry	Site Investigation and Downloading of Temperatures, Kumak I-25/Unipkat M-45 Remote Sump	2007	Unipkat M-45 Kumak I-25
Summary Report	IWB Registry	Environmental Imaging to Investigate Subsurface Conditions at the F29 Sump Location Northwest of Inuvik, Northwest Territories	2005	Itiginpak F-29
Summary Report	IWB Registry	Site Investigation and Downloading of Temperatures	2005	Itiginpak F-29
Summary Report	IWB Registry	Site Investigation and Downloading of Temperatures	2004	Itiginpak F-29
Summary Report	IWB Registry	Environmental Imaging to Investigate Subsurface Conditions at the F29 Sump Location Northwest of Inuvik, Northwest Territories	2004	Itiginpak F-29
Summary Report	IWB Registry	Site Investigation and Downloading of Temperatures Petro Canada Nuna I-30	2004	Nuna I-30
Summary Report	IWB Registry	Annual Report for the Encana Corporation Burnt Lake (Umiak N-05) Drilling Program 2004	2004	Umiak N-05
Summary Report	IWB Registry	Tuk 2 Winter Drilling Program 2001-2002	2003	Tuk M-18 Tuk B-02
Sump Monitoring Report	IWB Library	Report for the Encana Corporation, Umiak N-16 2006 Sump Monitoring Program	2006	Umiak N-16
Sump Monitoring Report	IWB Registry	Umiak N-05 2011 Annual Sump Monitoring Report	2011	Umiak N-05
Sump Monitoring Report	IWB Registry	Umiak N-05 2010 Annual Sump Monitoring Report	2010	Umiak N-05
Sump Monitoring Report	IWB Registry	2009 Umiak N-05 Annual Sump Monitoring Report	2009	Umiak N-05
Sump Monitoring Report	IWB Registry	2007 Umiak N05 Annual Sump Monitoring Report	2007	Umiak N-05
Sump Monitoring Report	IWB Registry	2006 Site Visit and Surface Water Sampling at the Nuna I-30 Wellsite - Water Licence N7L1-1788	2006	Nuna I-30
Sump Monitoring Report	IWB Registry	Report for the Encana Corporation Umiak N-05 2006 Sump Monitoring Program	2006	Umiak N-05
Sump Monitoring Report	IWB Registry	Report for the Encana Corporation Umiak N-05 Sump Monitoring Program 2005	2005	Umiak N-05
Water Licence Inspection Report	EISC	Industrial Water Use Inspection Report	2014	Langley K-30
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2017	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2017	Umiak N-05
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2017	Umiak N-16
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2016	Umiak N-05
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2016	Umiak N-16
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2014	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2014	Umiak N-05
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2014	Umiak N-16
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2014	Unipkat I-22
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Itiginpak F-29
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Kugpik L-46
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Tuk M-18 Tuk B-02
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Umiak N-05

Document Type	Source	Document Title	Year	Relevant Wells
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Umiak N-16
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2013	Unipkat I-22
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2012	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2012	Umiak N-16
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2012	Unipkat I-22
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2011	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2010	Umiak N-05
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2019	Ikhil J-35 Ikhil N-26
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2002	Kugpik L-46
Water Licence Inspection Report	IWB Registry	Industrial Water Use Inspection Report	2002	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Report	IWB Registry	Water Licence N7L1-1822 Annual Water Report 2007	2007	Aput D-48 Atik P-19 Langley E-07
Water Licence Report	IWB Registry	Water Licence N7L1-1822 Annual Water Report 2008	2009	Aput D-48 Atik P-19 Langley E-07
Water Licence Report	IWB Registry	Water Consumption Report	2002	Mallik 3L-38 Mallik 4L-38 Mallik 5L-38
Water Licence Report	IWB Registry	Wrap-up Report for Water use Licence N3L1-1710	1998	Ikhil J-35 Ikhil N-26

Table B-4: The corporate names of the companies that own the well sites within the Inuvialuit Settlement Region.

Company	Corporate Name
Imperial	Imperial Oil Limited
ConocoPhillips	ConocoPhillips
Shell	Shell Oil Company
Suncor	Suncor Energy
Husky	Husky Energy inc.
Chevron	Chevron Corporation
BP	BP Canada Energy Group ULC
MGM Energy Corp.	MGM Energy Corp.
Inuvialuit Petroleum	Inuvialuit Petroleum Corporation
Japex	Japan Petroleum Exploration Company Limitied
Canadian Natural Resources Ltd.	Canadian Natural Resources Ltd.
Encana	Encana Corporation (As of Jan 2020, known as Ovintiv Inc.)
Deminex	Deminex Ltd.
Murphy Oil Corporation	Murphy Oil Corporation
Repsol Oil and Gas Canada Inc.	Repsol Oil and Gas Canada Inc.
Utility Group Facilities Inc.	Utility Group Facilities Inc.

Table B-5: The questions asked during the community based monitoring program.

No.	Question
1.	Are there sumps that you have observed that you consider a problem for the ISR and local hunters and trappers?
2.	What are the locations of those sumps (refer to Arktis solution maps)?
3.	How did you notice the problem sump (i.e. while hunting, trapping, fishing, traveling etc.)?
4.	If there are any problems with the sumps, what are the problems?
5.	What do you consider to be specific problems from the sumps (i.e.) did you notice a smell, see contamination like oil sheens or see if it affected the vegetation?
6.	What do you consider to be specific problems from the sumps (i.e.) did you notice a smell, see contamination like oil sheens or see if it affected the vegetation?
7.	Are there problem sumps located in special or sensitive areas? (i.e. fish, birds, traplines etc.)?
8.	Why do you coincide an area in which the sump is located to be “special”?
9.	Can you describe the use of the area in which the sump is located and any sensitivities? i.e. goose hunting, trapping, harvesting and fishing
10.	What time of year did you notice the “problem” with the sump?
11.	Are there any other problems or issues associated with the “problem sumps”? Such as, used barrels, pipes, or waste materials at the site?
12.	Are there reports of sump problems from any other hunters or trappers that you are aware of regarding observations sites that you may not have personally visited?
13.	Over the past several years, have you noticed any changes at the sump sites with which you are familiar that indicated an acceleration of problems at those sites?

Table B-6: Environmental impacts at each sump site within the Inuvialuit Settlement Region.

Sump Name	Summer Operation (May-Sep)	Soil Type	Surficial Deposits	Cracking or Sloughing	Subsidence	Sedimentation or Erosion	Ponding (Minor <20% Moderate 20-50% Major >50%)	Ponding Depth (m)	Salt Staining	Evidence of Migration Beyond Sump	Soil Chloride Above Background (Yes/No)	Water Chloride Above Background (Yes/No)	Water Chloride Above CCME (Yes/No)	Water Chloride above CCME and Background (Yes/No)	Average Active Layer Depth Below Background (cm)	Percent Difference of Average Active Layer Depth from Background (Low <30% High >=30%)	Vegetation Stress (Low <=100 m2 High >100 m2)	Area of Stressed Vegetation (m2)	Vegetation Cover (Negligible <10% Minor 10-25% Moderate 25-50% Very High 50-70% Very High >70%)	Sump Distance to Open Water Body (m)	Within Protected Area
AKKU F-14	No	fine, coarse, organic	plain glaciofluvial	No	n/a	No	None	n/a	Yes	Yes	Yes	n/a	n/a	n/a	24	High	None	0	High	108	no
AKLAVIK A-37	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	390	no
AMAGUK H-16	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	286	no
AMAROK N-44	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	229	no
ANDREASEN L-32	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	340	no
APOLLO C-73	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	470	no
APUT D-43	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump
ATERTAK E-41	Yes	medium, coarse, organic	lacustrine sand	No	Collapsed with surface water ponding	Yes	Major	>1.5	No	No	n/a	n/a	Yes	n/a	38	High	Yes	n/a	n/a	409	no
ATERTAK K-31	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	170	no
ATIGI G-04	No	medium, coarse, organic	till blanket	No	Collapsed with surface water ponding	Yes	Major	<1.5	Yes	Yes	n/a	Yes	No	No	38	High	None	0	n/a	96	no
ATIGI O-48	No	n/a	n/a	Yes	Yes	No	Minor	n/a	n/a	Yes	Yes	Yes	Yes	Yes	n/a	n/a	Yes	n/a	Moderate	670	no
ATIK P-19	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump
ATKINSON A-55	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	227	no
ATKINSON H-25	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	519	no
ATKINSON M-33	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	253	no
BAR HARBOUR E-76	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	552	no
BEAVER HOUSE CREEK H-13	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1520	no
BLOW RIVER YT E-47	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	375	no
BROCK C-50	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	87	no
BROCK I-20	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	264	no
BURNT LK	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CAPE NOREM A-80	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	108	no
CASTEL BAY C-68	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	229	yes
CROSSLEY LK S K-60	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	576	no
DEPOT ISLAND C-44	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	362	no
DUNDAS C-80	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	188	no
DYER BAY L-49	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	108	no
E. HECLA C-32	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	252	no
E. HECLA F-62	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10	no
EGLINTON P-24	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	140	no
ELLICE I-48	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	188	no

Sump Name	Summer Operation (May-Sep)	Soil Type	Surficial Deposits	Cracking or Sloughing	Subsidence	Sedimentation or Erosion	Ponding (Minor <20% Moderate 20-50% Major >50%)	Ponding Depth (m)	Salt Staining	Evidence of Migration Beyond Sump	Soil Chloride Above Background (Yes/No)	Water Chloride Above Background (Yes/No)	Water Chloride Above CCME (Yes/No)	Water Chloride above CCME and Background (Yes/No)	Average Active Layer Depth Below Background (cm)	Percent Difference of Average Active Layer Depth from Background (Low <30% High >=30%)	Vegetation Stress (Low <=100 m2 High >100 m2)	Area of Stressed Vegetation (m2)	Vegetation Cover (Negligible <10% Minor 10-25% Moderate 25-50% High 50-70% Very High >70%)	Sump Distance to Open Water Body (m)	Within Protected Area
ELLICE J-27	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump
ELLICE O-14	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	414	no
EMERALD K-33	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	64	no
ESKIMO J-07	Yes	medium-coarse grained	plain glaciofluvial	No	None	No	None	n/a	No	Yes	Yes	n/a	n/a	n/a	21	n/a	None	0	High	381	no
FISH RIVER B-60	Yes	organic	till veneer	No	Partial collapse	Yes	Minor	<1.5	No	No	Yes	n/a	Yes	n/a	n/a	n/a	None	0	Moderate	393	no
GARRY G-07	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	604	no
GARRY P-04	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	43	yes
HANSEN G-07	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	216	no
HEARNE F-85	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1024	no
HECLA I-69	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15	no
HECLA J-60	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	174	no
HORTON RIVER G-02	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	343	no
IKHIL A-01	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	399	no
IKHIL I-37	Yes	n/a	n/a	No	Yes with surface water ponding	n/a	Major	n/a	n/a	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Moderate	404	no
IKHIL J-35	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	516	no
IKHIL K-35	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	189	no
IKHIL N-26	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	no
IKHIL UGFI 02/J-35	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump
IKKARIKTOK M-64	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	164	no
IMNAK J-29	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	186	no
INTREPID INLET H-49	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	68	no
IOL DRILL SUMP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ITIGINKPAK F-29	No	n/a	n/a	No	Yes	n/a	None	n/a	n/a	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Moderate	374	no
ITKRILEK B-52	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	no
IVIK C-52	No	fine grained	till blanket	No	NW corner of sump	Yes	Minor	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	15	Low	None	0	High	113	no
IVIK J-26	Yes	medium grained	till blanket	No	Minor	No	Moderate	>1.5	Yes	Yes	Yes	Yes	No	No	31	High	None	0	High	594	no
IVIK K-54	Yes	fine grained	till blanket	No	Collapsed with surface water ponding	Yes	Moderate	<1.5	Yes	Yes	Yes	n/a	Yes	n/a	35	n/a	High	224	High	390	no
IVIK N-17	No	fine grained	till blanket	No	None	n/a	None	n/a	Yes	Yes	n/a	Yes	Yes	Yes	9	Low	Low	100	High	417	no
JAMESON BAY C-31	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	44	no
KAMIK D-48	No	medium, coarse, organic	complex, glaciofluvial	No	None	No	None	n/a	Yes	No	Yes	Yes	Yes	Yes	14	Low	None	0	High	154	no

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KAMIK D-58	No	medium-coarse grained	complex, glaciofluvial	No	Minor	Yes	None	n/a	Yes	No	Yes	Yes	Yes	Yes	7	Low	None	0	High	85	no
KAMIK F-38	No	medium grained	complex, glaciofluvial	No	Minor	No	Minor	<1.5	Yes	No	No	n/a	No	n/a	3	Low	None	0	High	574	no
KAMIK L-60	Yes	fine-coarse grained	complex, glaciofluvial	Yes	Minor	Yes	None	n/a	Yes	Yes	Yes	n/a	Yes	n/a	24	High	None	0	High	244	no
KANGUK F-42	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	310	no
KANGUK I-24	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	104	no
KAPIK J-39	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	700	no
KIKORALOK N-46	No	n/a	n/a	Yes	Yes	n/a	Minor	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	None	0	Very high	250	no
KILAGMIOTAK F-48	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	248	no
KILAGMIOTAK M-16	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18	no
KILIGVAK I-29	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	153	no
KIMIK D-29	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	211	no
KIPNIK O-20	Yes	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	Yes	Major	<1.5	Yes	No	Yes	Yes	Yes	Yes	51	High	High	2500	Minor	113	no
KITSON R. C-71	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	432	no
KUGALUK N-02	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	127	no
KUGPIK L-24	No	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	>1.5	Yes	Yes	Yes	Yes	Yes	Yes	4	Low	High	150	Moderate	113	no
KUGPIK L-46	No	n/a	n/a	No	Yes with surface water ponding	No	Major	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	None	0	High	168	no
KUGPIK O-13	Yes	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	Yes	Major	>1.5	Yes	Yes	Yes	Yes	Yes	Yes	21	Low	High	2500	Moderate	108	no
KUMAK A-29 (I-29)	No	coarse grained, organic	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	<1.5	No	Yes	Yes	Yes	No	No	36	High	None	0	High	182	yes
KUMAK C-58	Yes	fine grained, organic	Alluvial deposits	No	Collapsed with surface water ponding	No	Moderate	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	30	High	Low	6	Moderate	413	yes

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KUMAK E-58	Yes	fine grained, organic	Alluvial deposits	No	Minor	No	None	n/a	Yes	Yes	Yes	Yes	Yes	Yes	32	High	None	0	High	430	yes
KUMAK I-25 and UNIPKAT M-45	No	n/a	n/a	Yes	Yes with surface water ponding	No	Minor	n/a	n/a	No	No	No	No	No	n/a	n/a	None	0	Very high	290	yes
KUMAK J-06	Yes	coarse grained, organic	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	<1.5	Yes	Yes	Yes	n/a	n/a	n/a	11	Low	High	400	Minor	548	yes
KUMAK K-16	Yes	coarse grained	Alluvial deposits	No	Minor	No	Minor	<1.5	Yes	Yes	No	n/a	n/a	n/a	39	High	None	0	High	233	yes
KURK M-15	No	n/a	n/a	Yes	Minor	Yes	Minor	n/a	n/a	Yes	Yes	No	Yes	Yes	n/a	n/a	n/a	n/a	Moderate	460	no
KURK M-39	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	272	no
KUSRHAAK D-16	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	389	yes
LANGLEY E-07	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump
LANGLEY E-29	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	257	no
LANGLEY K-30	No	n/a	n/a	Yes	Yes	Yes	None	n/a	n/a	No	n/a	No	Yes	No	n/a	n/a	Yes	n/a	Very high	70	no
LOUTH K-45	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	480	no
MAGAK A-32	No	medium grained	plain glaciofluvial	Yes	Minor	Yes	None	n/a	Yes	Yes	Yes	Yes	No	No	34	High	None	0	Minor	0	no
MALLIK 2L-38	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	12	no
MALLIK 3L,4L,5L-38	No	n/a	n/a	No	Yes with surface water ponding	n/a	Major	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Minor	70	no
MALLIK 6L-38	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	59	no
MALLIK A-06	Yes	fine grained	till blanket	No	Collapsed with surface water ponding	No	Moderate	<1.5	Yes	No	Yes	Yes	Yes	Yes	39	High	None	0	High	447	no
MALLIK J-37	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	115	no
MALLIK L-38	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	no
MALLIK P-59	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	no
MARIE BAY D-02	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	174	no
MAYOGIAK G-12	No	fine grained	Alluvial	No	Minor	No	Minor	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	25	High	None	0	High	117	no
MAYOGIAK J-17	Yes	fine-coarse grained	Surficial Deposits	No	Minor	Yes	None	n/a	No	Yes	n/a	n/a	n/a	n/a	33	High	Low	25	n/a	635	no
MAYOGIAK L-39	Yes	fine-coarse grained	lacustrine sand	No	None	No	None	n/a	No	No	Yes	Yes	No	No	31	High	None	0	High	62	no
MAYOGIAK M-16	No	fine grained	alluvial	No	None	No	None	n/a	No	No	Yes	Yes	Yes	Yes	16	High	Low	10.5	High	389	no

Sump Name	Summer Operation (May-Sep)	Soil Type	Surficial Deposits	Cracking or Sloughing	Subsidence	Sedimentation or Erosion	Ponding (Minor <20% Moderate 20-50% Major >50%)	Ponding Depth (m)	Salt Staining	Evidence of Migration Beyond Sump	Soil Chloride Above Background (Yes/No)	Water Chloride Above Background (Yes/No)	Water Chloride Above CCME (Yes/No)	Water Chloride above CCME and Background (Yes/No)	Average Active Layer Depth Below Background (cm)	Percent Difference of Average Active Layer Depth from Background (Low <30% High >=30%)	Vegetation Stress (Low <=100 m2 High >100 m2)	Area of Stressed Vegetation (m2)	Vegetation Cover (Negligible <10% Minor 10-25% Moderate 25-50% High 50-70% Very High >70%)	Sump Distance to Open Water Body (m)	Within Protected Area
MAYOGIAK N-34	No	coarse grained	Alluvial	No	Collapsed with surface water ponding	No	Minor	<1.5	No	No	Yes	Yes	No	No	41	High	None	0	High	185	no
MUSKOX D-87	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	96	no
N. DUNDAS N-82	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	141	no
N2006A0029	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NANUK D-76	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	150	yes
NAPARTOK M-01	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	791	no
NAPOIAK F-31	Yes	na	Alluvial deposits	No	Collapsed with surface water ponding	n/a	n/a	n/a	n/a	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10	no
NATAGNAK H-50	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	317	no
NATAGNAK K-23	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	66	no
NATAGNAK K-53	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	no
NATAGNAK O-59	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	no
NICHOLSON G-56	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	556	no
NICHOLSON N-45	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	no
NIGLINTGAK B-19	No	fine grained, organic	Alluvial deposits	No	Minor	No	Minor	<1.5	Yes	Yes	Yes	No	Yes	No	18	Low	None	0	High	0	no
NIGLINTGAK H-30	No	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	Yes	Major	>1.5	Yes	Yes	Yes	No	Yes	No	16	Low	High	780	Moderate	230	no
NIGLINTGAK M-19	Yes	fine-medium grained	Alluvial deposits	No	Collapsed with surface water ponding	No	Moderate	>1.5	Yes	Yes	Yes	No	No	No	-6	Low	None	0	Moderate	460	no
NORTH ELLICE J-17	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump
NORTH ELLICE J-23	No	medium grained	Alluvial deposits	No	Collapsed	Yes	Moderate	<1.5	Yes	No	Yes	Yes	Yes	Yes	39	High	High	3888	Moderate	0	no
NUKTAK C-22	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	no
NUNA A-10	No	fine grained, organic	complex, glaciofluvial	No	Minor	Yes	n/a	n/a	Yes	Yes	Yes	n/a	n/a	n/a	52	High	Low	25	High	82	no
NUNA A-32	No	fine grained	complex, glaciofluvial	No	Collapsed	No	Minor	<1.5	Yes	No	Yes	Yes	No	No	20	High	None	0	High	528	no
NUNA E-40 (D-40)	No	medium grained, organic	lacustrine sand	No	None	No	None	n/a	Yes	No	Yes	No	No	No	58	High	Low	6	High	385	no
NUNA I-30	No	n/a	n/a	Yes	None	No	Minor	2	n/a	No	n/a	Yes	Yes	Yes	n/a	n/a	Yes	n/a	Negligible	199	no

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NUVORAK O-09	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	206	no
OGEOQEOQ J-06	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	253	no
OGRUKNANG M-31	Yes	n/a	n/a	No	Minor	No	Minor	n/a	n/a	No	n/a	Yes	No	No	n/a	n/a	None	0	Negligible	745	no
OH1 SUMP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ONIGAT C-38	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	49	no
ONIGAT D-52	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	565	no
ONIGAT K-49	No	fine grained	till blanket	No	Minor	No	Minor	<1.5	Yes	No	Yes	Yes	No	No	-4	Low	Low	75	High	100	no
ORKSUT I-44	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	41	yes
PARKER RIVER J-72	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	243	no
PARSONS A-44	Yes	fine grained	complex, glaciofluvial	No	Minor	No	None	n/a	No	Yes	Yes	Yes	Yes	Yes	64	High	None	0	Minor	161	no
PARSONS D-20	Yes	medium grained	complex, glaciofluvial	Yes	Minor	Yes	None	n/a	Yes	Yes	Yes	Yes	Yes	Yes	24	High	Low	100	Negligible	306	no
PARSONS E-02	No	fine-coarse grained	complex, glaciofluvial	Yes	Collapsed with surface water ponding	Yes	Major	>1.5	No	No	Yes	n/a	No	n/a	-2	Low	None	0	High	279	no
PARSONS F-09	No	medium grained	complex, glaciofluvial	Yes	Collapsed with surface water ponding	Yes	Moderate	>1.5	Yes	Yes	Yes	Yes	Yes	Yes	17	High	None	0	High	144	no
PARSONS L-37	No	medium, coarse, organic	complex, glaciofluvial	No	Minor	Yes	Minor	<1.5	Yes	No	n/a	Yes	Yes	Yes	14	High	None	0	High	117	no
PARSONS L-43	No	fine grained	complex, glaciofluvial	No	Collapsed with surface water ponding	Yes	Major	>1.5	No	No	Yes	No	No	No	19	High	None	0	Minor	190	no
PARSONS N-10	Yes	medium grained	complex, glaciofluvial	No	None	No	None	n/a	No	Yes	n/a	n/a	n/a	n/a	-13	Low	None	0	Moderate	143	no
PARSONS N-17	No	fine-coarse grained	complex, glaciofluvial	Yes	Collapsed with surface water ponding	Yes	Moderate	<1.5	No	Yes	Yes	Yes	Yes	Yes	15	Low	Low	2.25	High	164	no
PARSONS O-27	Yes	fine-coarse grained	complex, glaciofluvial	Yes	Collapsed with surface water ponding	Yes	Moderate	<1.5	No	Yes	Yes	Yes	Yes	Yes	15	Low	Low	2.25	High	0	no

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PARSONS P-41	No	fine grained	till blanket	No	Collapsed with surface water ponding	No	Minor	<1.5	No	No	Yes	No	No	No	15	Low	None	0	High	401	no
PARSONS P-53	No	fine grained	complex, glaciofluvial	Yes	Collapsed with surface water ponding	No	Minor	<1.5	No	No	Yes	Yes	Yes	Yes	6	Low	None	0	High	367	no
PEDDER POINT D-49	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	251	no
PIKIOLIK E-54	No	medium grained, organic	Alluvial	No	Minor	n/a	Moderate	>1.5	Yes	No	Yes	Yes	Yes	Yes	40	High	Low	9	High	192	no
PIKIOLIK G-21	No	fine grained	complex	Yes	Minor	n/a	Minor	<1.5	Yes	No	Yes	n/a	Yes	n/a	45	High	Low	25	High	405	no
PIKIOLIK M-26	No	fine grained	Alluvial	No	Minor	n/a	Minor	<1.5	No	Yes	No	Yes	Yes	Yes	34	High	None	0	High	0	no
RED FOX P-21	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	no
REINDEER A-41	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	376	no
REINDEER C-36 (F-36)	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	253	no
REINDEER D-27	Yes	n/a	n/a	Yes	Collapsed with surface water ponding	No	Major	n/a	n/a	No	n/a	No	No	No	50	n/a	Yes	n/a	Minor	99	no
ROLAND BAY Y.T. L-41	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	539	yes
RUSSELL H-23	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	242	no
SABINE BAY A-07	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	117	no
SADENE D-02	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	635	no
SANDY POINT L-46	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	141	no
SATELLITE F-68	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	172	no
SHAKGATLATACHIG D-50	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	90	no
SHAVILIG J-20	No	fine grained	Alluvial deposits	No	Minor	No	Minor	<1.5	No	No	Yes	Yes	No	No	23	Low	None	0	Moderate	318	no
SHOLOKPAOQAK P-60	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	no
SIKU A-12	Yes	coarse grained	complex, glaciofluvial	No	None	No	None	n/a	No	Yes	n/a	n/a	n/a	n/a	n/a	n/a	None	0	Moderate	156	no
SIKU C-11	No	coarse grained	complex, glaciofluvial	Yes	Collapsed with surface water ponding	No	Moderate	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	20	Low	High	1311	High	338	no

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SIKU C-55	Yes	n/a	n/a	Yes	Collapsed with surface water ponding	No	Major	n/a	n/a	No	Yes	Yes	Yes	Yes	50	n/a	Yes	n/a	Moderate	251	no
SIKU E-21	Yes	medium grained	complex, glaciofluvial	No	None	No	None	n/a	No	No	n/a	n/a	n/a	n/a	1	Low	None	0	High	121	no
SMOKING HILLS A-23	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	156	no
SPRING RIVER YT N-58	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	415	yes
STORKERSON BAY A-15	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1064	yes
TAGLU C-42	Yes	fine grained	Peat overlying delta deposited silts	Yes	Yes with surface water ponding	n/a	Moderate	>1.5	Yes	No	Yes	n/a	Yes	n/a	n/a	n/a	None	n/a	High	35	no
TAGLU D-43	Yes	fine grained, organic	n/a	Yes	Yes with surface water ponding	n/a	Major	>1.5	Yes	No	Yes	Yes	No	No	Yes	High	None	n/a	High	60	yes
TAGLU D-55	Yes	fine grained, organic	n/a	Yes	Yes with surface water ponding	n/a	Major	>1.5	Yes	n/a	n/a	No	No	No	Yes	High	None	n/a	Minor	617	yes
TAGLU G-33	Yes	fine grained, organic	n/a	Yes	Yes with surface water ponding	n/a	Major	>1.5	Yes	No	No	No	No	No	Yes	High	None	n/a	Moderate	60	no
TAGLU H-54	No	fine grained, organic	n/a	Yes	Minor	n/a	None	n/a	Yes	Yes	Yes	No	No	No	Yes	High	None	n/a	High	340	yes
TAGLU N-43	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	533	yes
TAGLU WEST H-06	Yes	fine grained, organic	n/a	No	None	n/a	None	n/a	No	No	No	No	No	No	Yes	High	None	n/a	Negligible	220	yes
TAGLU WEST P-03	No	fine grained, organic	n/a	Yes	Yes with surface water ponding	n/a	Minor	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High	None	n/a	Moderate	528	yes
TIRITCHIK M-48	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	80	no
TITALIK K-26	No	medium grained	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	>1.5	No	Yes	Yes	Yes	No	No	17	Low	None	0	High	154	no

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TITALIK O-15	Yes	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	>1.5	No	Yes	n/a	Yes	No	No	n/a	n/a	None	0	Moderate	525	no
TOAPOLOK H-24	Yes	n/a	n/a	Yes	None	No	Minor	n/a	n/a	Yes	Yes	Yes	Yes	Yes	n/a	n/a	None	0	High	65	no
TOAPOLOK O-54	No	fine grained, organic	till blanket	Yes	Collapsed with surface water ponding	Yes	Major	>1.5	No	Yes	Yes	Yes	No	No	17	Low	Yes	n/a	Negligible	634	no
TUK B-02 and M-18	No	n/a	n/a	Yes	Yes with surface water ponding	No	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	Very high	236	no
TUK B-40	No	fine grained	complex, glaciofluvi al	Yes	None	Yes	n/a	n/a	Yes	Yes	Yes	n/a	n/a	n/a	22	High	None	0	High	60	no
TUK E-20	No	fine grained, organic	complex, glaciofluvi al	Yes	None	Yes	None	n/a	No	No	n/a	Yes	Yes	Yes	24	High	None	0	High	169	no
TUK F-18	No	organic	complex, glaciofluvi al	Yes	Collapsed with surface water ponding	No	Moderate	>1.5	No	No	n/a	Yes	No	No	21	High	None	0	n/a	0	no
TUK G-39	No	fine grained	complex, glaciofluvi al	No	None	No	None	n/a	No	Yes	Yes	Yes	No	No	12	Low	None	0	High	306	no
TUK G-48	No	fine grained	lacustrine sand	No	Minor	No	Minor	<1.5	No	Yes	Yes	Yes	Yes	Yes	19	High	None	0	High	356	no
TUK H-30	Yes	fine grained	complex	No	None	n/a	None	n/a	Yes	Yes	No	Yes	No	No	25	High	None	0	High	148	no
TUK J-29	No	fine grained	complex, glaciofluvi al	No	Minor	No	Minor	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	25	High	Low	4	High	113	no
TUK L-09	No	medium grained, organic	complex, glaciofluvi al	Yes	Minor	Yes	Moderate	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	21	High	High	900	High	247	no
TUKTU O-19	No	medium grained	complex	No	Collapsed with surface water ponding	No	Major	>1.5	No	Yes	Yes	n/a	No	n/a	24	High	None	0	Minor	138	no
TUKTUK A-12	No	fine grained	Alluvial	No	None	No	Minor	<1.5	Yes	Yes	Yes	n/a	No	n/a	26	n/a	None	0	High	80	no
TUKTUK D-11	No	organic	Alluvial	No	Minor	No	Minor	<1.5	Yes	Yes	Yes	Yes	Yes	Yes	20	High	Low	100	High	174	no
TUKTUK H-22	No	medium grained	Alluvial	No	None	No	None	n/a	No	Yes	Yes	Yes	No	No	22	High	None	0	High	160	no

Sump Name	Summer Operation (May-Sep)	Soil Type	Surficial Deposits	Cracking or Sloughing	Subsidence	Sedimentation or Erosion	Ponding (Minor <20% Moderate 20-50% Major >50%)	Ponding Depth (m)	Salt Staining	Evidence of Migration Beyond Sump	Soil Chloride Above Background (Yes/No)	Water Chloride Above Background (Yes/No)	Water Chloride Above CCME (Yes/No)	Water Chloride above CCME and Background (Yes/No)	Average Active Layer Depth Below Background (cm)	Percent Difference of Average Active Layer Depth from Background (Low <30% High >=30%)	Vegetation Stress (Low <=100 m2 High >100 m2)	Area of Stressed Vegetation (m2)	Vegetation Cover (Negligible <10% Minor 10-25% Moderate 25-50% High 50-70% Very High >70%)	Sump Distance to Open Water Body (m)	Within Protected Area
TULLUGAK K-31	No	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	>1.5	No	No	Yes	Yes	No	No	22	Low	None	0	Minor	416	no
TUNUNUK F-30	Yes	n/a	n/a	No	None	No	Minor	n/a	n/a	No	Yes	n/a	n/a	n/a	n/a	n/a	None	0	High	846	no
TUNUNUK K-10	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	220	no
ULU A-35	Yes	na	Alluvial deposits	No	Collapsed with surface water ponding	n/a	Moderate	>1.5	n/a	No	Yes	n/a	Yes	n/a	28	Low	None	0	High	393	no
UMIAK J-37	No	fine grained	till blanket	No	None	Yes	Minor	<1.5	No	No	Yes	n/a	No	n/a	24	High	None	0	High	57	no
UMIAK N-05	No	n/a	n/a	Yes	Yes	No	Yes	n/a	n/a	Yes	Yes	Yes	Yes	Yes	n/a	n/a	Yes	n/a	Very high	205	no
UMIAK N-10	Yes	medium grained	till blanket	No	Collapsed with surface water ponding	No	Moderate	>1.5	Yes	No	Yes	Yes	Yes	Yes	27	High	None	0	Moderate	413	no
UMIAK N-16	No	n/a	n/a	Yes	Yes	No	Minor	n/a	n/a	Yes	Yes	Yes	Yes	Yes	n/a	n/a	Yes	n/a	Very high	235	no
UMINMAK H-07	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	255	no
UNAK B-11	No	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	Yes	Major	>1.5	Yes	Yes	Yes	Yes	No	No	-1	Low	None	0	High	389	no
UNAK L-28	Yes	fine grained	Alluvial deposits	No	Collapsed with surface water ponding	No	Major	>1.5	No	Yes	Yes	No	No	No	13	Low	None	0	High	98	no
UNIPKAT B-12	No	fine grained	Alluvial deposits	No	Minor	No	Minor	<1.5	Yes	No	No	Yes	No	No	21	High	None	0	High	57	no
UNIPKAT I-22	Yes	medium grained	Alluvial deposits	Yes	Yes	Yes	None	n/a	No	Yes	Yes	Yes	Yes	Yes	No	Low	None	0	Moderate	38	no
UNIPKAT N-12	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	689	no
UPLUK A-42	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	673	no
UPLUK C-21	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	269	no
UPLUK L-42	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	262	no
UPLUK M-38	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	279	no
VICTORIA ISLAND F-36	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	124	no
W. HECLA C-05	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	27	no
WAGNARK C-23	Yes	fine grained	lacustrine sand	No	Minor	No	None	n/a	Yes	Yes	Yes	Yes	No	No	36	High	Low	25	High	452	no
WAGNARK G-12	Yes	fine grained	lacustrine sand	No	Minor	No	Minor	<1.5	Yes	Yes	Yes	Yes	No	No	25	High	None	0	High	201	no
WAGNARK L-36	No	fine grained	lacustrine sand	No	Minor	Yes	n/a	n/a	Yes	No	No	n/a	n/a	n/a	43	High	None	0	High	171	no

Sump Name	Summer Operation (May-Sep)	Soil Type	Surficial Deposits	Cracking or Sloughing	Subsidence	Sedimentation or Erosion	Ponding (Minor <20% Moderate 20-50% Major >50%)	Ponding Depth (m)	Salt Staining	Evidence of Migration Beyond Sump	Soil Chloride Above Background (Yes/No)	Water Chloride Above Background (Yes/No)	Water Chloride Above CCME (Yes/No)	Water Chloride above CCME and Background (Yes/No)	Average Active Layer Depth Below Background (cm)	Percent Difference of Average Active Layer Depth from Background (Low <30% High >=30%)	Vegetation Stress (Low <=100 m2 High >100 m2)	Area of Stressed Vegetation (m2)	Vegetation Cover (Negligible <10% Minor 10-25% Moderate 25-50% High 50-70% Very High >70%)	Sump Distance to Open Water Body (m)	Within Protected Area
WILKIE POINT J-51	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	98	no
WILKINS E-60	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	107	no
WINTER HARBOUR NO.1(A-09)	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	no
WOLVERINE H-34	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	884	no
YA-YA A-28	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	349	no
YA-YA I-17	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	232	no
YA-YA M-33	No	n/a	n/a	Yes	None	No	Minor	n/a	n/a	Yes	Yes	Yes	Yes	Yes	n/a	n/a	Yes	n/a	High	393	no
YA-YA P-53	No	n/a	n/a	Yes	Collapsed with surface water ponding	No	Major	n/a	n/a	No	Yes	Yes	No	No	n/a	n/a	Yes	n/a	Negligible	330	no
ZEUS F-11	Yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	169	no

Table B-7: Sumps within the Inuvialuit Settlement Region and their associated sump class.

Well Name	Owner	Closure Year	Noted as Failed in Reporting	Cracking or Sloughing Weight - Yes = 1 No = 0	Subsidence Weight None/Minor = 0 Other = 1	Sedimentation or Erosion Weight Yes = 1 No = 0	Ponding Weight None = 0 Minor = 0.33 Moderate = 0.66 Major = 1	Total	Sump Class 1-3	Risk Rank	GNWT Priority	Inuvialuit Engagement Priority
AKKU F-14	Imperial	1973	n/a	0	n/a	0	0	0.00	3	Low	-	-
AKLAVIK A-37	Shell	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
AMAGUK H-16	Husky	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
AMAROK N-44	Imperial	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
ANDREASEN L-32	Husky	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
APOLLO C-73	Suncor	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
APUT D-43	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	-	Yes
ATERTAK E-41	Imperial	1972	n/a	0	1	1	1	0.75	1	Medium	-	Yes
ATERTAK K-31	Imperial	1986	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ATIGI G-04	ConocoPhillips	1971	n/a	0	1	1	1	0.75	1	Medium	-	-
ATIGI O-48	ConocoPhillips	1974	Yes	1	1	0	0.33	0.58	1	Low	-	-
ATIK P-19	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	-	-
ATKINSON A-55	Imperial	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ATKINSON H-25	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ATKINSON M-33	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
BAR HARBOUR E-76	Suncor	1976	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
BEAVER HOUSE CREEK H-13	Shell	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
BLOW RIVER YT E-47	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
BROCK C-50	Suncor	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
BROCK I-20	Suncor	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
BURNT LK	Uncertain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
CAPE NOREM A-80	Husky	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
CASTEL BAY C-68	Suncor	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
CROSSLEY LK S K-60	Encana	1969	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
DEPOT ISLAND C-44	Suncor	1977	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
DUNDAS C-80	Suncor	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
DYER BAY L-49	Husky	1976	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
E. HECLA C-32	Suncor	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
E. HECLA F-62	Suncor	1995	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
EGLINTON P-24	Suncor	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
ELLICE I-48	Uncertain	2004	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
ELLICE J-27	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	-	-
ELLICE O-14	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
EMERALD K-33	BP	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ESKIMO J-07	Imperial	1969	n/a	0	0	0	0	0.00	3	Low	-	-
FISH RIVER B-60	Chevron	1977	n/a	0	1	1	0.33	0.58	2	Medium	-	Yes
GARRY G-07	Uncertain	1997	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
GARRY P-04	Uncertain	1976	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
HANSEN G-07	Imperial	1986	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
HEARNE F-85	BP	1979	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
HECLA I-69	Suncor	1991	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
HECLA J-60	Suncor	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
HORTON RIVER G-02	Husky	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IKHIL A-01	ConocoPhillips	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IKHIL I-37	Uncertain	1973	Yes	0	1	n/a	1	0.67	1	Medium	-	Yes
IKHIL J-35	Inuvialuit Petroleum Corporation	1998	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IKHIL K-35	Inuvialuit Petroleum Corporation	1986	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IKHIL N-26	Inuvialuit Petroleum Corporation	1998	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IKHIL UGFI 02/J-35	Utility Group Facilities Inc.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	-	-

Well Name	Owner	Closure Year	Noted as Failed in Reporting	Cracking or Sloughing Weight - Yes = 1 No = 0	Subsidence Weight None/Minor = 0 Other = 1	Sedimentation or Erosion Weight Yes = 1 No = 0	Ponding Weight None = 0 Minor = 0.33 Moderate = 0.66 Major = 1	Total	Sump Class 1-3	Risk Rank	GNWT Priority	Inuvialuit Engagement Priority
IKKARIKTOK M-64	Uncertain	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IMNAK J-29	BP	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
INTREPID INLET H-49	Husky	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
IOL DRILL SUMP	Uncertain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ITIGINKPAK F-29	Canadian Natural Resources	2003	No	0	1	n/a	0	0.33	2	Low	Yes	Yes
ITKRILEK B-52	Imperial	1985	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
IVIK C-52	Imperial	1973	n/a	0	1	1	0.33	0.58	2	Medium	-	-
IVIK J-26	Imperial	1972	n/a	0	0	0	0.66	0.17	3	Medium	-	-
IVIK K-54	Imperial	1973	n/a	0	1	1	0.66	0.67	2	Medium	-	-
IVIK N-17	Imperial	1973	n/a	0	0	n/a	0	0.00	3	Low	-	-
JAMESON BAY C-31	Husky	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KAMIK D-48	ConocoPhillips	1976	n/a	0	0	0	0	0.00	3	Low	-	-
KAMIK D-58	ConocoPhillips	1975	n/a	0	0	1	0	0.25	3	Low	-	-
KAMIK F-38	ConocoPhillips	1977	n/a	0	0	0	0.33	0.08	3	Low	-	-
KAMIK L-60	ConocoPhillips	1975	n/a	1	0	1	0	0.50	2	Medium	-	-
KANGUK F-42	Imperial	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KANGUK I-24	Imperial	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
KAPIK J-39	Imperial	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KIKORALOK N-46	ConocoPhillips	1975	No	1	1	n/a	0.33	0.78	2	Low	-	Yes
KILAGMIOTAK F-48	ConocoPhillips	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KILAGMIOTAK M-16	ConocoPhillips	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KILIGVAK I-29	Husky	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KIMIK D-29	Imperial	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
KIPNIK O-20	Shell	1974	n/a	0	1	1	1	0.75	1	Medium	-	-
KITSON R. C-71	Suncor	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
KUGALUK N-02	Encana	1969	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KUGPIK L-24	Shell	1975	n/a	0	1	0	1	0.50	2	Medium	-	Yes
KUGPIK L-46	Suncor	2002	No	0	1	0	1	0.50	2	Low	Yes	Yes
KUGPIK O-13	Shell	1973	n/a	0	1	1	1	0.75	1	Medium	-	Yes
KUMAK A-29 (I-29)	Shell	n/a	n/a	0	1	0	1	0.50	2	Medium	-	-
KUMAK C-58	Shell	1973	n/a	0	1	0	0.66	0.42	2	Medium	-	Yes
KUMAK E-58	Shell	1996	n/a	0	0	0	0	0.00	3	Medium	-	Yes
KUMAK I-25 and UNIPKAT M-45	MGM Energy Corp.	2007	No	1	1	0	0.33	0.58	2	Low	-	Yes
KUMAK J-06	Shell	1974	n/a	0	1	0	1	0.50	2	Medium	-	Yes
KUMAK K-16	Shell	1975	n/a	0	0	0	0.33	0.08	3	Medium	-	-
KURK M-15	Suncor	2001	No	1	0	1	0.33	0.58	2	Low	Yes	-
KURK M-39	Imperial	1977	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
KUSRHAAK D-16	Husky	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
LANGLEY E-07	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	-	-
LANGLEY E-29	Imperial	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
LANGLEY K-30	MGM Energy Corp.	2003	No	1	1	1	0	0.75	2	Low	Yes	Yes
LOUTH K-45	Imperial	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
MAGAK A-32	Imperial	1971	n/a	1	0	1	0	0.50	2	Medium	-	-
MALLIK 2L-38	Japex	1998	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
MALLIK 3L,4L,5L-38	Japex	2002	Yes	0	1	n/a	1	0.67	1	Low	-	Yes
MALLIK 6L-38	Japex	2007	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
MALLIK A-06	Imperial	1972	n/a	0	1	0	0.66	0.42	2	Medium	-	-
MALLIK J-37	Imperial	1978	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
MALLIK L-38	Imperial	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	Yes
MALLIK P-59	Imperial	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-

Well Name	Owner	Closure Year	Noted as Failed in Reporting	Cracking or Sloughing Weight - Yes = 1 No = 0	Subsidence Weight None/Minor = 0 Other = 1	Sedimentation or Erosion Weight Yes = 1 No = 0	Ponding Weight None = 0 Minor = 0.33 Moderate = 0.66 Major = 1	Total	Sump Class 1-3	Risk Rank	GNWT Priority	Inuvialuit Engagement Priority
MARIE BAY D-02	Suncor	1969	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
MAYOGIAK G-12	Imperial	1986	n/a	0	0	0	0.33	0.08	3	Medium	-	-
MAYOGIAK J-17	Imperial	1971	n/a	0	0	1	0	0.25	3	Low	-	-
MAYOGIAK L-39	Imperial	1974	n/a	0	0	0	0	0.00	3	Low	-	-
MAYOGIAK M-16	Imperial	1980	n/a	0	0	0	0	0.00	3	Low	-	-
MAYOGIAK N-34	Imperial	1986	n/a	0	1	0	0.33	0.33	2	Low	-	-
MUSKOX D-87	Chevron	1982	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
N. DUNDAS N-82	BP	1979	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
N2006A0029	Uncertain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
NANUK D-76	Husky	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NAPARTOK M-01	Imperial	1979	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
NAPOIAK F-31	Shell	1974	n/a	0	1	n/a	n/a	0.50	2	Low	-	Yes
NATAGNAK H-50	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NATAGNAK K-23	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NATAGNAK K-53	Imperial	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NATAGNAK O-59	Imperial	1983	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NICHOLSON G-56	Chevron	1962	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NICHOLSON N-45	Chevron	1962	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NIGLINTGAK B-19	Shell	1976	n/a	0	0	0	0.33	0.08	3	Medium	-	-
NIGLINTGAK H-30	Shell	1973	n/a	0	1	1	1	0.75	1	Medium	-	-
NIGLINTGAK M-19	Shell	1975	n/a	0	1	0	0.66	0.42	2	Medium	-	-
NORTH ELLICE J-17	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	-	Yes
NORTH ELLICE J-23	Chevron	1976	n/a	0	1	1	0.66	0.67	2	Medium	-	-
NUKTAK C-22	Imperial	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
NUNA A-10	Imperial	1984	n/a	0	0	1	n/a	0.33	2	Medium	-	-
NUNA A-32	Imperial	1974	n/a	0	1	0	0.33	0.33	2	Low	-	-
NUNA E-40 (D-40)	Imperial	1986	n/a	0	0	0	0	0.00	3	Low	-	-
NUNA I-30	Suncor	2003	No	1	0	0	0.33	0.33	2	Low	Yes	-
NUVORAK O-09	Imperial	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
OGEOQEOQ J-06	ConocoPhillips	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
OGRUKNANG M-31	ConocoPhillips	1977	No	0	0	0	0.33	0.08	3	Low	-	-
OH1 SUMP	Uncertain	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
ONIGAT C-38	ConocoPhillips	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ONIGAT D-52	ConocoPhillips	1985	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
ONIGAT K-49	ConocoPhillips	1986	n/a	0	0	0	0.33	0.08	3	Low	-	-
ORKSUT I-44	Deminex	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
PARKER RIVER J-72	Chevron	1979	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
PARSONS A-44	ConocoPhillips	1975	n/a	0	0	0	0	0.00	3	Medium	-	Yes
PARSONS D-20	ConocoPhillips	1976	n/a	1	0	1	0	0.50	2	Medium	-	-
PARSONS E-02	ConocoPhillips	1986	n/a	1	1	1	1	1.00	1	Low	-	-
PARSONS F-09	ConocoPhillips	1972	Yes	1	1	1	0.66	0.92	1	Medium	-	Yes
PARSONS L-37	ConocoPhillips	1977	n/a	0	0	1	0.33	0.33	2	Medium	-	Yes
PARSONS L-43	ConocoPhillips	1976	n/a	0	1	1	1	0.75	1	Low	-	-
PARSONS N-10	ConocoPhillips	1973	n/a	0	0	0	0	0.00	3	Low	-	-
PARSONS N-17	ConocoPhillips	1976	n/a	1	1	1	0.66	0.92	1	Medium	-	-
PARSONS O-27	ConocoPhillips	1974	n/a	1	1	1	0.66	0.92	1	Medium	-	-
PARSONS P-41	ConocoPhillips	1977	n/a	0	1	0	0.33	0.33	2	Low	-	-
PARSONS P-53	ConocoPhillips	1974	n/a	1	1	0	0.33	0.58	2	Low	-	-
PEDDER POINT D-49	Suncor	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-

Well Name	Owner	Closure Year	Noted as Failed in Reporting	Cracking or Sloughing Weight - Yes = 1 No = 0	Subsidence Weight None/Minor = 0 Other = 1	Sedimentation or Erosion Weight Yes = 1 No = 0	Ponding Weight None = 0 Minor = 0.33 Moderate = 0.66 Major = 1	Total	Sump Class 1-3	Risk Rank	GNWT Priority	Inuvialuit Engagement Priority
PIKIOLIK E-54	Imperial	1972	n/a	0	0	n/a	0.66	0.22	3	Low	-	-
PIKIOLIK G-21	Imperial	1983	n/a	1	0	n/a	0.33	0.44	2	Medium	-	-
PIKIOLIK M-26	Imperial	1972	n/a	0	0	n/a	0.33	0.11	3	Medium	-	-
RED FOX P-21	Uncertain	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
REINDEER A-41	ConocoPhillips	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
REINDEER C-36	Uncertain	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
REINDEER D-27	Uncertain	1966	Yes	1	1	0	1	0.75	1	Low	-	-
ROLAND BAY Y.T. L-41	Imperial	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
RUSSELL H-23	Imperial	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SABINE BAY A-07	Suncor	1976	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SADENE D-02	Uncertain	1977	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SANDY POINT L-46	Suncor	1969	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SATELLITE F-68	Repsol Oil and Gas Canada Inc.	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
SHAKGATLATACHIG D-50	ConocoPhillips	1985	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SHAVILIG J-20	Shell	1992	n/a	0	0	0	0.33	0.08	3	Low	-	-
SHOLOKPAOQAK P-60	ConocoPhillips	1970	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SIKU A-12	ConocoPhillips	1976	n/a	0	0	0	0	0.00	3	Low	-	-
SIKU C-11	ConocoPhillips	1976	n/a	1	1	0	0.66	0.67	2	Medium	-	-
SIKU C-55	ConocoPhillips	1972	Yes	1	1	0	1	0.75	1	Low	-	-
SIKU E-21	ConocoPhillips	1977	n/a	0	0	0	0	0.00	3	Low	-	-
SMOKING HILLS A-23	Uncertain	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
SPRING RIVER YT N-58	Imperial	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
STORKERSON BAY A-15	Husky	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
TAGLU C-42	Imperial	1972	n/a	1	1	n/a	0.66	0.89	1	Medium	-	Yes
TAGLU D-43	Imperial	1973	n/a	1	1	n/a	1	1.00	1	Medium	Yes	Yes
TAGLU D-55	Imperial	1972	n/a	1	1	n/a	1	1.00	1	Medium	-	Yes
TAGLU G-33	Imperial	1971	n/a	1	1	n/a	1	1.00	1	Medium	Yes	Yes
TAGLU H-54	Imperial	1977	n/a	1	1	n/a	0	0.67	2	Medium	-	Yes
TAGLU N-43	Imperial	1977	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
TAGLU WEST H-06	Imperial	1985	n/a	0	0	n/a	0	0.00	3	Medium	-	-
TAGLU WEST P-03	Imperial	1972	n/a	1	1	n/a	0.33	0.78	1	Medium	-	Yes
TIRITCHIK M-48	Husky	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
TITALIK K-26	Uncertain	1973	n/a	0	1	0	1	0.50	2	Medium	-	Yes
TITALIK O-15	Uncertain	1975	n/a	0	1	0	1	0.50	2	Low	-	-
TOAPOLOK H-24	ConocoPhillips	1974	No	1	0	0	0.33	0.33	2	Low	-	-
TOAPOLOK O-54	ConocoPhillips	1974	n/a	1	1	1	1	1.00	1	Medium	-	-
TUK B-02 and M-18	Canadian Natural Resources	2002	No	1	1	0	1	0.75	2	Low	-	Yes
TUK B-40	Imperial	1986	n/a	1	0	1	n/a	0.67	2	Medium	-	-
TUK E-20	Imperial	1991	n/a	1	0	1	0	0.50	2	Low	-	-
TUK F-18	Imperial	1969	n/a	1	1	0	0.66	0.67	2	Medium	-	Yes
TUK G-39	Imperial	1986	n/a	0	0	0	0	0.00	3	Low	-	Yes
TUK G-48	Imperial	1986	n/a	0	0	0	0.33	0.08	3	Low	-	Yes
TUK H-30	Imperial	1985	n/a	0	0	n/a	0	0.00	3	Medium	-	-
TUK J-29	Imperial	1985	n/a	0	0	0	0.33	0.08	3	Medium	-	-
TUK L-09	Imperial	1984	n/a	1	0	1	0.66	0.67	2	Medium	-	-
TUKTU O-19	Imperial	1971	n/a	0	1	0	1	0.50	2	Low	-	-
TUKTUK A-12	Imperial	1986	n/a	0	0	0	0.33	0.08	3	Low	-	-
TUKTUK D-11	Imperial	1986	n/a	0	0	0	0.33	0.08	3	Medium	-	-
TUKTUK H-22	Imperial	1986	n/a	0	0	0	0	0.00	3	Medium	-	-

Well Name	Owner	Closure Year	Noted as Failed in Reporting	Cracking or Sloughing Weight - Yes = 1 No = 0	Subsidence Weight None/Minor = 0 Other = 1	Sedimentation or Erosion Weight Yes = 1 No = 0	Ponding Weight None = 0 Minor = 0.33 Moderate = 0.66 Major = 1	Total	Sump Class 1-3	Risk Rank	GNWT Priority	Inuvialuit Engagement Priority
TULLUGAK K-31	Shell	1977	n/a	0	1	0	1	0.50	2	Low	-	Yes
TUNUNUK F-30	ConocoPhillips	1976	No	0	0	0	0.33	0.08	3	Low	-	Yes
TUNUNUK K-10	Imperial	1969	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
ULU A-35	Shell	1976	n/a	0	1	n/a	0.66	0.55	2	Low	-	Yes
UMIAK J-37	Imperial	1973	n/a	0	0	1	0.33	0.33	2	Low	-	Yes
UMIAK N-05	MGM Energy Corp.	2005	No	1	1	0	1	0.75	2	Medium	-	Yes
UMIAK N-10	Imperial	1977	n/a	0	1	0	0.66	0.42	2	Medium	-	-
UMIAK N-16	MGM Energy Corp.	2004	No	1	1	0	0.33	0.58	2	Low	-	Yes
UMINMAK H-07	Husky	1972	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
UNAK B-11	Shell	1974	n/a	0	1	1	1	0.75	1	Medium	-	Yes
UNAK L-28	Shell	1986	n/a	0	1	0	1	0.50	2	Medium	-	-
UNIPKAT B-12	Shell	1992	n/a	0	0	0	0.33	0.08	3	Low	-	-
UNIPKAT I-22	Shell	1973	Yes	1	1	1	0	0.75	1	Medium	-	-
UNIPKAT N-12	Shell	1990	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
UPLUK A-42	Chevron	1977	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
UPLUK C-21	Chevron	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
UPLUK L-42	Chevron	1985	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
UPLUK M-38	Chevron	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
VICTORIA ISLAND F-36	Murphy Oil Company Ltd.	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
W. HECLA C-05	Suncor	1976	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
WAGNARK C-23	Imperial	1976	n/a	0	0	0	0	0.00	3	Medium	-	-
WAGNARK G-12	Imperial	1973	n/a	0	0	0	0.33	0.08	3	Medium	-	-
WAGNARK L-36	Imperial	1986	n/a	0	0	1	n/a	0.33	2	Low	-	-
WILKIE POINT J-51	Husky	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-
WILKINS E-60	Husky	1971	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
WINTER HARBOUR NO.1(A-09)	BP	1962	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
WOLVERINE H-34	Chevron	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	-
YA-YA A-28	Uncertain	1974	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
YA-YA I-17	Uncertain	1975	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	-	Yes
YA-YA M-33	ConocoPhillips	1975	No	1	0	0	0.33	0.33	2	Low	-	Yes
YA-YA P-53	Uncertain	1973	Yes	1	1	0	1	0.75	1	Low	-	Yes
ZEUS F-11	Suncor	1973	n/a	n/a	n/a	n/a	n/a	n/a	Unknown	Low	Yes	-

Table B-8: Sumps within the Inuvialuit Region and their associated risk ranking.

		Hazard Factors				Receptor Factors		Exposure Pathway Factors									
		Soil		Water		Human	Ecological	Stability				Environmental Settings					
		H1	H2	H3	H4	R1	R2	E1	E2	E3	E4	E5	E6	E7			
Well Name	Owner	Soil contamination	Salt staining	Surface water contamination	Contaminant migration beyond sump	Distance to surface water	Within Recognized Protected Area	Cap vegetation layer deficiency	Cap subsidence	Surface water ponding	Cap cracking, sloughing, sedimentation or erosion	Seasonality of sump operation	Site soil characteristics conducive to surface water runoff	Active layer depths with potential for release of contaminants	Total Risk Score	Risk Rank	% Factors Available
AKKU F-14	Imperial	0.5	1	n/a	1	0.3	0	0	n/a	n/a	0	0	0.25	1	4	Low	76.9
AKLAVIK A-37	Shell	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
AMAGUK H-16	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
AMAROK N-44	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
ANDREASEN L-32	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
APOLLO C-73	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	2.25	Low	30.8
APUT D-43	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	0.0
ATERTAK E-41	Imperial	n/a	0	1	0	0.3	0	1	1	n/a	0.5	1	0.25	1	5	Medium	76.9
ATERTAK K-31	Imperial	n/a	n/a	n/a	1	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	3.25	Low	38.5
ATIGI G-04	ConocoPhillips	n/a	1	0.5	1	0.8	0	0.5	1	0.33	0.5	0	0.25	1	6.83	Medium	92.3
ATIGI O-48	ConocoPhillips	0.5	n/a	n/a	1	0.0	0	0.5	1	1	0.5	0	n/a	n/a	4.5	Low	69.2
ATIK P-19	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	0.0
ATKINSON A-55	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
ATKINSON H-25	Imperial	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
ATKINSON M-33	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
BAR HARBOUR E-76	Suncor	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
BEAVER HOUSE CREEK H-13	Shell	n/a	n/a	n/a	1	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	30.8
BLOW RIVER YT E-47	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
BROCK C-50	Suncor	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.75	Low	23.1
BROCK I-20	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
BURNT LK		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	Low	0.0
CAPE NOREM A-80	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
CASTEL BAY C-68	Suncor	n/a	n/a	n/a	n/a	0.3	1	n/a	n/a	n/a	n/a	0	n/a	n/a	1.25	Low	23.1
CROSSLEY LK S K-60	Encana	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1	Low	23.1
DEPOT ISLAND C-44	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
DUNDAS C-80	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
DYER BAY L-49	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
E. HECLA C-32	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
E. HECLA F-62	Suncor	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	23.1
EGLINTON P-24	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
ELLICE I-48	Uncertain	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	0	n/a	n/a	1.25	Low	30.8
ELLICE J-27	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	0.0
ELLICE O-14	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
EMERALD K-33	BP	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	0	n/a	0	n/a	n/a	0.75	Low	30.8
ESKIMO J-07	Imperial	0.5	0	n/a	1	0.3	0	0	0	0.33	0	1	0.5	n/a	3.58	Low	84.6
FISH RIVER B-60	Chevron	1	0	1	0	0.3	0	0	1	n/a	0.5	1	0.5	n/a	5.25	Medium	84.6
GARRY G-07	Uncertain	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1	Low	23.1
GARRY P-04	Uncertain	n/a	n/a	n/a	n/a	0.8	1	n/a	n/a	n/a	n/a	1	n/a	n/a	2.75	Low	23.1
HANSEN G-07	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
HEARNE F-85	BP	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
HECLA I-69	Suncor	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	23.1
HECLA J-60	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
HORTON RIVER G-02	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
IKHIL A-01	ConocoPhillips	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	2.25	Low	30.8
IKHIL I-37	Uncertain	1	n/a	1	1	0.3	0	0	1	n/a	0	1	n/a	n/a	5.25	Medium	69.2
IKHIL J-35	Inuvialuit Petroleum Corporation	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
IKHIL K-35	Inuvialuit Petroleum Corporation	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
IKHIL N-26	Inuvialuit Petroleum Corporation	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	0	n/a	n/a	1.25	Low	30.8
IKHIL UGFI 02/J-35	Utility Group Facilities Inc.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	0.0
IKKARIKTOK M-64	Uncertain	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1

		Hazard Factors				Receptor Factors		Exposure Pathway Factors									
		Soil		Water		Human	Ecological	Stability				Environmental Settings					
		H1	H2	H3	H4	R1	R2	E1	E2	E3	E4	E5	E6	E7			
Well Name	Owner	Soil contamination	Salt staining	Surface water contamination	Contaminant migration beyond sump	Distance to surface water	Within Recognized Protected Area	Cap vegetation layer deficiency	Cap subsidence	Surface water ponding	Cap cracking, sloughing, sedimentation or erosion	Seasonality of sump operation	Site soil characteristics conducive to surface water runoff	Active layer depths with potential for release of contaminants	Total Risk Score	Risk Rank	% Factors Available
IMNAK J-29	BP	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
INTREPID INLET H-49	Husky	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.75	Low	23.1
IOL DRILL SUMP		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	n/a	n/a	n/a	n/a	0	Low	7.7
ITIGINKPAK F-29	Canadian Natural Resources	n/a	n/a	n/a	1	0.3	0	0	1	n/a	0	0	n/a	n/a	2.25	Low	53.8
ITKRILEK B-52	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0.33	n/a	0	n/a	n/a	0.58	Low	30.8
IVIK C-52	Imperial	0.5	1	1	1	0.3	0	0	1	0.66	0.5	0	0	0	5.91	Medium	100.0
IVIK J-26	Imperial	0.5	1	0.5	1	0.0	0	0	0.2	0.66	0	1	0	1	5.86	Medium	100.0
IVIK K-54	Imperial	0.5	1	0.5	1	0.3	0	0.5	1	0	0.5	1	1	n/a	7.25	Medium	92.3
IVIK N-17	Imperial	n/a	1	1	1	0.3	0	0	0	n/a	0	0	0	0	3.25	Low	84.6
JAMESON BAY C-31	Husky	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	0	n/a	1	n/a	n/a	1.75	Low	30.8
KAMIK D-48	ConocoPhillips	0.5	1	1	0	0.3	0	0	0	0	0	0	0.25	0	3	Low	100.0
KAMIK D-58	ConocoPhillips	0.5	1	1	0	0.8	0	0	0.2	0.33	0.5	0	0.5	0	4.78	Low	100.0
KAMIK F-38	ConocoPhillips	0.5	1	0	0	0.0	0	0	0.2	0	0	0	0.75	0	2.45	Low	100.0
KAMIK L-60	ConocoPhillips	0.5	1	1	1	0.3	0	0	0.2	n/a	1	1	0.75	1	7.7	Medium	92.3
KANGUK F-42	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
KANGUK I-24	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
KAPIK J-39	Imperial	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	0.33	n/a	0	n/a	n/a	0.33	Low	30.8
KIKORALOK N-46	ConocoPhillips	n/a	n/a	n/a	0	0.3	0	0	1	n/a	0.5	0	n/a	n/a	1.75	Low	53.8
KILAGMIOTAK F-48	ConocoPhillips	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
KILAGMIOTAK M-16	ConocoPhillips	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	23.1
KILIGVAK I-29	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
KIMIK D-29	Imperial	n/a	n/a	n/a	1	0.3	0	n/a	n/a	1	n/a	0	n/a	n/a	2.25	Low	38.5
KIPNIK O-20	Shell	0.5	1	1	0	0.3	0	1	1	n/a	0.5	1	1	1	8.25	Medium	92.3
KITSON R. C-71	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
KUGALUK N-02	Encana	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	2.25	Low	30.8
KUGPIK L-24	Shell	n/a	1	n/a	1	0.3	0	0.5	1	1	0	0	1	0	5.75	Medium	84.6
KUGPIK L-46	Suncor	n/a	n/a	n/a	0	0.3	0	0	1	1	0	0	n/a	n/a	2.25	Low	61.5
KUGPIK O-13	Shell	1	1	1	1	0.3	0	0.5	1	1	0.5	1	1	0	9.25	Medium	100.0
KUMAK A-29 (I-29)	Shell	0.5	0	n/a	1	0.3	1	0	1	0.66	0	0	0	1	5.41	Medium	92.3
KUMAK C-58	Shell	0.5	1	1	1	0.3	1	0	1	0	0	1	0.5	1	8.25	Medium	100.0
KUMAK E-58	Shell	0.5	1	1	1	0.3	1	0	0.2	0.33	0	1	0.5	1	7.78	Medium	100.0
KUMAK I-25 and UNIPKAT M-45	MGM Energy Corp.	0.5	n/a	0.5	0	0.3	1	0	1	1	0.5	0	n/a	n/a	4.75	Low	76.9
KUMAK J-06	Shell	0.5	1	1	1	0.0	1	1	1	0.33	0	1	0	0	7.83	Medium	100.0
KUMAK K-16	Shell	0.5	1	n/a	1	0.3	1	0	0.2	0.33	0	1	0.5	1	6.78	Medium	92.3
KURK M-15	Suncor	0.5	n/a	0	1	0.3	0	0	0.2	n/a	1	0	n/a	n/a	2.95	Low	69.2
KURK M-39	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
KUSRHAAK D-16	Husky	n/a	n/a	n/a	n/a	0.3	1	n/a	n/a	1	n/a	1	n/a	n/a	3.25	Low	30.8
LANGLEY E-07	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	0.0
LANGLEY E-29	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0	n/a	1	n/a	n/a	1.25	Low	30.8
LANGLEY K-30	MGM Energy Corp.	1	n/a	0	0	0.8	0	0.5	1	n/a	1	0	n/a	n/a	4.25	Low	69.2
LOUTH K-45	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0	n/a	0	n/a	n/a	0.25	Low	30.8
MAGAK A-32	Imperial	0.5	1	0.5	1	1.0	0	1	0.2	n/a	1	0	0.75	1	7.95	Medium	92.3
MALLIK 2L-38	Japex	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	1	n/a	0	n/a	n/a	2	Low	30.8
MALLIK 3L,4L,5L-38	Japex	n/a	n/a	n/a	n/a	0.8	0	1	1	n/a	0	0	n/a	n/a	2.75	Low	46.2
MALLIK 6L-38	Japex	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	0.66	n/a	0	n/a	n/a	1.41	Low	30.8
MALLIK A-06	Imperial	1	1	1	0	0.3	0	0	1	n/a	0	1	0	1	6.25	Medium	92.3
MALLIK J-37	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
MALLIK L-38	Imperial	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	23.1
MALLIK P-59	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
MARIE BAY D-02	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0.33	n/a	1	n/a	n/a	1.58	Low	30.8
MAYOGIAK G-12	Imperial	0.5	1	1	1	0.3	0	0	0.2	0	0	0	1	1	5.95	Medium	100.0
MAYOGIAK J-17	Imperial	n/a	0	n/a	1	0.0	0	0.5	0.2	0	0.5	1	0.75	1	4.95	Low	84.6
MAYOGIAK L-39	Imperial	0.5	0	0.5	0	0.8	0	0	0	0	0	1	0.75	1	4.5	Low	100.0
MAYOGIAK M-16	Imperial	0.5	0	1	0	0.3	0	0	0	0.33	0	0	1	1	4.08	Low	100.0
MAYOGIAK N-34	Imperial	0.5	0	0.5	0	0.3	0	0	1	n/a	0	0	0.5	1	3.75	Low	92.3

		Hazard Factors				Receptor Factors		Exposure Pathway Factors									
		Soil		Water		Human	Ecological	Stability				Environmental Settings					
		H1	H2	H3	H4	R1	R2	E1	E2	E3	E4	E5	E6	E7			
Well Name	Owner	Soil contamination	Salt staining	Surface water contamination	Contaminant migration beyond sump	Distance to surface water	Within Recognized Protected Area	Cap vegetation layer deficiency	Cap subsidence	Surface water ponding	Cap cracking, sloughing, sedimentation or erosion	Seasonality of sump operation	Site soil characteristics conducive to surface water runoff	Active layer depths with potential for release of contaminants	Total Risk Score	Risk Rank	% Factors Available
MUSKOX D-87	Chevron	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.75	Low	23.1
N. DUNDAS N-82	BP	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
N2006A0029		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	Low	0.0
NANUK D-76	Husky	n/a	n/a	n/a	n/a	0.3	1	n/a	n/a	n/a	n/a	0	n/a	n/a	1.25	Low	23.1
NAPARTOK M-01	Imperial	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
NAPOIAK F-31	Shell	n/a	n/a	n/a	1	1.0	0	n/a	1	n/a	0	1	na	n/a	4	Low	46.2
NATAGNAK H-50	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
NATAGNAK K-23	Imperial	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.75	Low	23.1
NATAGNAK K-53	Imperial	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	23.1
NATAGNAK O-59	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
NICHOLSON G-56	Chevron	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1	Low	23.1
NICHOLSON N-45	Chevron	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	0.33	n/a	0	n/a	n/a	1.33	Low	30.8
NIGLINTGAK B-19	Shell	0.5	1	0.5	1	1.0	0	0	0.2	1	0	0	0.5	0	5.7	Medium	100.0
NIGLINTGAK H-30	Shell	0.5	1	0.5	1	0.3	0	0.5	1	0.66	0.5	0	1	0	6.91	Medium	100.0
NIGLINTGAK M-19	Shell	1	1	n/a	1	0.3	0	0	1	1	0	1	0.75	0	7	Medium	92.3
NORTH ELLICE J-17	MGM Energy Corp.	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	No sump	0.0
NORTH ELLICE J-23	Chevron	0.5	1	1	0	1.0	0	0.5	1	n/a	0.5	0	0.75	1	7.25	Medium	92.3
NUKTAK C-22	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
NUNA A-10	Imperial	0.5	1	n/a	1	0.8	0	0	0.2	0.33	0.5	0	0.5	1	5.78	Medium	92.3
NUNA A-32	Imperial	0.5	1	0.5	0	0.0	0	0	1	0	0	0	0	1	4	Low	100.0
NUNA E-40 (D-40)	Imperial	0.5	1	1	0	0.3	0	0	0	0.33	0	0	0.25	1	4.33	Low	100.0
NUNA I-30	Suncor	n/a	n/a	0.5	0	0.3	0	1	0	n/a	0.5	0	n/a	n/a	2.25	Low	61.5
NUVORAK O-09	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
OGEOQEOQ J-06	ConocoPhillips	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0.33	n/a	0	n/a	n/a	0.58	Low	30.8
OGRUKNANG M-31	ConocoPhillips	n/a	n/a	n/a	0	0.0	0	1	0.2	n/a	0	1	n/a	n/a	2.2	Low	53.8
OH1 SUMP		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0	Low	0.0
ONIGAT C-38	ConocoPhillips	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.75	Low	23.1
ONIGAT D-52	ConocoPhillips	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	0.33	n/a	0	n/a	n/a	0.33	Low	30.8
ONIGAT K-49	ConocoPhillips	1	1	0.5	0	0.3	0	0	0.2	n/a	0	0	0	0	2.95	Low	92.3
ORKSUT I-44	Deminex	n/a	n/a	n/a	n/a	0.8	1	n/a	n/a	n/a	n/a	0	n/a	n/a	1.75	Low	23.1
PARKER RIVER J-72	Chevron	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0	n/a	1	n/a	n/a	1.25	Low	30.8
PARSONS A-44	ConocoPhillips	1	0	1	1	0.3	0	1	0.2	0	0	1	0	1	6.45	Medium	100.0
PARSONS D-20	ConocoPhillips	0.5	1	1	1	0.3	0	1	0.2	1	1	1	0.75	1	9.7	Medium	100.0
PARSONS E-02	ConocoPhillips	0.5	0	n/a	0	0.3	0	0	1	0.66	1	0	0.75	0	4.16	Low	92.3
PARSONS F-09	ConocoPhillips	1	1	1	1	0.3	0	0	1	0.33	1	0	0	1	7.58	Medium	100.0
PARSONS L-37	ConocoPhillips	0.5	1	1	0	0.3	0	0	0.2	1	0.5	0	0.25	1	5.7	Medium	100.0
PARSONS L-43	ConocoPhillips	0.5	0	0.5	0	0.3	0	1	1	0	0.5	0	0	1	4.75	Low	100.0
PARSONS N-10	ConocoPhillips	n/a	0	n/a	1	0.3	0	0	0	0.66	0	1	0.75	0	3.66	Low	84.6
PARSONS N-17	ConocoPhillips	1	0	1	1	0.3	0	0	1	0.66	1	0	0.75	0	6.66	Medium	100.0
PARSONS O-27	ConocoPhillips	1	0	1	1	1.0	0	0	1	0.33	1	1	0.75	0	8.08	Medium	100.0
PARSONS P-41	ConocoPhillips	0.5	0	0.5	0	0.3	0	0	1	0.33	0	0	0	0	2.58	Low	100.0
PARSONS P-53	ConocoPhillips	0.5	0	1	0	0.3	0	0	1	n/a	0.5	0	0	0	3.25	Low	92.3
PEDDER POINT D-49	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0.66	n/a	0	n/a	n/a	0.91	Low	30.8
PIKIOLIK E-54	Imperial	0.5	1	1	0	0.3	0	0	0.2	0.33	0	0	0.25	1	4.53	Low	100.0
PIKIOLIK G-21	Imperial	0.5	1	1	0	0.3	0	0	0.2	0.33	0.5	0	1	1	5.78	Medium	100.0
PIKIOLIK M-26	Imperial	0.5	0	1	1	1.0	0	0	0.2	n/a	0	0	1	1	5.7	Medium	92.3
RED FOX P-21	Uncertain	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	1	n/a	n/a	2	Low	23.1
REINDEER A-41	ConocoPhillips	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
REINDEER C-36	Uncertain	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	2.25	Low	30.8
REINDEER D-27	Uncertain	n/a	n/a	n/a	0	0.8	0	1	1	n/a	0.5	1	n/a	n/a	4.25	Low	53.8
ROLAND BAY Y.T. L-41	Imperial	n/a	n/a	n/a	n/a	0.0	1	n/a	n/a	n/a	n/a	0	n/a	n/a	1	Low	23.1
RUSSELL H-23	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
SABINE BAY A-07	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
SADENE D-02	Uncertain	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1	Low	23.1
SANDY POINT L-46	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1

		Hazard Factors				Receptor Factors		Exposure Pathway Factors									
		Soil		Water		Human	Ecological	Stability				Environmental Settings					
		H1	H2	H3	H4	R1	R2	E1	E2	E3	E4	E5	E6	E7			
Well Name	Owner	Soil contamination	Salt staining	Surface water contamination	Contaminant migration beyond sump	Distance to surface water	Within Recognized Protected Area	Cap vegetation layer deficiency	Cap subsidence	Surface water ponding	Cap cracking, sloughing, sedimentation or erosion	Seasonality of sump operation	Site soil characteristics conducive to surface water runoff	Active layer depths with potential for release of contaminants	Total Risk Score	Risk Rank	% Factors Available
SATELLITE F-68	Repsol Oil and Gas Canada Inc.	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
SHAKGATLATACHIG D-50	ConocoPhillips	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	0.33	n/a	0	n/a	n/a	1.08	Low	30.8
SHAVILIG J-20	Shell	1	0	0.5	0	0.3	0	0	0.2	n/a	0	0	1	0	2.95	Low	92.3
SHOLOKPAOQAK P-60	ConocoPhillips	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0	n/a	0	n/a	n/a	0.25	Low	30.8
SIKU A-12	ConocoPhillips	n/a	0	n/a	1	0.3	0	0	0	0.66	0	1	0.5	n/a	3.41	Low	76.9
SIKU C-11	ConocoPhillips	0.5	1	1	1	0.3	0	0.5	1	1	0.5	0	0.5	0	7.25	Medium	100.0
SIKU C-55	ConocoPhillips	1	n/a	n/a	0	0.3	0	0.5	1	0	0.5	1	n/a	n/a	4.25	Low	69.2
SIKU E-21	ConocoPhillips	n/a	0	n/a	0	0.3	0	0	0	n/a	0	1	0.75	0	2	Low	76.9
SMOKING HILLS A-23	Uncertain	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
SPRING RIVER YT N-58	Imperial	n/a	n/a	n/a	n/a	0.3	1	n/a	n/a	n/a	n/a	0	n/a	n/a	1.25	Low	23.1
STORKERSON BAY A-15	Husky	n/a	n/a	n/a	n/a	0.0	1	n/a	n/a	0.66	n/a	0	n/a	n/a	1.66	Low	30.8
TAGLU C-42	Imperial	0.5	1	1	0	0.8	0	0	1	1	0.5	1	1	n/a	7.75	Medium	92.3
TAGLU D-43	Imperial	1	1	0.5	0	0.8	1	0	1	1	0.5	1	0.5	1	9.25	Medium	100.0
TAGLU D-55	Imperial	n/a	1	0.5	n/a	0.0	1	1	1	1	0.5	1	0.5	1	8.5	Medium	84.6
TAGLU G-33	Imperial	0	1	0.5	0	0.8	0	0	1	0	0.5	1	0.5	1	6.25	Medium	100.0
TAGLU H-54	Imperial	0.5	1	0.5	1	0.3	1	0	0.2	n/a	0.5	0	0.5	1	6.45	Medium	92.3
TAGLU N-43	Imperial	n/a	n/a	n/a	n/a	0.0	1	n/a	n/a	0	n/a	0	n/a	n/a	1	Low	30.8
TAGLU WEST H-06	Imperial	1	0	0.5	0	0.3	1	1	0	0.33	0	1	0.5	1	6.58	Medium	100.0
TAGLU WEST P-03	Imperial	0.5	1	1	1	0.0	1	0	1	n/a	0.5	0	0.5	1	7.5	Medium	92.3
TIRITCHIK M-48	Husky	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	1	n/a	0	n/a	n/a	1.75	Low	30.8
TITALIK K-26	Uncertain	0.5	0	0.5	1	0.3	0	0	1	1	0	0	0.75	0	5	Medium	100.0
TITALIK O-15	Uncertain	n/a	0	0.5	1	0.0	0	0	1	0.33	0	1	0	n/a	3.83	Low	84.6
TOAPOLOK H-24	ConocoPhillips	0.5	n/a	n/a	1	0.8	0	0	0	1	0.5	1	n/a	n/a	4.75	Low	69.2
TOAPOLOK O-54	ConocoPhillips	1	0	0.5	1	0.0	0	1	1	0.66	1	0	0.5	0	6.66	Medium	100.0
TUK B-02 and M-18	Canadian Natural Resources	n/a	n/a	n/a	n/a	0.3	0	0.5	1	n/a	0.5	0	n/a	n/a	2.25	Low	46.2
TUK B-40	Imperial	0.5	1	n/a	1	0.8	0	0	0	0	1	0	0	1	5.25	Medium	92.3
TUK E-20	Imperial	n/a	0	1	0	0.3	0	0	0	0.66	1	0	0.5	1	4.41	Low	92.3
TUK F-18	Imperial	n/a	0	0.5	0	1.0	0	0.5	1	0	0.5	0	0.5	1	5	Medium	92.3
TUK G-39	Imperial	0.5	0	0.5	1	0.3	0	0	0	0.33	0	0	0	0	2.58	Low	100.0
TUK G-48	Imperial	1	0	1	1	0.3	0	0	0.2	0	0	0	0	1	4.45	Low	100.0
TUK H-30	Imperial	1	1	0.5	1	0.3	0	0	0	0.33	0	1	0	1	6.08	Medium	100.0
TUK J-29	Imperial	0.5	1	1	1	0.3	0	0	0.2	0.66	0	0	1	1	6.61	Medium	100.0
TUK L-09	Imperial	0.5	1	1	1	0.3	0	0.5	0.2	1	1	0	0.25	1	7.7	Medium	100.0
TUKTU O-19	Imperial	0.5	0	n/a	1	0.3	0	0	0	1	0	0	0.75	1	4.5	Low	92.3
TUKTUK A-12	Imperial	1	0	n/a	1	0.8	0	1	1	0.33	0	0	0.75	1	6.83	Medium	92.3
TUKTUK D-11	Imperial	1	1	1	1	0.3	0	0	0	0.33	0	0	1	n/a	5.58	Medium	92.3
TUKTUK H-22	Imperial	0.5	1	0.5	1	0.3	0	0	0.2	0	0	0	0.5	1	4.95	Low	100.0
TULLUGAK K-31	Shell	0.5	0	0.5	0	0.3	0	1	1	0.33	0	0	1	0	4.58	Low	100.0
TUNUNUK F-30	ConocoPhillips	0.5	n/a	n/a	0	0.0	0	0	0	n/a	0	1	n/a	n/a	1.5	Low	61.5
TUNUNUK K-10	Imperial	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0.66	n/a	1	n/a	n/a	1.91	Low	30.8
ULU A-35	Shell	0.5	n/a	1	0	0.3	0	0	1	0.33	0	1	na	0	4.08	Low	84.6
UMIAK J-37	Imperial	0.5	0	n/a	0	0.8	0	0	0	0.66	0.5	0	0	1	3.41	Low	92.3
UMIAK N-05	MGM Energy Corp.	0.5	n/a	1	1	0.3	0	0.5	1	0.66	0.5	0	n/a	n/a	5.41	Medium	76.9
UMIAK N-10	Imperial	0.5	1	0.5	0	0.3	0	0	1	0.33	0	1	0.75	1	6.33	Medium	100.0
UMIAK N-16	MGM Energy Corp.	0.5	n/a	0.5	1	0.3	0	0.5	1	n/a	0.5	0	n/a	n/a	4.25	Low	69.2
UMINMAK H-07	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	2.25	Low	30.8
UNAK B-11	Shell	0.5	1	0.5	1	0.3	0	0	1	1	0.5	0	1	0	6.75	Medium	100.0
UNAK L-28	Shell	0.5	0	n/a	1	0.8	0	0	1	0.33	0	1	1	0	5.58	Medium	92.3
UNIPKAT B-12	Shell	0.5	1	0.5	0	0.8	0	0	0.2	0	0	0	1	1	4.95	Low	100.0
UNIPKAT I-22	Shell	1	0	1	1	0.8	0	0	1	n/a	1	1	0.75	0	7.5	Medium	92.3
UNIPKAT N-12	Shell	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
UPLUK A-42	Chevron	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1

		Hazard Factors				Receptor Factors		Exposure Pathway Factors									
		Soil		Water		Human	Ecological	Stability				Environmental Settings					
		H1	H2	H3	H4	R1	R2	E1	E2	E3	E4	E5	E6	E7			
Well Name	Owner	Soil contamination	Salt staining	Surface water contamination	Contaminant migration beyond sump	Distance to surface water	Within Recognized Protected Area	Cap vegetation layer deficiency	Cap subsidence	Surface water ponding	Cap cracking, sloughing, sedimentation or erosion	Seasonality of sump operation	Site soil characteristics conducive to surface water runoff	Active layer depths with potential for release of contaminants	Total Risk Score	Risk Rank	% Factors Available
UPLUK C-21	Chevron	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
UPLUK L-42	Chevron	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
UPLUK M-38	Chevron	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
VICTORIA ISLAND F-36	Murphy Oil Company Ltd.	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
W. HECLA C-05	Suncor	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	0	n/a	1	n/a	n/a	2	Low	30.8
WAGNARK C-23	Imperial	0.5	1	0.5	1	0.3	0	0	0.2	0.33	0	1	0	1	5.78	Medium	100.0
WAGNARK G-12	Imperial	1	1	0.5	1	0.3	0	0	0.2	n/a	0	1	0	1	5.95	Medium	92.3
WAGNARK L-36	Imperial	0.5	1	0.5	0	0.3	0	0	0.2	n/a	0.5	0	0	1	3.95	Low	92.3
WILKIE POINT J-51	Husky	n/a	n/a	n/a	n/a	0.8	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.75	Low	23.1
WILKINS E-60	Husky	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0.25	Low	23.1
WINTER HARBOUR NO.1(A-09)	BP	n/a	n/a	n/a	n/a	1.0	0	n/a	n/a	n/a	n/a	1	n/a	n/a	2	Low	23.1
WOLVERINE H-34	Chevron	n/a	n/a	n/a	n/a	0.0	0	n/a	n/a	n/a	n/a	0	n/a	n/a	0	Low	23.1
YA-YA A-28	Uncertain	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	n/a	n/a	1	n/a	n/a	1.25	Low	23.1
YA-YA I-17	Uncertain	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	0.33	n/a	0	n/a	n/a	0.58	Low	30.8
YA-YA M-33	ConocoPhillips	1	n/a	n/a	1	0.3	0	0.5	0	1	0.5	0	n/a	n/a	4.25	Low	69.2
YA-YA P-53	Uncertain	0.5	n/a	n/a	0	0.3	0	1	1	n/a	0.5	0	n/a	n/a	3.25	Low	61.5
ZEUS F-11	Suncor	n/a	n/a	n/a	n/a	0.3	0	n/a	n/a	1	n/a	1	n/a	n/a	2.25	Low	30.8

APPENDIX C: AIR AND GROUND TEMPERATURE EVALUATION AND 10-YEAR FORECAST IN THE INUVIALUIT SETTLEMENT REGION

Air and Ground Temperature Evaluation and 10-Year Forecast in the Inuvialuit Settlement Region

SLR Project No: 203.02377.0000

February 2020

SLR

Air and Ground Temperature Evaluation and a 10-Year Forecast in the Inuvialuit Settlement Region
SLR Project No: 203.02377.00000

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This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Distribution: 1 copy (PDF) – Arktis Solutions Inc.
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1. INTRODUCTION

The Inuvialuit Settlement Region (ISR), which supports one of the world's major rivers, has warmed by 1.7 degrees Celsius (°C) over the past century. This warming has endangered the long-term stability of much of the permafrost—the frozen mix of rock, soil, and ice that underlies and surrounds the river basin—raising the risk of erosion, flooding, landslides, and other significant changes to the landscape. As a result of ground ice melting, reduction in the extent and distribution of permafrost and in permafrost-related geomorphic processes along with a northward shift in the southern limits of the permafrost zones is likely to occur. An increase in the active layer (seasonal thaw zone) may also occur leading to the drainage of small lakes and ponds. Furthermore, warming temperatures may also decrease the load-bearing strength of the permafrost, thus decreasing the stability of roads, airstrips, pipelines and building foundations (ESRF 2005, Dyke, 2000; Harris, 1987).

Oil and gas exploration began in ISR in 1961 and over 300 wells were drilled since that time (ESRF 2005). The most common disposal method for drilling waste mud and cuttings was below-grade freeze-back, which involved burying waste muds and cuttings in the permafrost and underneath the season thaw zone. This method was understood to provide permanent isolation and containment of the drilling waste.

The Environmental Studies Research Funds report describes August 2004 field program undertaken to characterize drilling waste disposal sumps at selected sites in the ISR (ESRF 2005). The objective of the study was to conduct the sump inventory, including literature review and field assessment and sampling. The 2004 study recommended future monitoring and/or additional field investigations at select locations.

However, since 2004 when the original study was undertaken, climate change impacts are expected to result in further changes in active layer, water balance, and drainage, which could result in potential flooding, and increased risk to the sumps stability and additional permafrost degradation.

2. OBJECTIVES

SLR Consulting (Canada) Ltd. (SLR) has conducted current climate change study to meet the following objectives:

- Evaluate the air/ground temperatures in the region and the predicted changes to the future air/ground temperatures.
- Assess the potential impacts to the receiving environment that could result from the changes in the air/ground temperatures.

SLR conducted a comprehensive climate data analysis to evaluate air and ground temperature to date, and project climate change impacts on air temperature, ground temperature and precipitation in the future 10 years.

2.1 SCOPE OF WORK

The scope of work included the following study phases:

1) Data Collection and Processing

Long-term historical regional climate data (40 years, 1979-2018) was collected at a high-resolution modelling grid consisting of 32 kilometers (km) by 32 km cells across the ISR. This is a backcasting climatic dataset called the North American Regional Reanalysis (NARR) dataset, generated by the National Center for Environmental Prediction (NCEP) of the United States of America (USA). NARR has successfully assimilated high-quality and detailed air and ground temperature, precipitation and other climatic variables over North America, including the ISR. The NARR data was preferred over other available sources of climate data (such as Government of Canada's Climate Atlas) for the following reasons:

- The historical data from Climate Atlas is not derived directly from observation, it is collected from a statistic climate model; and therefore, is less accurate for local level climate studies.
- NARR provides better resolution for climate data resulting in 32 km x 32 km girds; as opposed to 150 km X 150 km grid spacing available from Climate Atlas.
- Climate project models used in Climate Atlas are outdated. The latest NA-CORDEX dataset was used to predict future climate.
- NARR data contains time series (every three hours for 40+ years), which is very important for climatic trend analysis.

All the conventional weather station data within ISR region were collected over the same period (1979-2018) and their data completeness and quality were examined. Therefore, eight local weather stations were used to validate and bias-correct NARR data, which will be explained below.

2) Climate Trend Analysis

The detection, estimation and prediction of trends and associated statistical significance are important aspects of climate research. Given a time series of temperature or precipitation, the trend is the rate at which temperature changes over a time period. Simple linear regression is most commonly used to estimate the linear trend (slope) and statistical significance (via a Student t-test). The non-parametric (i.e., distribution free) Mann-Kendall (M-K) test and the Sen's slope can be used to assess monotonic trend (linear or non-linear) significance as it is much less sensitive to outliers and skewed distributions.

3) Climate Data Analysis and Mapping

The trend analysis from the NARR dataset backcasting was conducted for the historical period and for near future (10 years) to evaluate changing climate in the ISR. Trend projection factors have been applied to near-future based on the past 10-year period due to a stronger relationship with the recent past than prior years.

The climate variables in the study include annual and seasonal air temperature, ground temperature and precipitation. The deliverables include:

- digital tables and maps, database of climate data assessment (delivered);
- paper and digital copies of the report (this copy).

4) Conclusions

The conclusions section presents a summary of the background, methods, and results of the study.

3. DATA COLLECTION AND PROCESSING

3.1 NORTH AMERICAN REGIONAL REANALYSIS (NARR) DATA

Since NARR is a long-term, high frequency, dynamically consistent meteorological and land surface hydrology dataset for the 40-yr period of 1979-2018, it is considered a very important backcasting resource over North America, including the ISR. In this project, statistical analyses of NARR data in ISR were conducted and compared with the past 40 years of local weather station data.

NARR data provides 8 times per day, 32 km by 32 km horizontal grid-size climate dataset over North America. Climate variables available include temperature, wind, humidity, air pressure and ground surface temperature at various depths, precipitation, snow melt and snow cover, soil moisture and surface runoff. **Figure 1** shows an example of underground soil temperature across the entire NARR model domain (0.1 m to 0.4 m below ground, mbg) at 18 UTC on September 18, 2003).

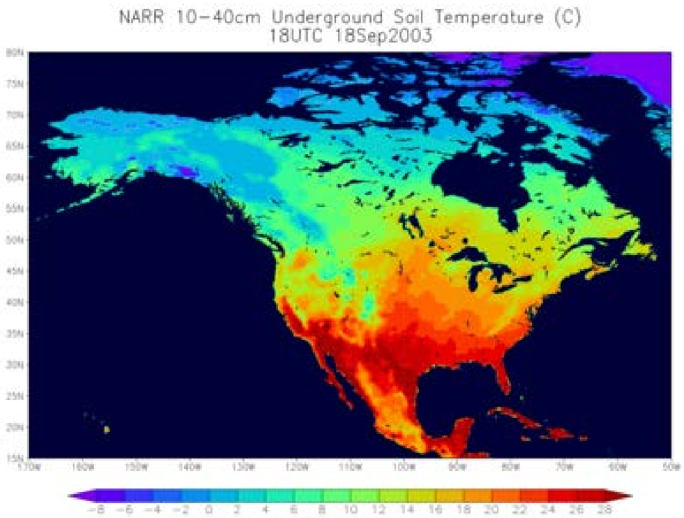

Figure 1: Regional Plot of NARR Underground Soil Temperature.

Raw NARR data is saved in a binary data format called GRIB. GRIB is a World Meteorological Organization (WMO) format for gridded data and is used by USA NOAA (National Oceanic and Atmospheric Administration) operational meteorological centers for storage and the exchange of gridded fields. GRIB's major advantages are as follows:

- files are typically half to one third in size when compared to normal binary files (floats),
- the fields are self-describing, and
- GRIB is an open, international standard.

A set of special software and scripts were required to read, decode and extract climatic variables from the NARR GRIB files. Of the numerous GRIB decoders available, wgrib, was selected for this project because it is the most widely used GRIB decoders and was subsequently installed on SLR's Linux™ cluster at Guelph office. Once NARR data was decoded, the output was used by Google earth and other applications.

NARR data extracted for this study included: daily precipitation; air temperature at 2 m above ground; ground soil temperature at 0 m (surface) and underground at 0.1, 0.4 and 1 mbg.

Figure 2 is the domain coverage of the NARR grids for this project. There are 274 NARR grids that were analyzed during this study and they are indexed from 1 to 274 for identification purposes. Sump sites are shown as red dots. Temperature at each sump site can be determined by the temperature within the corresponding NARR grid.

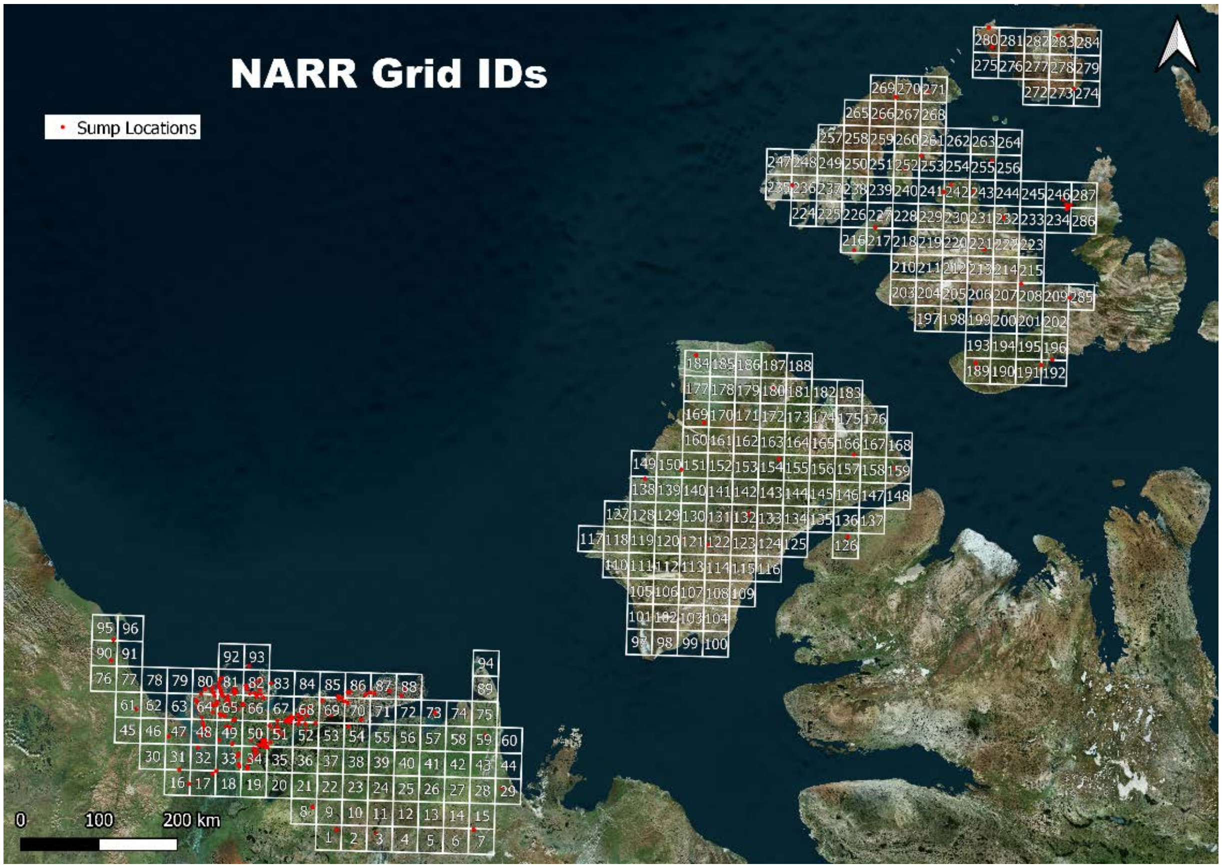

Figure 2: NARR Project Domain Coverage with Grid Ids and Sump Site Locations

In this study,

- Daily mean temperature is the average of the 8 times temperature values measured within 24 hours.
- Monthly mean temperature is the average of the daily mean temperature values of the month.
- Seasonal mean temperature is the average of the daily mean temperature values of the season. Seasons are defined as: Spring – March to May; Summer – June to August; Fall – September to November; and Winter – December to February.
- Annual mean temperature is the average of the daily mean temperature values of the year.
- Same definition applied to precipitation. Precipitation include snow and rain.

3.2 WEATHER STATION DATA AND BIAS CORRECTION

Local weather data[1] from eight weather stations across ISR were downloaded to validate NARR data and applied for bias correction of NARR data using the same 40-year data period (from 1979 to 2018).

Observation vs. NARR comparison (validation)

Although NARR datasets is one of the most reliable reanalysis datasets for North America, it is not a representation of "real" or "observed" values and may contain discrepancies from local observation data. For this reason, NARR data was bias-corrected by the local observed data. Using linear regression analysis, eight observation stations, with high data completeness and quality, were selected to compare daily mean temperature with that of the NARR grid. The linear regression analysis demonstrated that NARR correlates with the weather station data very well, i.e., R value ranges from 0.94 to 0.98 as summarized in the **Table 1** below.

Table 1: Conventional Weather Station Air Temperature Regression Analysis

NAME	WMO ID	Lat/Long	Regression correlation coefficient (R)	Slope "a" of regression correlation	Intercept "b" of regression correlation
INUVIK CLIMATE	713640	68.317N,133.517W	0.97	0.99899	-0.32700
PELLY ISLAND	715020	69.617N,135.433W	0.94	1.15119	2.055457
TRAIL VALLEY	716830	68.75N,133.5W	0.98	1.0199	-0.8958
INUVIK AIRPORT	719570	68.304N,133.483W	0.97	1.01625	-0.22077
AKLAVIK	719575	68.223N,135.006W	0.97	1.01867	-0.41427
TUKTOYAKTUK AIRPORT	719595	69.433N,133.026W	0.97	1.10318	0.37881
LIVERPOOL BAY	719600	69.6N,130.9W	0.97	1.09159	-2.58142
TUKTOYAKTUK(AUTO)	719850	69.433N,133.017W	0.97	1.11123	-0.30375

[1] Obtained from https://gis.ncdc.noaa.gov/maps/ncei/cdo/daily

Figure 3 is the linear regression plot of air temperature between observation and NARR at these locations. The figure shows the scatter plots and correlation of observed versus NARR daily average temperature at observation locations (Note X axis is NARR data and Y axis is observed data).

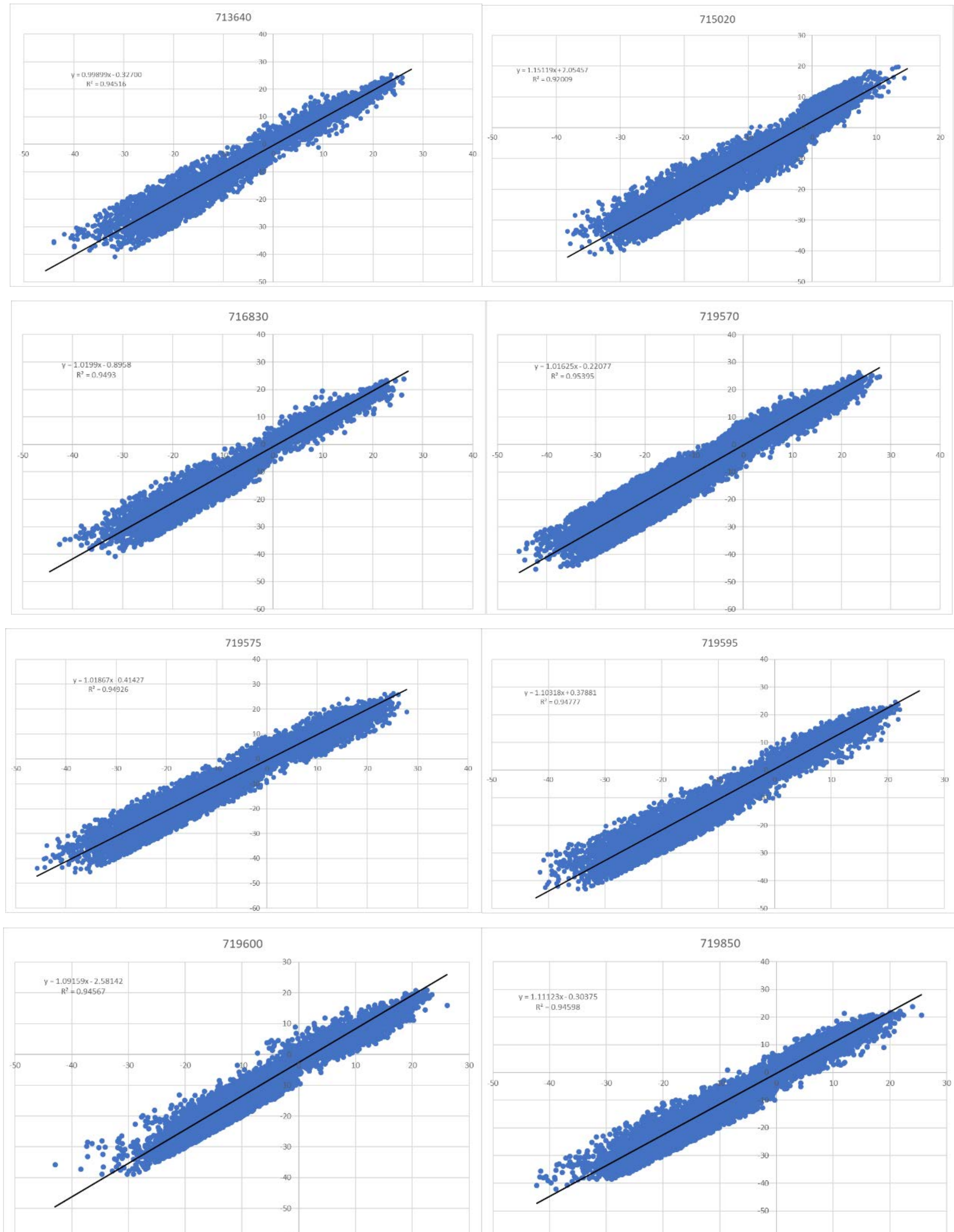

Figure 3: Linear Regression Plot of Air Temperature Between Observation and NARR At These Locations

Figure 4 presents an example of 365-day time series of NARR temperature compared to the Inuvik climate station observations for the year 2011. The NARR Winter temperature shows slightly higher bias than the Summer season, however overall NARR performance is very consistent.

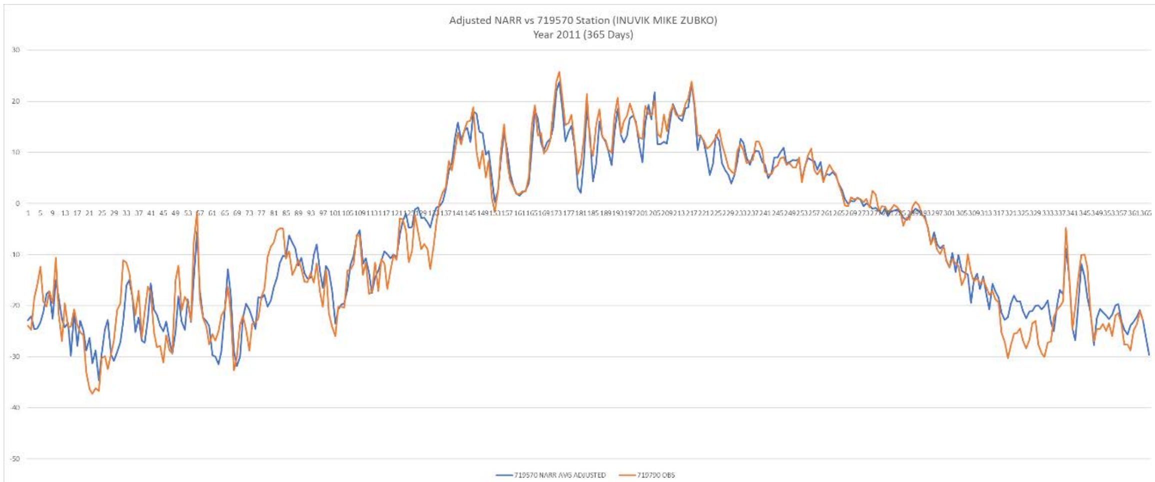

Figure 4: Time Series of Daily Temperature Comparison Between NARR and Weather Station Data.

<u>Bias Correction</u>

NARR air temperature bias correction was conducted by applying a regression formula and then deriving the "corrected" air temperature from NARR grids. This can be achieved by interpolating the regression analysis parameters shown in **Figure 3** with inverse-distance algorithm, which is a widely recognized and popular gridding interpolation method in meteorological science. **Table 2** shows the comparison of NARR data versus observation performance before and after bias correction. Both MAE (Mean Absolute Error) and RMSE (Root Mean Square Error) were reduced and ME (Mean Error) became zero after the correction. All NARR gridded daily air temperatures were bias corrected prior to statistical analysis using this method.

Table 2: Comparison of NARR Performance Before and After Bias Correction.

NAME	Mean Absolute Error (MAE)		Root Mean Square Error (RMSE)		Mean Error (ME)		CORRELATION	
	before	after	Before	After	Before	After	Before	After
INUVIK CLIMATE	3.2	2.7	4.7	3.6	0.7	0.0	0.97	0.97
PELLY ISLAND	3.6	3.0	4.5	3.7	-0.7	0.0	0.94	0.94
TRAIL VALLEY	2.8	2.5	3.8	3.3	1.2	0.0	0.98	0.98
INUVIK AIRPORT	2.8	2.6	3.8	3.5	0.4	0.0	0.97	0.97
AKLAVIK	3.0	2.8	4.0	3.6	0.7	0.0	0.97	0.97
TUKTOYAKTUK AIRPORT	3.1	2.7	4.1	3.4	0.7	0.0	0.97	0.97
LIVERPOOL BAY	4.5	2.5	6.2	3.1	3.5	0.0	0.97	0.97
TUKTOYAKTUK(AUTO)	3.3	2.6	4.4	3.4	1.4	0.0	0.97	0.97

4. METHODOLOGY OF CLIMATE TREND ANALYSIS

Statistical trend estimation methods are well developed and include not only linear curves, but also change-points, accelerated increases, other nonlinear behaviour, and nonparametric descriptions. State-of-the-art, computing-intensive simulation algorithms take into account the peculiar aspects of climate data, namely non-Gaussian distributional shape and autocorrelation.

Tests for the detection of significant trends in climatologic time series can be classified as parametric and no-parametric methods. Parametric trend tests require data to be independent and normally distributed, while non-parametric trend tests require only that the data be independent. The non-parametric Mann-Kendell trend test and Sen's slope (Milan G and Slavisa T, 2013) were used to detect the trends of the climate variables.

4.1 MANN-KENDELL TREND TEST

The Mann-Kendell test statistic S is calculated as:

$$s = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn(x_j - x_i) \qquad (1)$$

Where n is the number of data points (number of years in this analysis), x_i and x_j are the data values of the climate variables (e.g., temperature, precipitation) in time series i and j (j>i), respectively and sgn is the sign function as:

$$sgn(x_j - x_i) = \begin{cases} +1, & if\ x_j - x_i > 0 \\ 0, & if\ x_j - x_i = 0 \\ -1, & if\ x_j - x_i < 0 \end{cases} \qquad (2)$$

The Variance is computed as:

$$Var(S) = \frac{n(n-1)(2n+5) - \sum_{i=1}^{m} t_i(t_i-1)(2t_i+5)}{18} \qquad (3)$$

Where n is the number of data points, m is the number of tied groups and t_i denotes the number of ties of extent i. A tied group is a set of sample data having the same value. In cases where the sample size n>10, the standard normal test statistic Z_S is computed using Eq. (4):

$$z_S = \begin{cases} \frac{S-1}{\sqrt{Var(S)}}, & if\ S > 0 \\ 0, & if\ S = 0 \\ \frac{S+1}{\sqrt{Var(S)}}, & if\ S < 0 \end{cases} \qquad (4)$$

Positive values of Z_S indicate increasing trends while negative Z_S values show decreasing trends.

4.2 SEN'S SLOPE

The usual method for estimating the slope of a regression line that fits a set of (x, y) data elements is based on a least squares estimate. This approach is not valid when the data elements don't fit a straight line; it is also sensitive to outliers.

The non-parametric Sen's slope overcomes the issues mentioned above and has been widely used in estimating the slope of trend in the sample of N pairs of data:

$$Q_i = \frac{x_j - x_k}{j-k} \; for \; i = 1, \ldots, N \qquad (5)$$

Where x_j and x_k are the data values at times j and k (j>k), respectively.

The N values of Q_i are ranked from smallest to largest and the median of the Sen's slope is computed as:

$$Q_{med} = \begin{cases} Q_{\{N+1)/2\}}, & if \; N \; is \; odd \\ \frac{Q_{[\frac{N}{2}]} + Q_{[\frac{N+2}{2}]}}{2}, & if \; N \; is \; even \end{cases} \qquad (6)$$

The Q_{med} sign reflects data trend reflection at the medium (50th percentile) confidence level, while its value indicates the steepness of the trend. Sen's slope can also generate Q values at any percentile of confidence level, such as Q_{95max} or Q_{95min}, which stand for Q values at the 5th or 95th percentiles. In this study, Q_{med} was applied for majority of the analysis, except for the near-future temperature predictions Q_{med}, Q_{95max} and Q_{95min} were used.

4.3 SIGNIFICANCE LEVEL

Once sample data, such as the NARR climate data or weather data, has been gathered through an observation or modelling, statistical inference allows analysts to assess evidence in favour of some claim about the population from which the sample has been drawn. The methods of inference used to support or reject claims based on sample data are known as tests of significance.

The significance level, also denoted as alpha or α, is a measure of the strength of the evidence that must be present in the sample before the null hypothesis is rejected and the conclusion has a statistically significant effect. The significance level is the probability of rejecting the null hypothesis when it is true. For example, a significance level of 0.05 indicates a 5% risk of concluding that a difference exists when there is no actual difference. The significance level is determined before conducting the M-K analysis and Sen's Slope.

Significance levels are used during hypothesis testing to help determine which hypothesis the data support. Testing trends were done at the specific α significance levels. When $|Z_S| > Z_{1-\alpha/2}$, the null hypothesis is rejected, and a significance trend exists in the time series. $Z_{1-\alpha/2}$ is obtained from the standard normal distribution table. In this study, testing trends (the hypothesis) were done at the specific α significance levels. In this analysis, significance levels of α=0.1, 0.05, 0.01, 0.001 were used.

Table 3 below shows the significance levels and corresponding symbols used in the mapping in this report. From the statistical significance testing, each of the output is labeled a symbol if the output is statistically significant. If the output has a blank label from the testing, the data will be rejected and if the trend analysis still generates the value – we call it statistically insignificant.

Table 3: Significance Levels and Explanation

Significance Levels (α)	Symbols	Explanation
-	-	Statistically insignificant (inconclusive)
0.1	+	Statistically significant with 10% error (Type II)
0.05	*	Statistically significant with 5% error (Type II)
0.01	**	Statistically significant with 1% error (Type II)
0.001	***	Statistically significant with 0.1% error (Type II)

Note that Type II Error is the error made when the null hypothesis is incorrectly accepted.

In summary, Sen's slope will generate Q value (in this study, Q stands for the trend, or change in temperature annum) on each of the NARR grids, while the M-K testing will provide statistical significance at the same grid. The rule of thumb is that the trend is considered valid only if statistically significant, regardless of the Q value. In other words, if any Q is associated with statistical insignificance, caution must be taken as this Q value is inconclusive.

5. CLIMATE DATA ANALYSIS AND MAPPING

The main focus of this analysis is to evaluate annual changes of temperature through M-K testing and Sen's Slope (Q, stands Q_{med}, at °C/year). Seasonal changes in temperature were also conducted. Q values derived from corrected gridded NARR data through M-K analysis and Sen's slope were georeferenced and mapped using GIS software to aid visualizing Q of both annual and seasonal mean temperature, shown in figures below.

Although NARR data ranges from 1979 to 2018, it is noticed that recent 20 years' temperature annual change rates (Q) are different from that of early 20 years. Considering the representation of current and near future's change in temperature, we used 2001 to 2018 NARR data to analyze Q rates.

5.1 AIR TEMPERATURE AT 2 M ABOVE GROUND

M-K testing suggests statistical significance was found over all grids (i.e., there is no grid indicating statistical insignificance or null) for annual mean temperature. **Figure 5** shows the change in annual temperature (Q) over the project domain in past 18 years. The highest Q rate (>0.2 °C/yr) is located in southwest quadrant of the ISR along the coastal region, where most of the sump sites are located. Relative higher Q rates were also found in the southern coastal areas at the central and northeast islands.

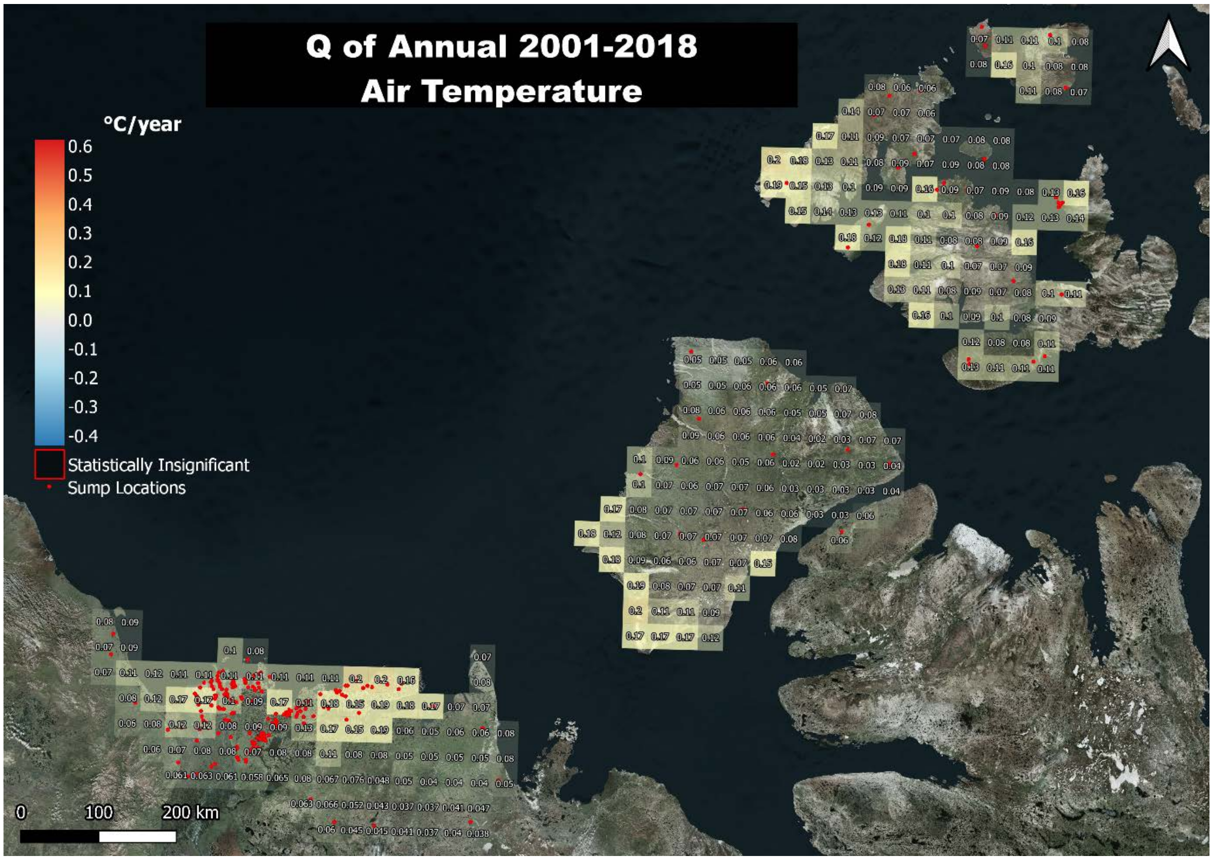

Figure 5: Change in Annual Temperature Q Rate (°C/Year)

Seasonal mean temperature analysis shows more variations than annual temperature**, see Figures 6, 7 8, 9 below.** Although the Sen's slope generates Q value on every grid, the M-K testing indicates that almost all Q values reported for the Summer are statistically insignificant (null), which means that Summer temperature change results are inconclusive. Secondly, temperature increases in Spring, Fall and Winter are apparent across most of the region, with coastal area changes more noticeable than inland. Spring and Winter temperature changes in some of the grid cells are also statistically insignificant.

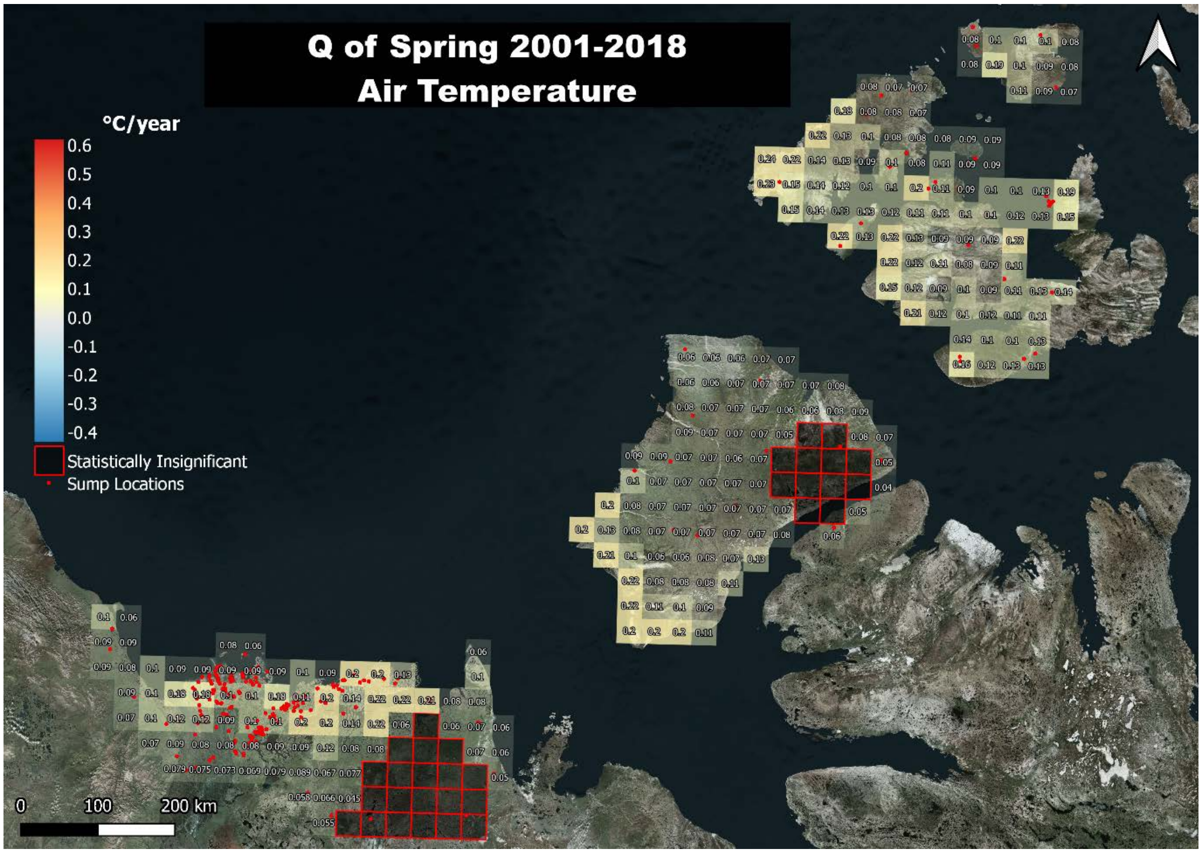

Figure 6: Change in Spring Temperature Q Rate (°C/Year)

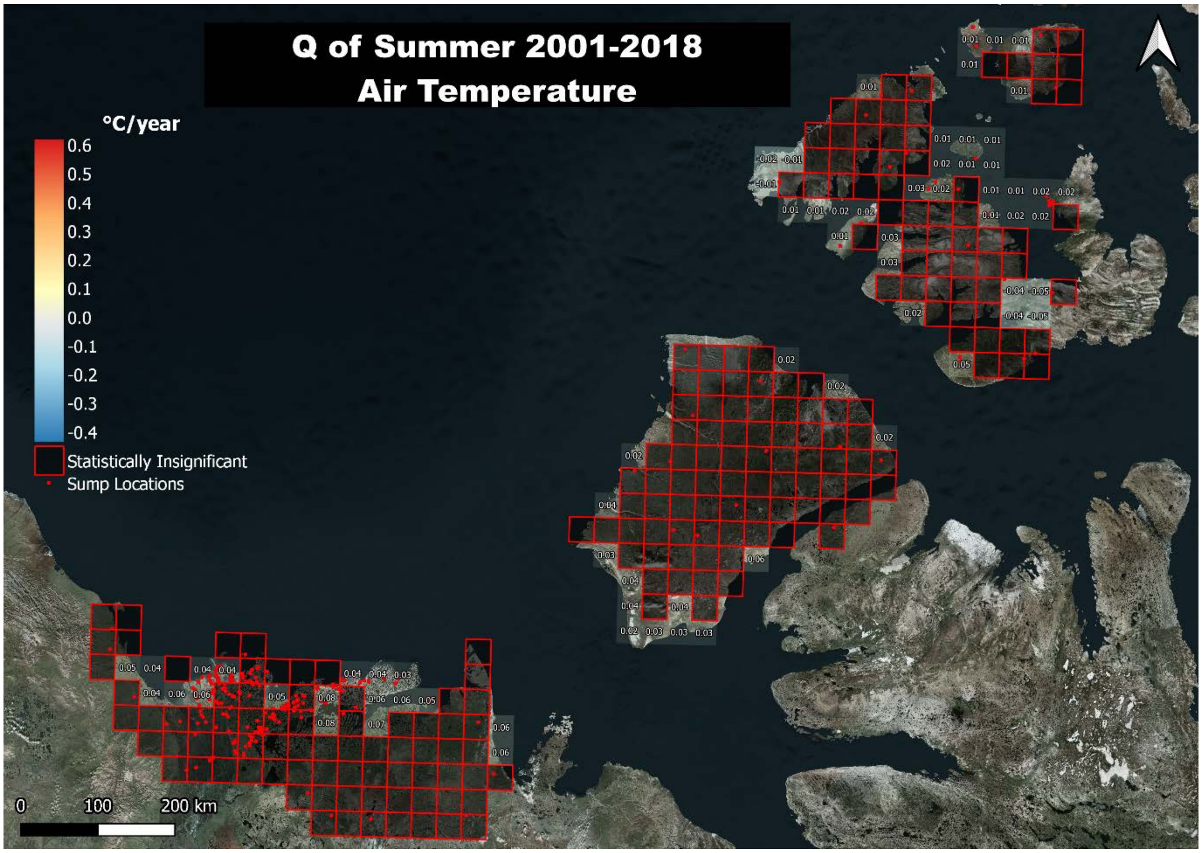

Figure 7: Change in Summer Temperature Q Rate (°C/Year)

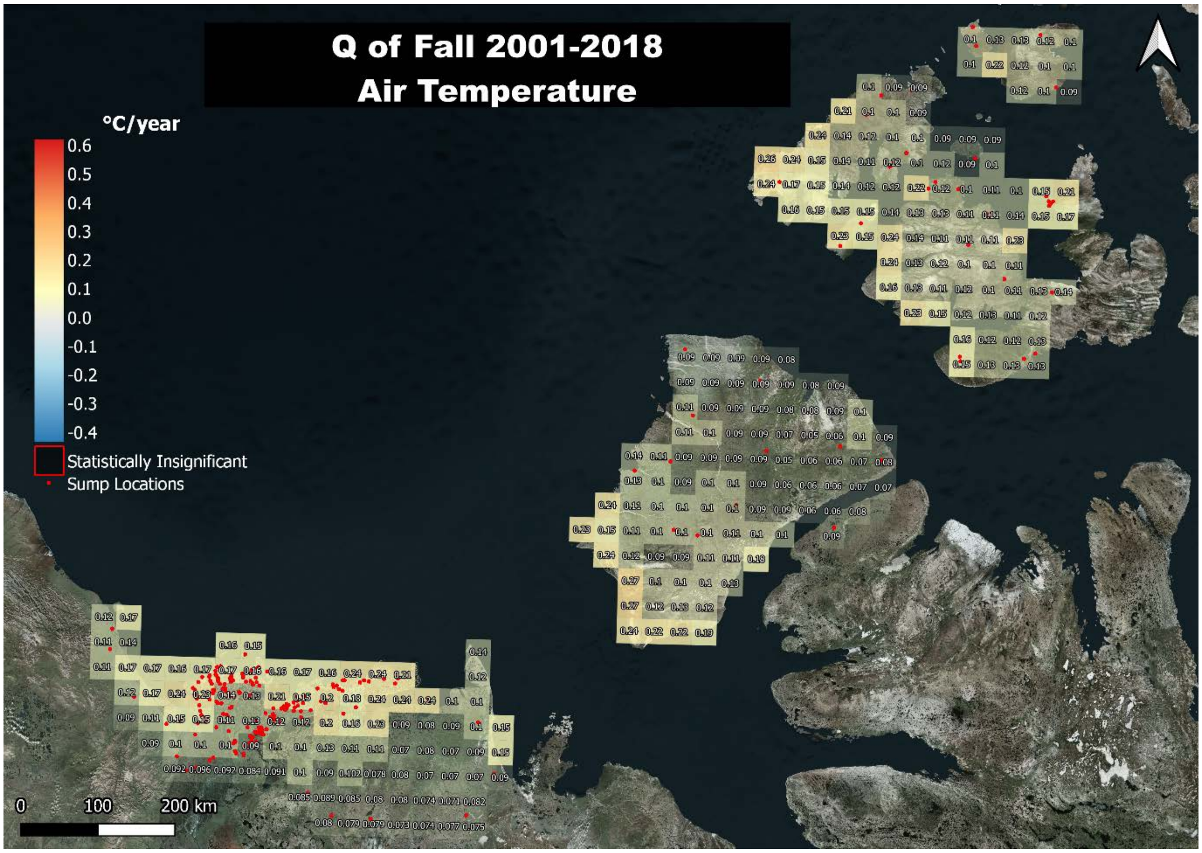

Figure 8: Change in Fall Temperature Q Rate (°C/Year)

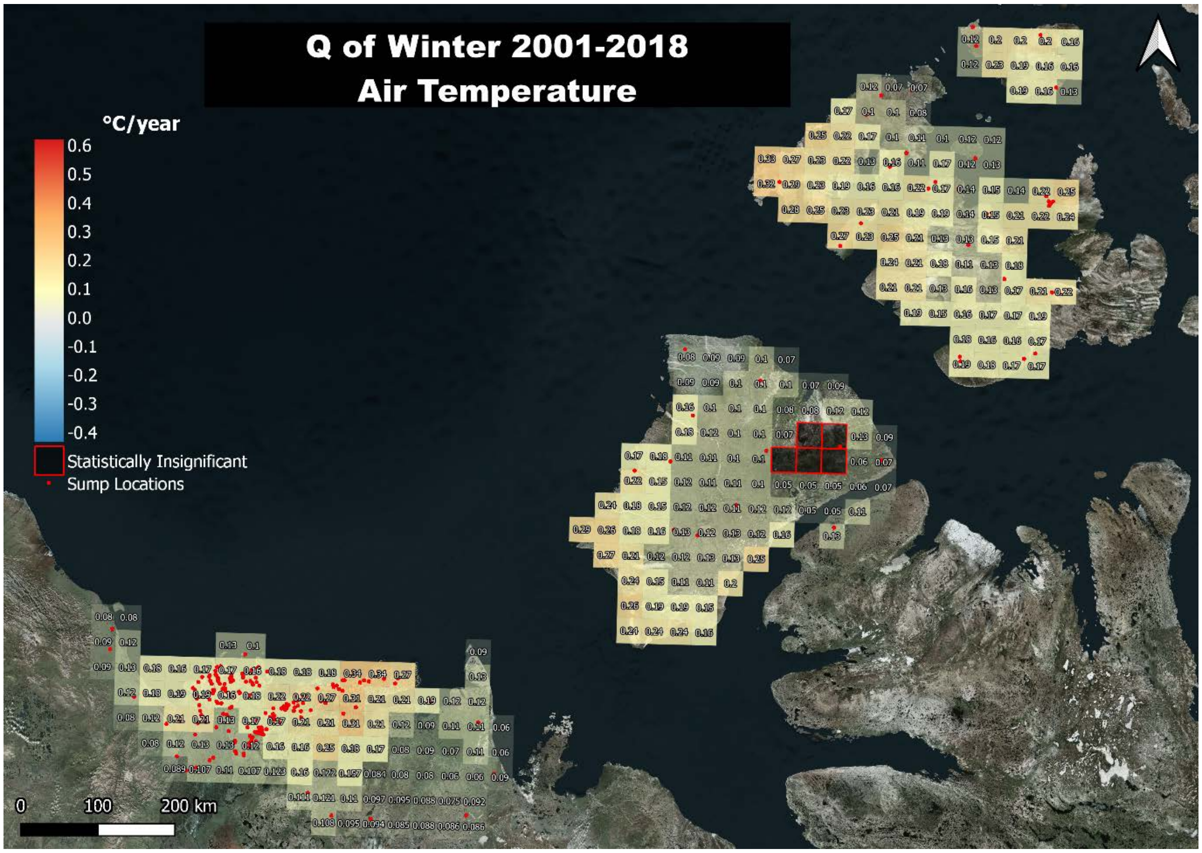

Figure 9: Change in Winter Temperature Q Rate (°C/Year)

5.2 GROUND TEMPERATURE – GROUND SURFACE

Figure 10 shows the change in annual ground surface temperature (Q) over the project area during the 18-year period (2001 to 2018). The highest Q (>0.2°C/yr) is located in the southwest quadrant of the ISR along the coastal region, where most of the sump sites are located. Ground temperature changes at the central island are mostly statistically insignificant, which means that there are no annual trends of change in the ground surface temperature, except for an increase reported in the western part of the island. Relative higher Q rates were also reported in the northern areas of the northeast island.

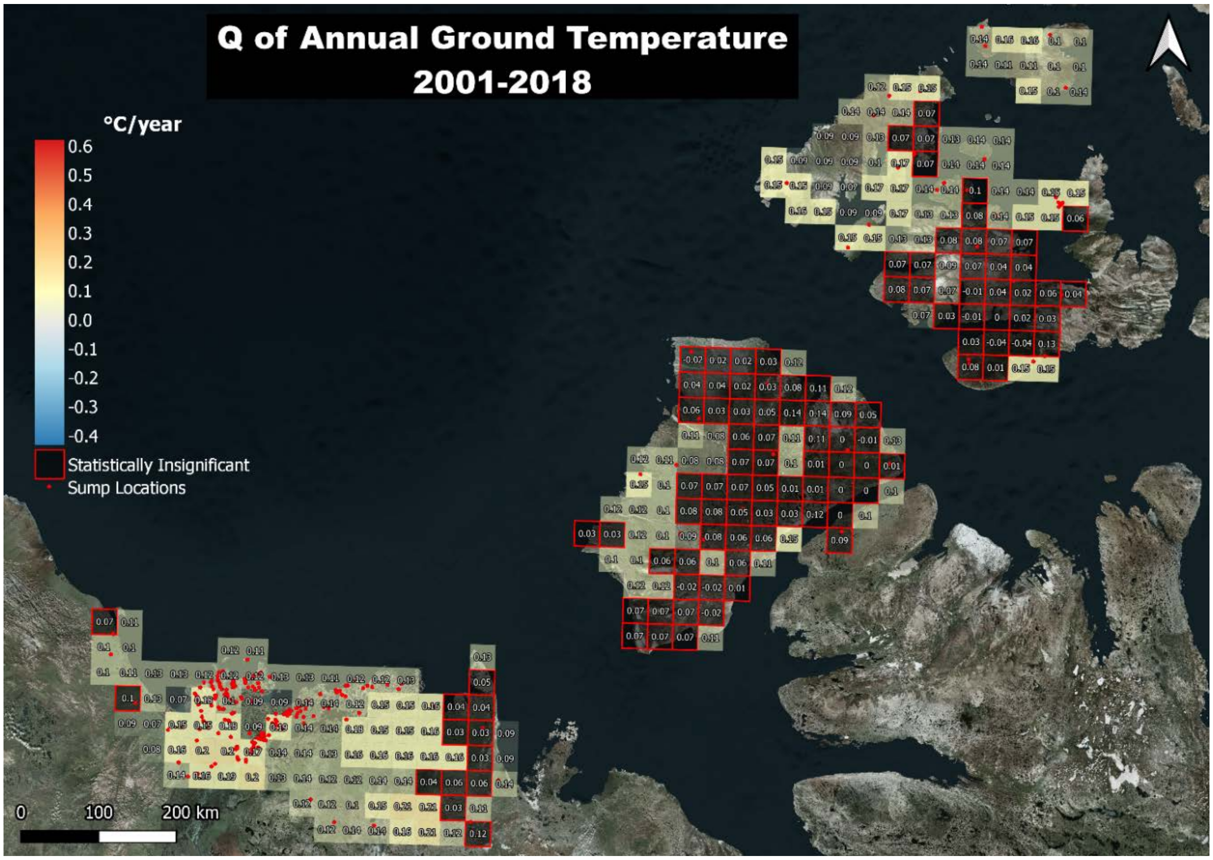

Figure 10: Change in Annual Ground Surface Temperature Q Rate (°C/Year)

Seasonal changes in ground surface temperature analysis show more variations than annual trend for the same parameter (see **Figures 11, 12, 13, 14 below**). In the Summer, negative Q or cooling trends are found in three parts of the study area, while the largest area is located in the central island. A large portion of grids showing statistically insignificant (null), which means there are no trends (no increase or decrease) found from these locations. Secondly, ground surface temperature increases are prominent in the Spring and Winter in most of the study area, with the highest increase in temperature in the Winter season. Although more air temperature increases are apparent in coastal area than inland, similar pattern does not occur for ground temperature. In the Fall, most of the grid cells are statistically insignificant.

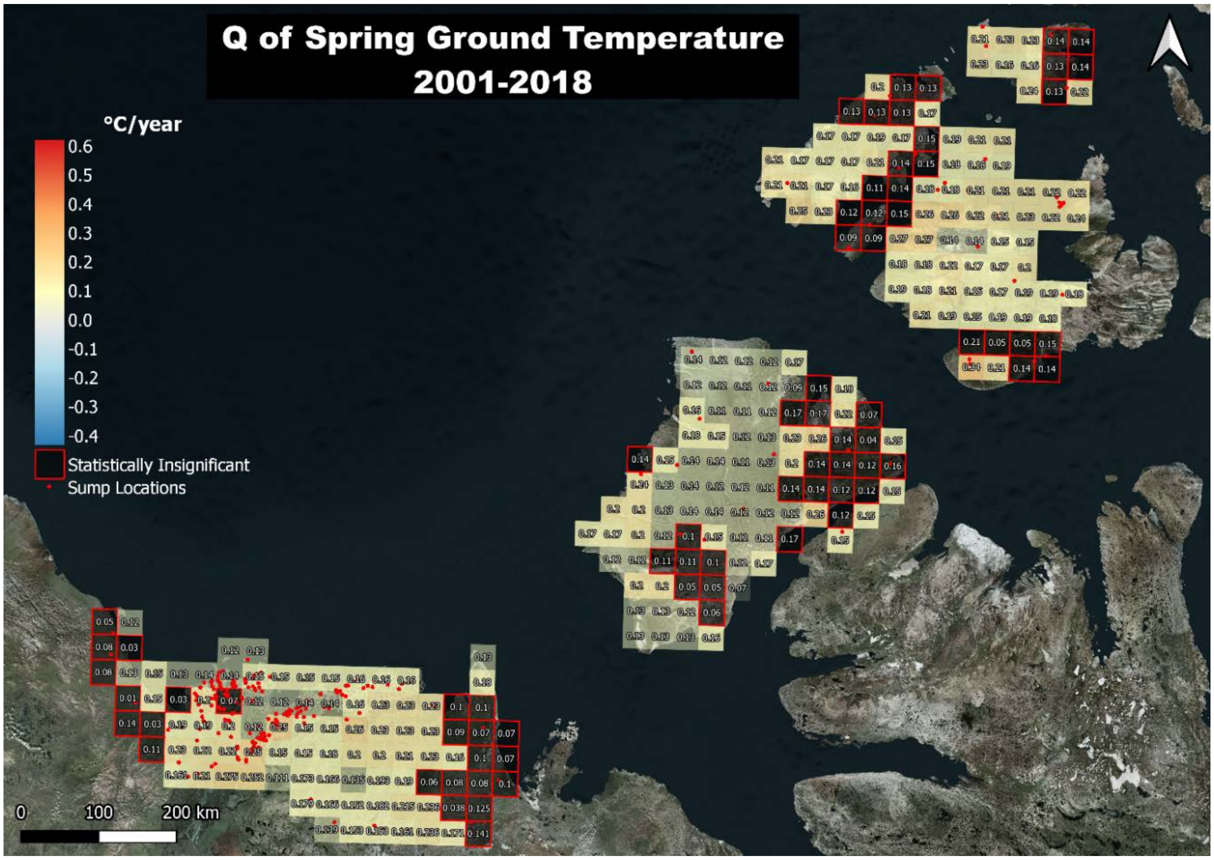

Figure 11: Change in Spring Ground Surface Temperature Q Rate (°C/Year)

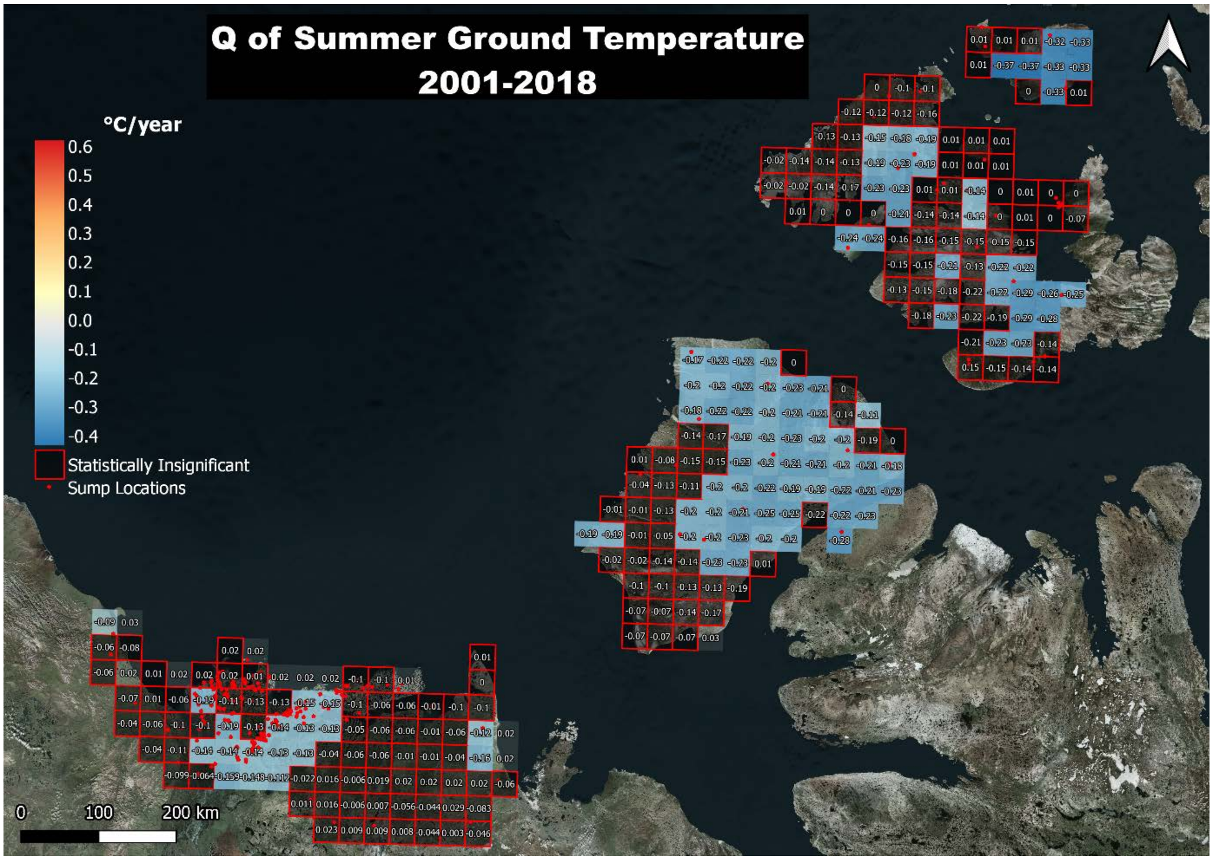

Figure 12: Change in Summer Ground Surface Temperature Q Rate (°C/Year)

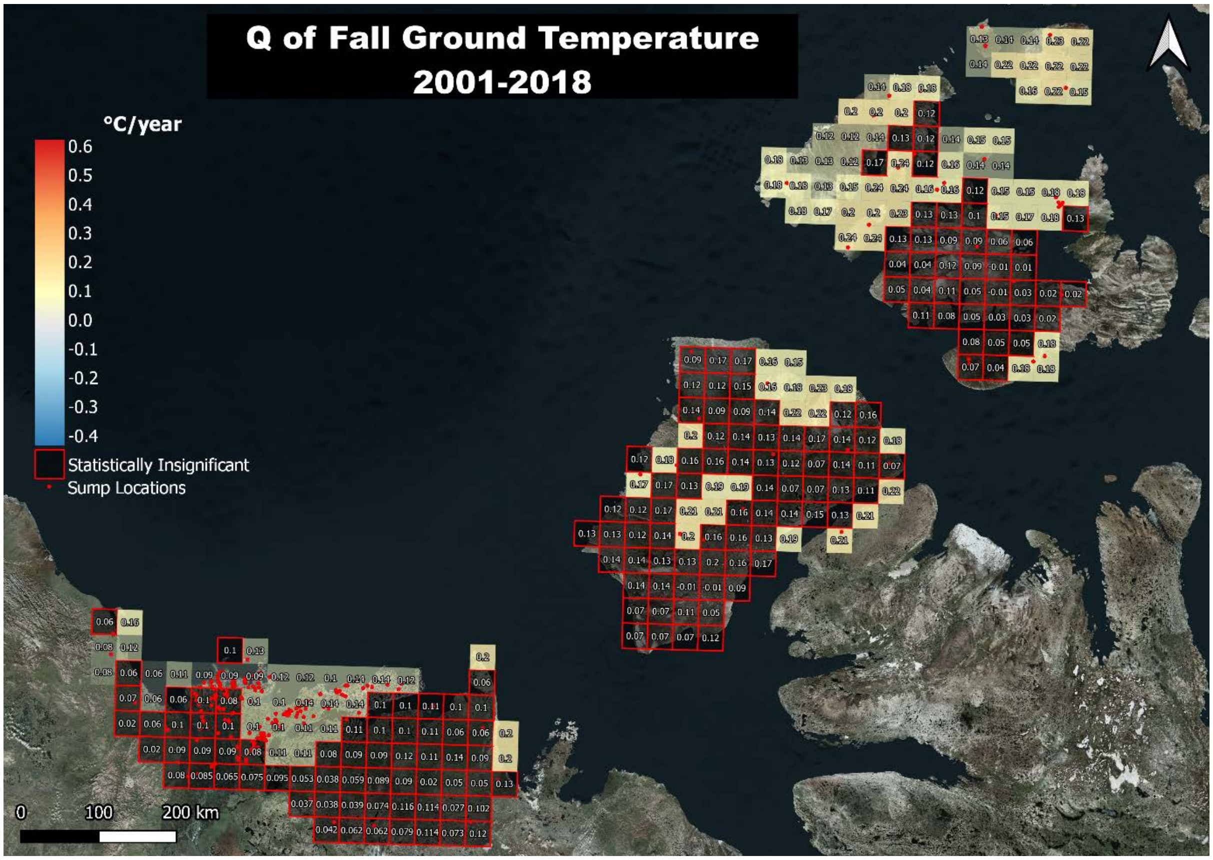

Figure 13: Change in Fall Ground Surface Temperature Q Rate (°C/Year)

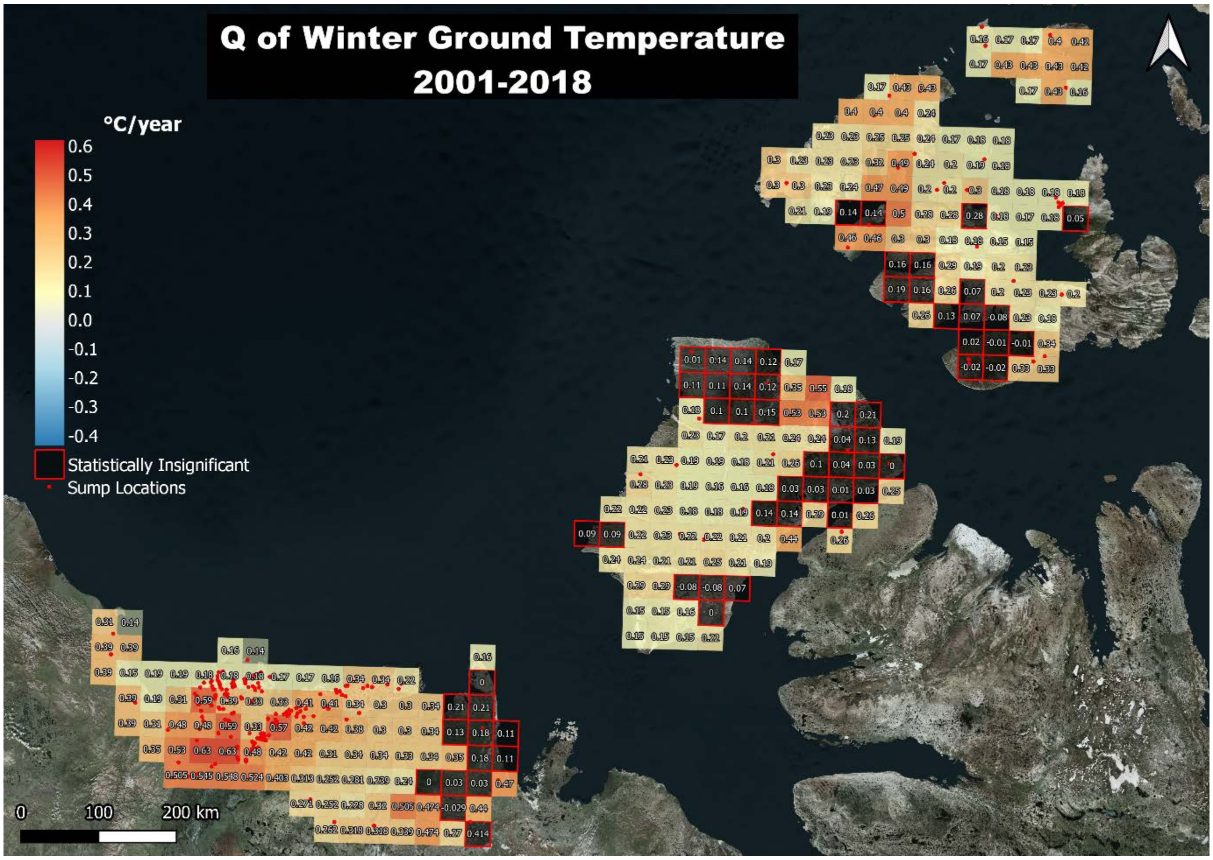

Figure 14: Change in Winter Ground Surface Temperature Q Rate (°C/Year)

5.3 UNDERGROUND TEMPERATURE (0.1 MBG)

Figure 15 shows annual 0.1 mbs temperature changes (Q) over the project area during the 18-year period (2001 to 2018). The highest Q rate (>0.2°C/yr) is located in southwest quadrant of ISR along the coastal region, where most of the sump sites are located. The central island, as well as the northern island are mostly statistically insignificant in change for 0.1 mbg temperature. This means that there are no annual trends of change in 0.1 mbg temperature, except for relatively higher Q rates reported at the northern areas of the northeast island. A decrease in the 0.1 mbg temperature (negative Q, cooling trend) was reported at the couple of grids in the northern island.

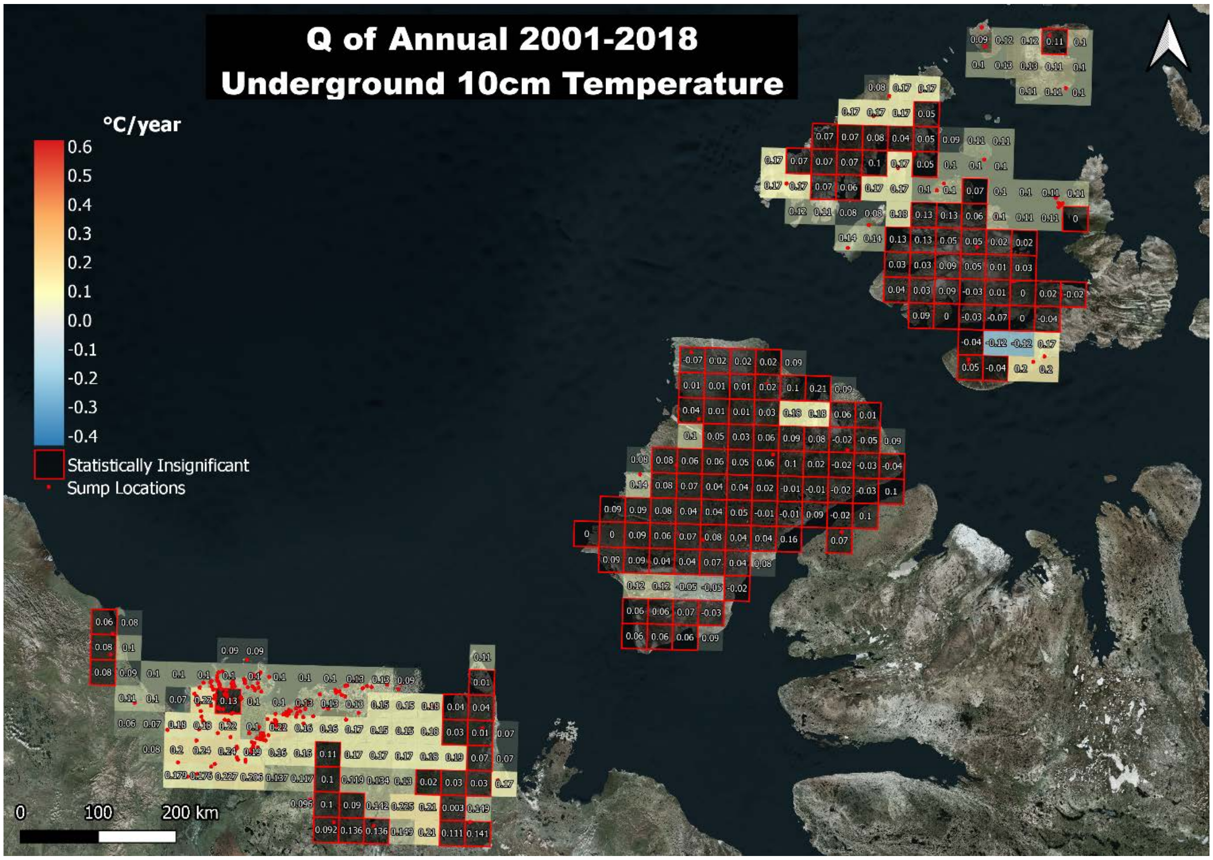

Figure 15: Change in Annual Underground 10cm Temperature Q Rate (°C/Year)

Seasonal changes in 0.10 mbg temperature analysis show more variations than annual changes for the same parameter (**Figures 16, 17, 18, 19**). Similar to the ground surface temperature, in Summer, cooler trends are found in three parts of the study area, while the largest one is located in the central island. There are a large number of grids showing statistically insignificant (null), which stands for no trends (no increase or decrease) are found at these locations. Secondly, 0.1 mbg temperature is increased during the Spring and Winter in most of the study area, with the highest increase occur in Winter season. Most of the grid cells in the Fall are statistically insignificant (no change).

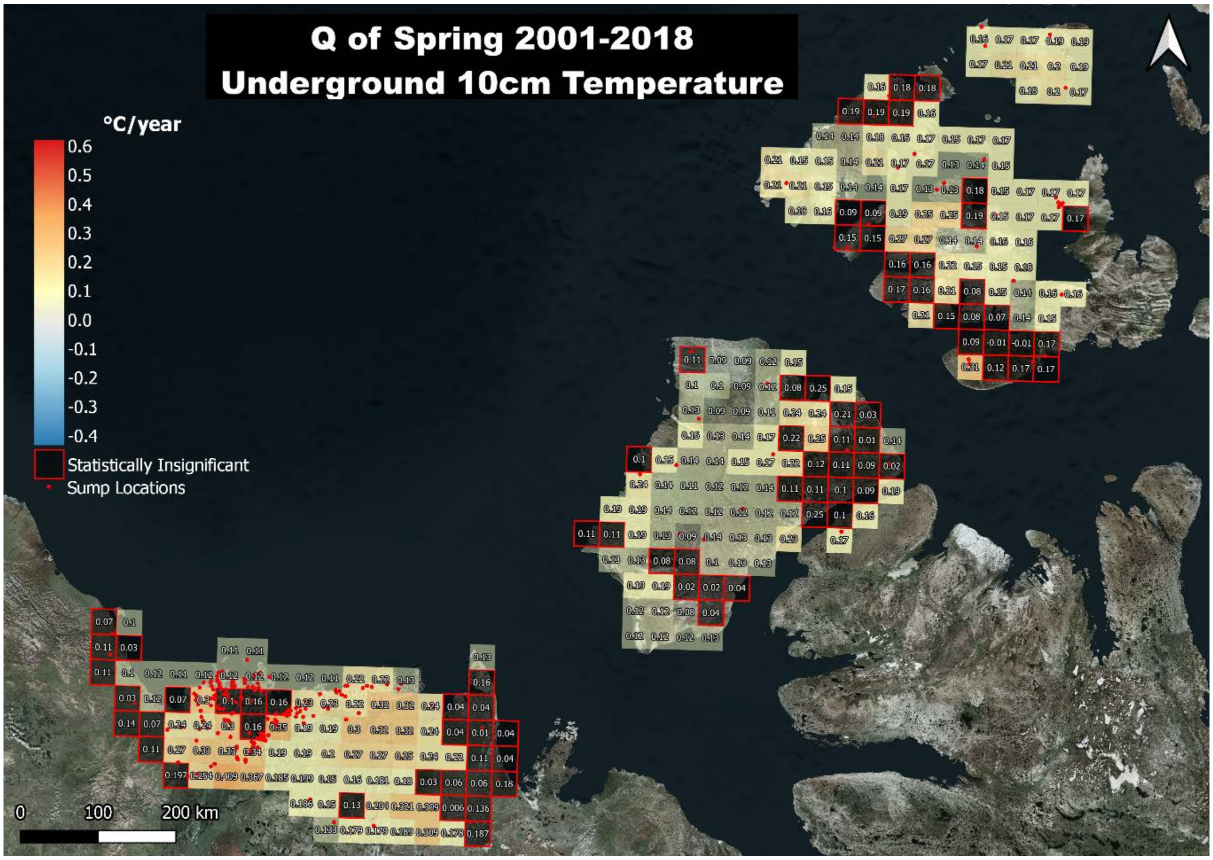

Figure 16: Change in Spring Underground 10cm Temperature Q Rate (°C/Year)

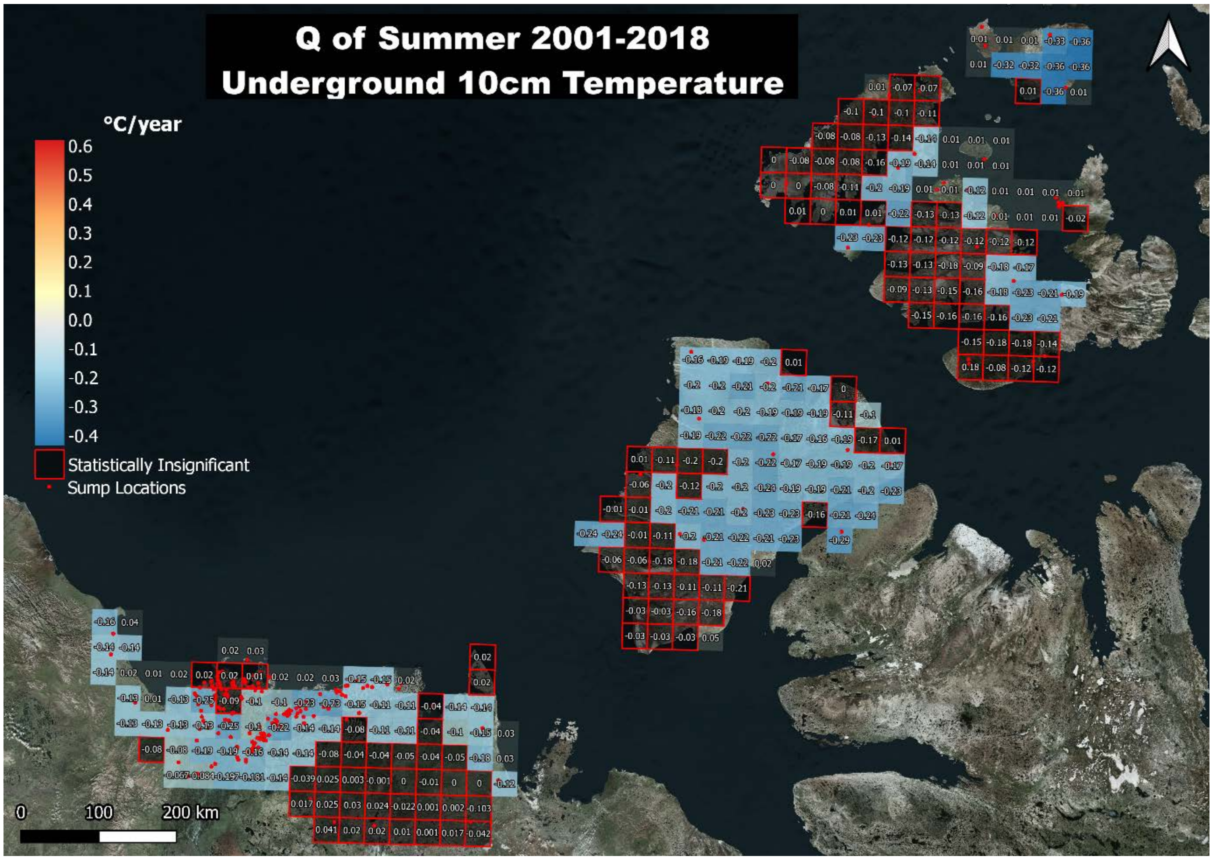

Figure 17: Change in Summer Underground 10cm Temperature Q Rate (°C/Year)

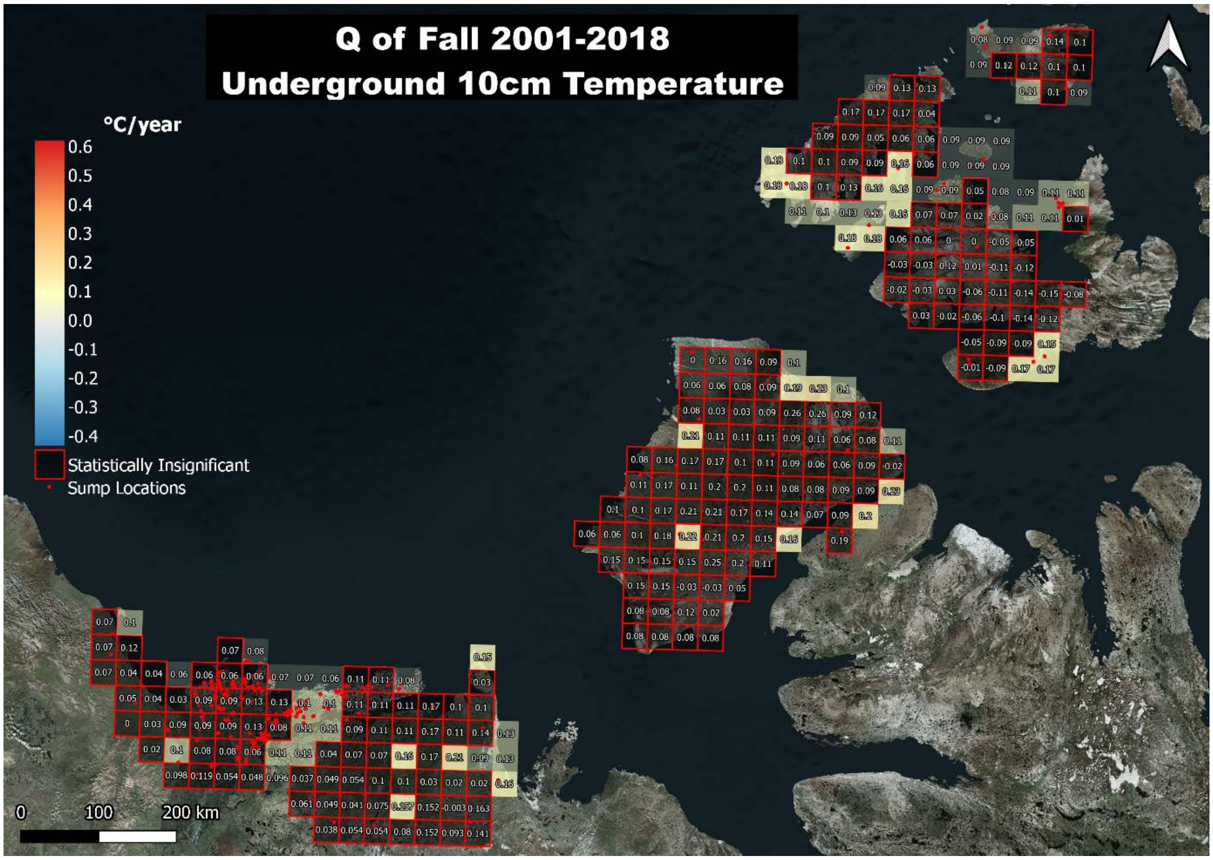

Figure 18: Change in Fall Underground 10cm Temperature Q Rate (°C/Year)

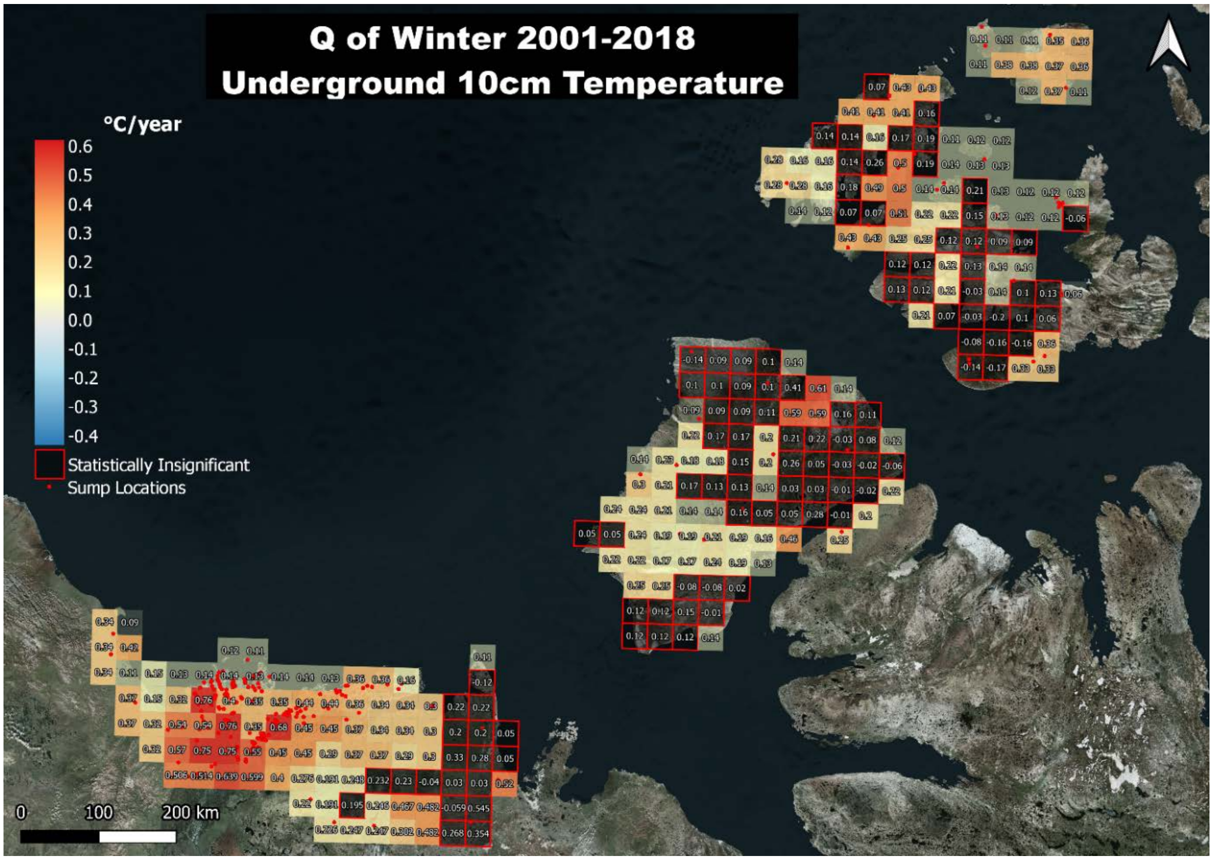

Figure 19: Change in Winter Underground 10cm Temperature Q Rate (°C/Year)

5.4 UNDERGROUND TEMPERATURE (0.40 MBG)

Figure 20 shows annual 0.40 mbg temperature changes (Q) over the project area during the 18-year period (2001 to 2018). The highest Q rate (>0.2°C/yr) is located in the southwest quadrant of ISR along the coastal region, where most of the sump sites are located. The central island as well as the northern island are mostly statistically insignificant in change of 0.40 mbg temperature. This means that there are no annual trends of change in 0.40 mbg temperature; except for relatively higher Q rates are found at the northern areas of the northeast island. A couple of grids show a decrease in temperature (negative Q; cooling) in the northern island.

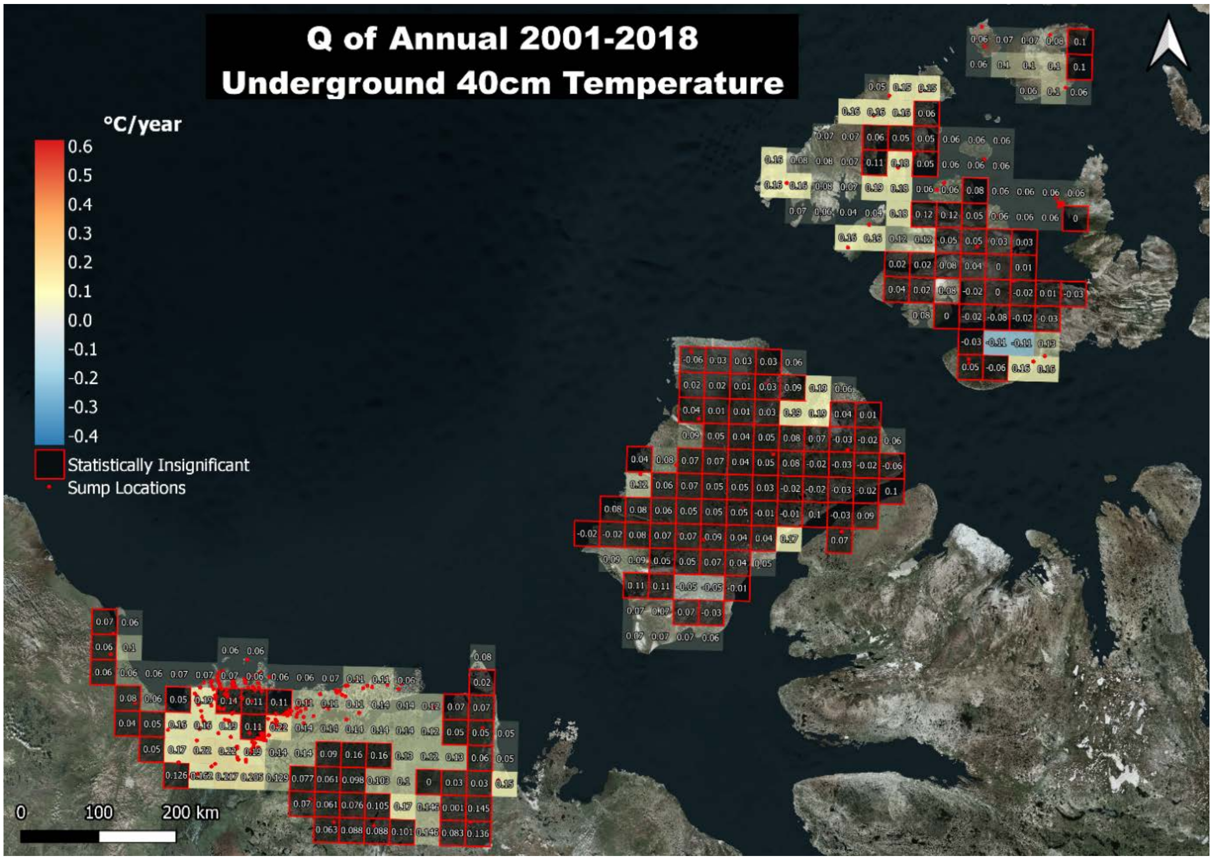

Figure 20: Change in Annual Underground 40cm Temperature Q Rate (°C/Year)

Seasonal changes in 0.40 mbg temperature analysis show more variations than annual changes of the same parameter (**Figures 21, 22, 23, 24 below**). Similar to the ground surface temperature, in Summer, cooler trends are found in three parts of the study area, while the largest one is located in the central island. A large number of grids show statistically insignificant (null) variation for this parameter. This means that there are no trends (no increase or decrease) reported at these locations. Secondly, 0.40 mbg temperature is increased in the Spring and Winter in most of the study area, with the highest increase occurring in the Winter season. In the Fall, most of the grid cells are statistically insignificant (no change).

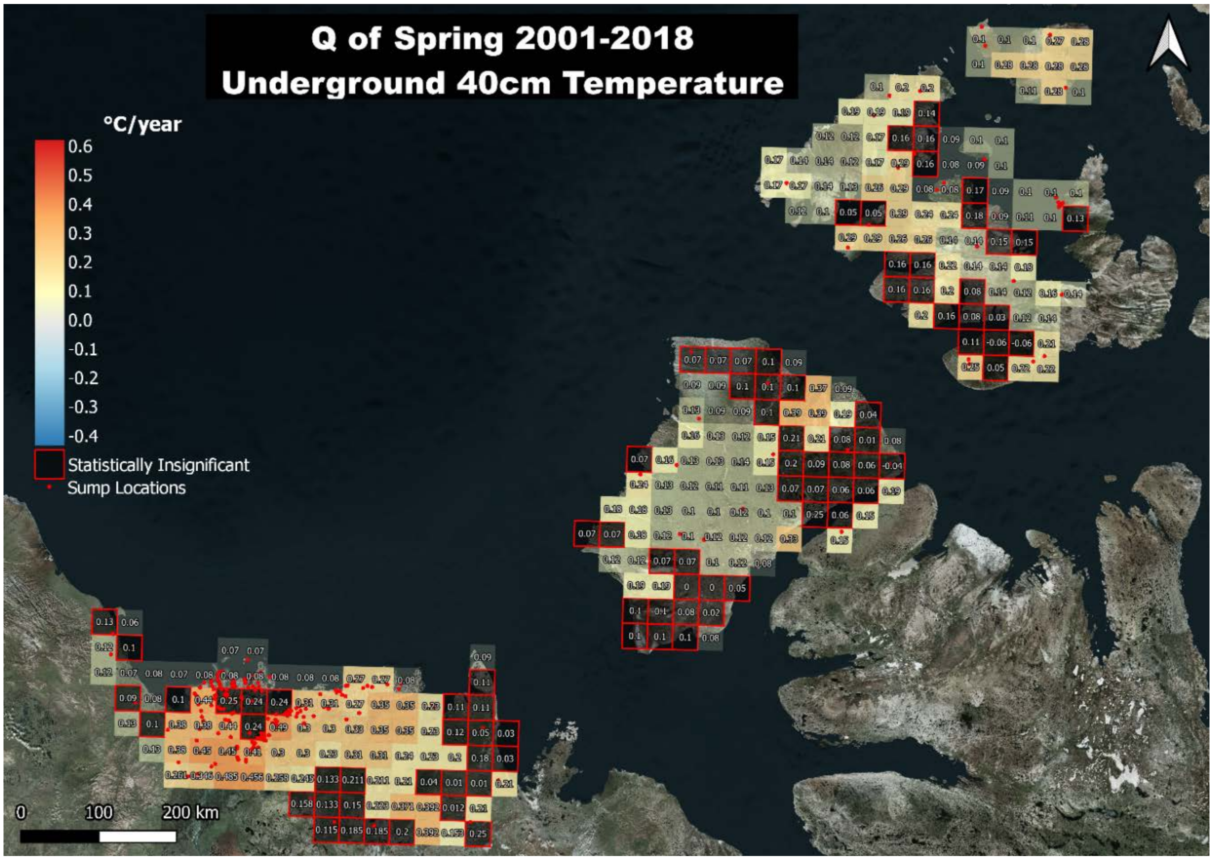

Figure 21: Change in Spring Underground 40cm Temperature Q Rate (°C/Year)

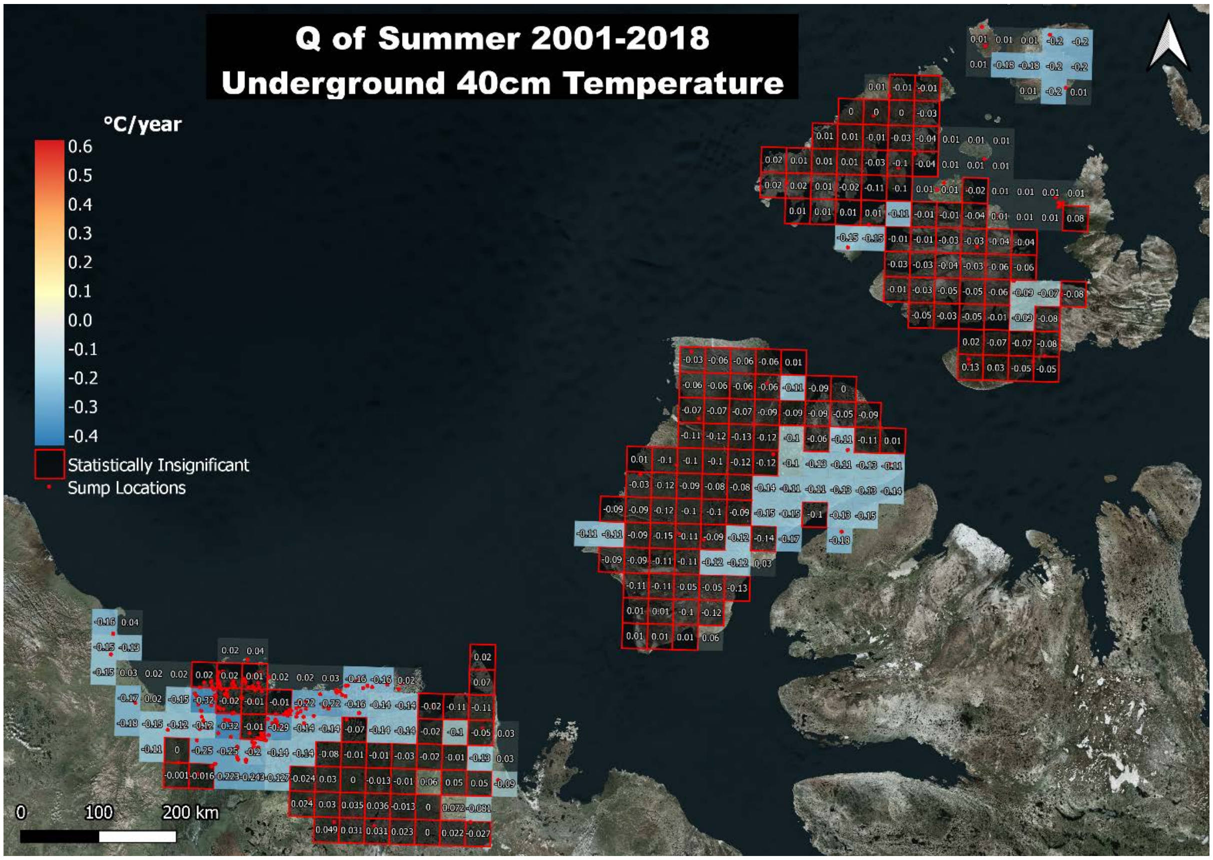

Figure 22: Change in Summer Underground 40cm Temperature Q Rate (°C/Year)

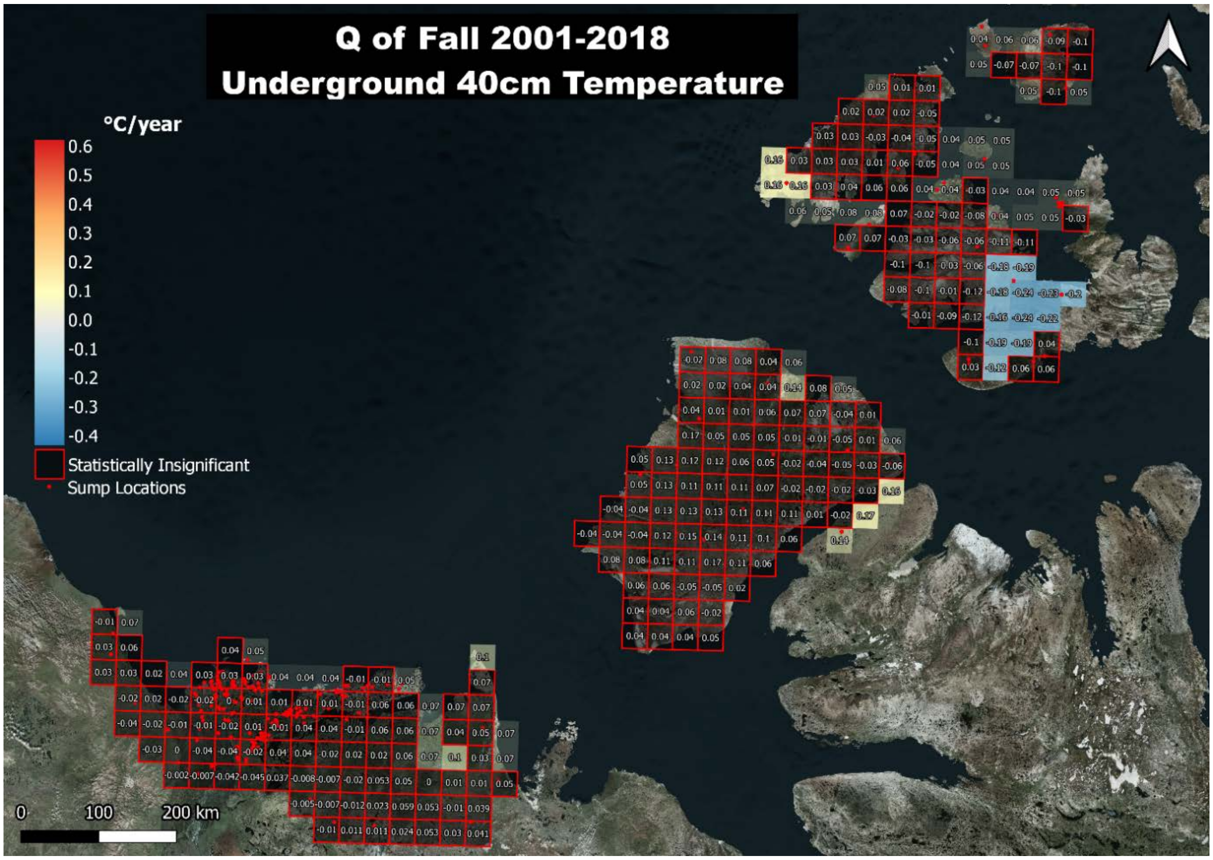

Figure 23: Change in Fall Underground 40cm Temperature Q Rate (°C/Year)

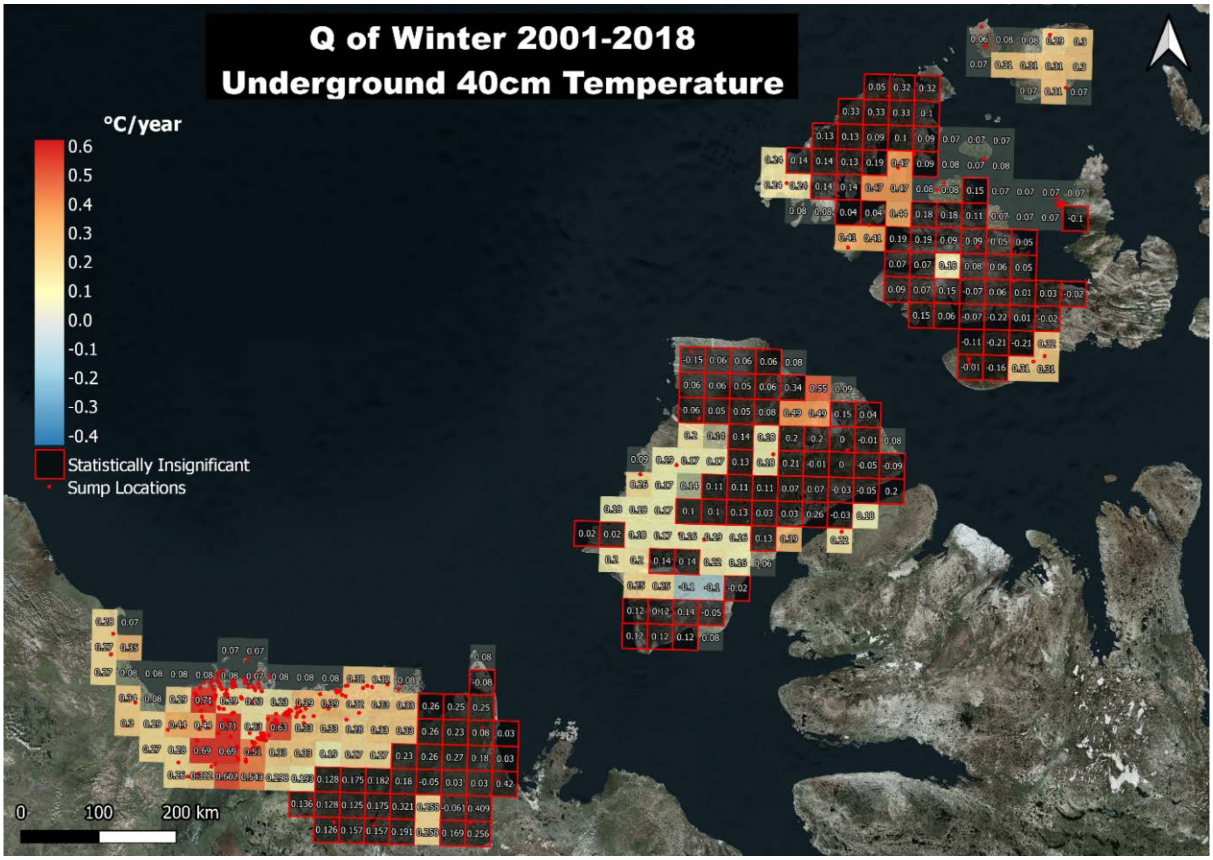

Figure 24: Change in Winter Underground 40cm Temperature Q Rate (°C/Year)

5.5 UNDERGROUND TEMPERATURE (1 MBG)

Figure 25 shows change in annual 1 mbg temperature (Q) over the project are during the 18-year period (2001 to 2018). Similar to 0.4 mbg temperature, the highest Q rate (>0.2°C/yr) is located at southwest quadrant of the ISR along the coastal region, where most of the sump sites are located. The majority of the study area are statistically insignificant in change of 1 mbg temperature, which means there are no annual trends of change for this parameter.

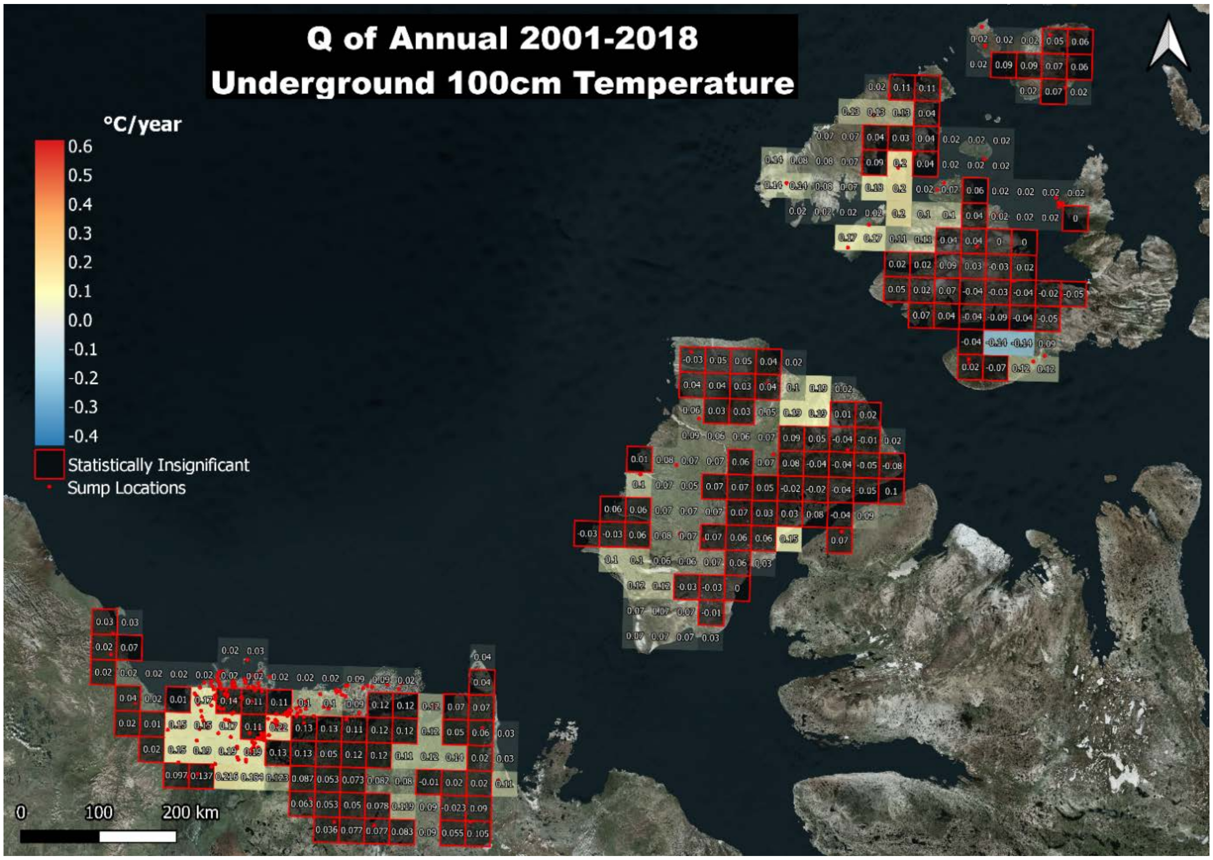

Figure 25: Change in Annual Underground 100cm Temperature Q Rate (°C/Year)

Seasonal changes in 1 mbg temperature (**Figures 26, 27, 28, 29**) are similar to 0.4 mbg temperature. In the Summer, cooler trends or no trend are found in three parts of the study area. There are large number of grids showing statistically insignificant (null) values, which means there are no trends (no increase or decrease) found at these locations. 1 mbg temperature increases in the Spring and Winter in most of the study area, with the highest increase occurring at the southern part of the study area, where most of the sumps are located. Most of the grid cells in the Summer and Fall are statistically insignificant (no change); except for cooler trend apparent on the northern Island.

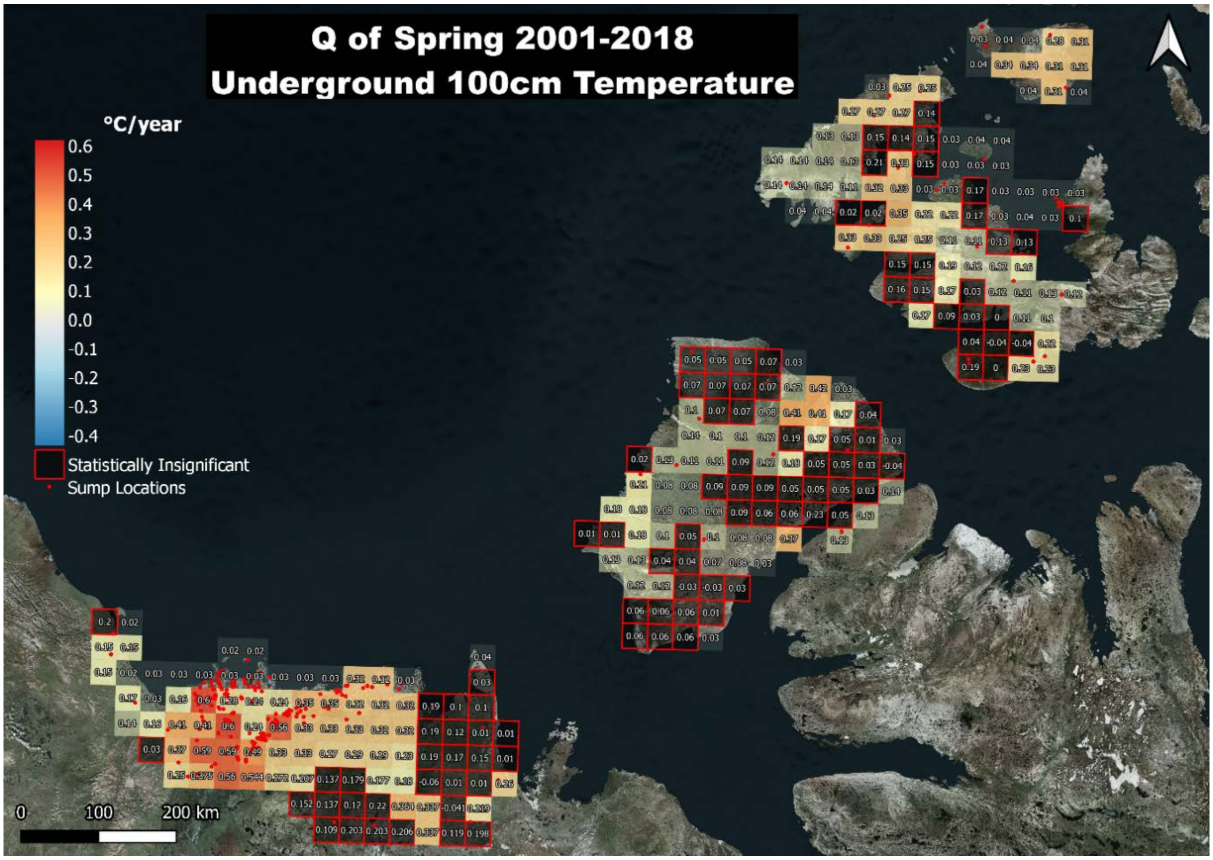

Figure 26: Change in Spring Underground 100cm Temperature Q Rate (°C/Year)

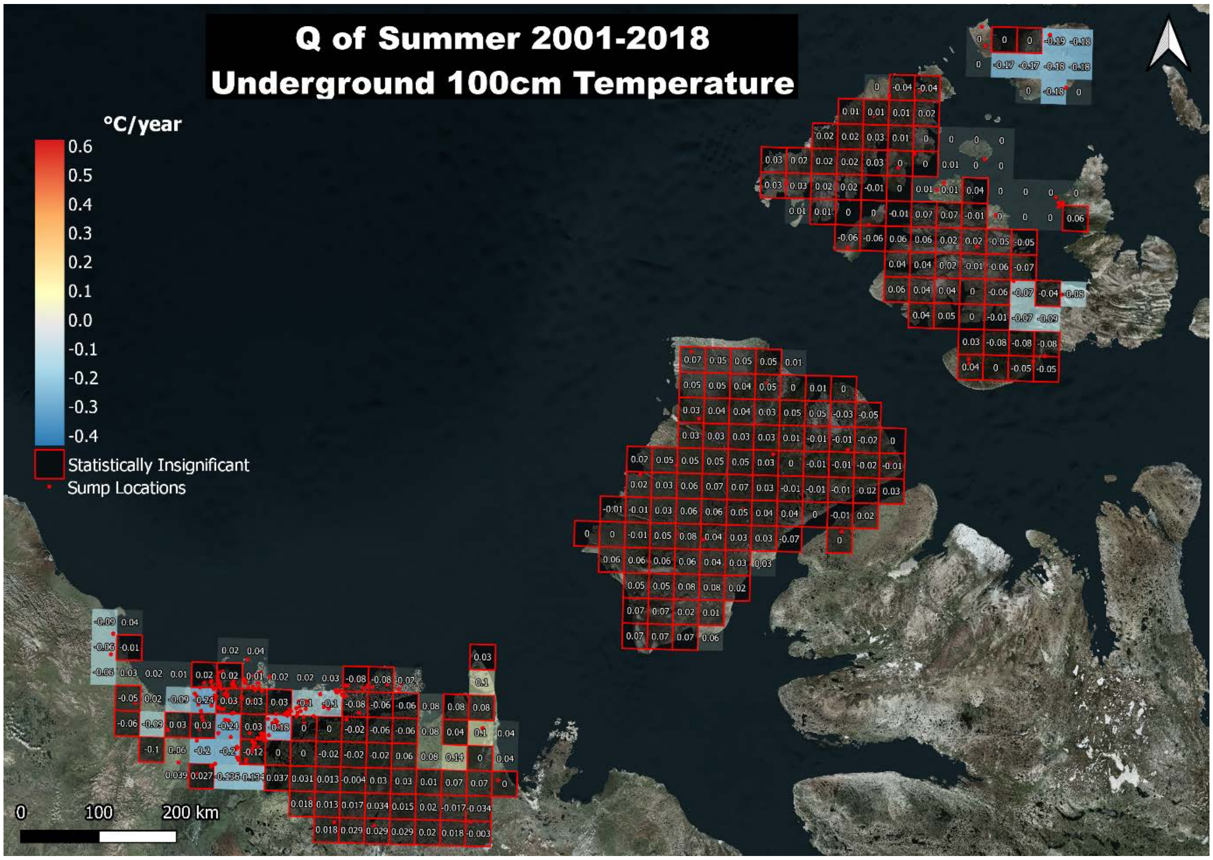

Figure 27: Change in Summer Underground 100cm Temperature Q Rate (°C/Year)

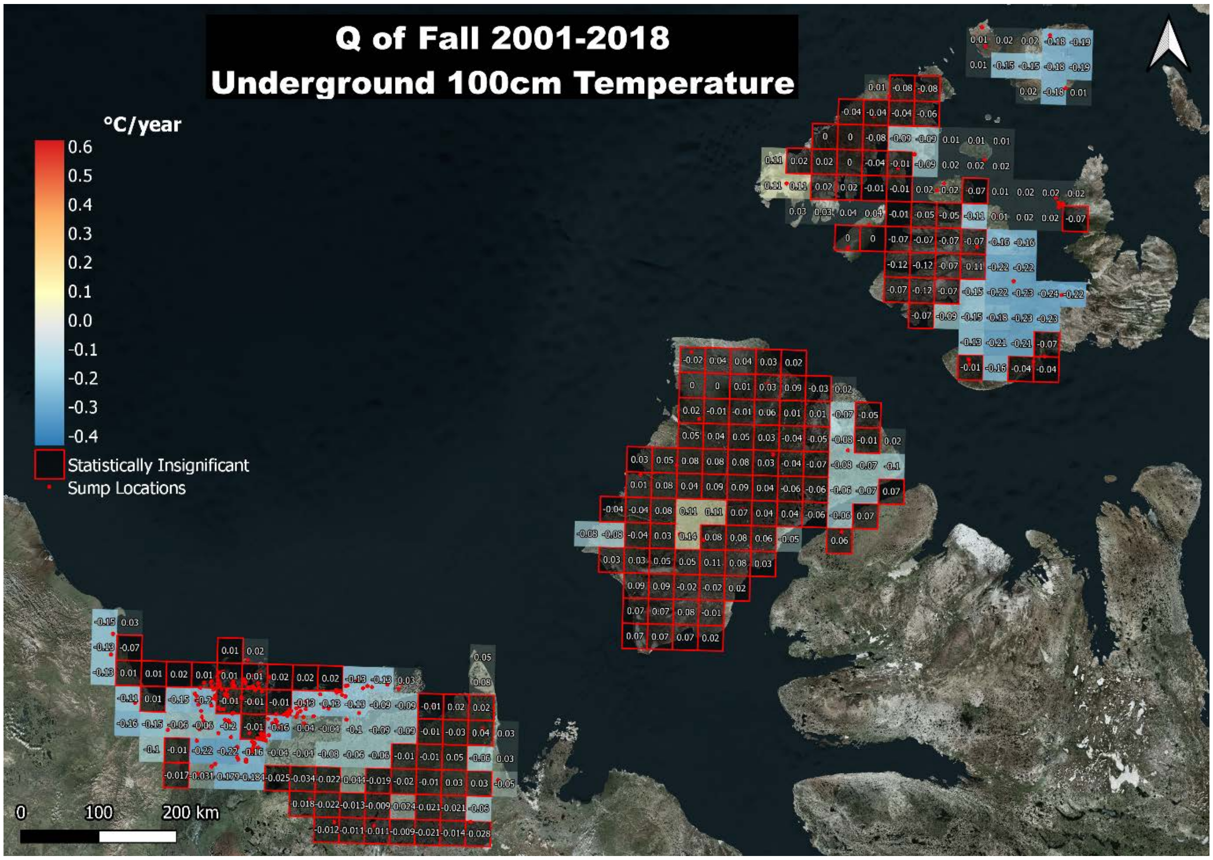

Figure 28: Change in Fall Underground 100cm Temperature Q Rate (°C/Year)

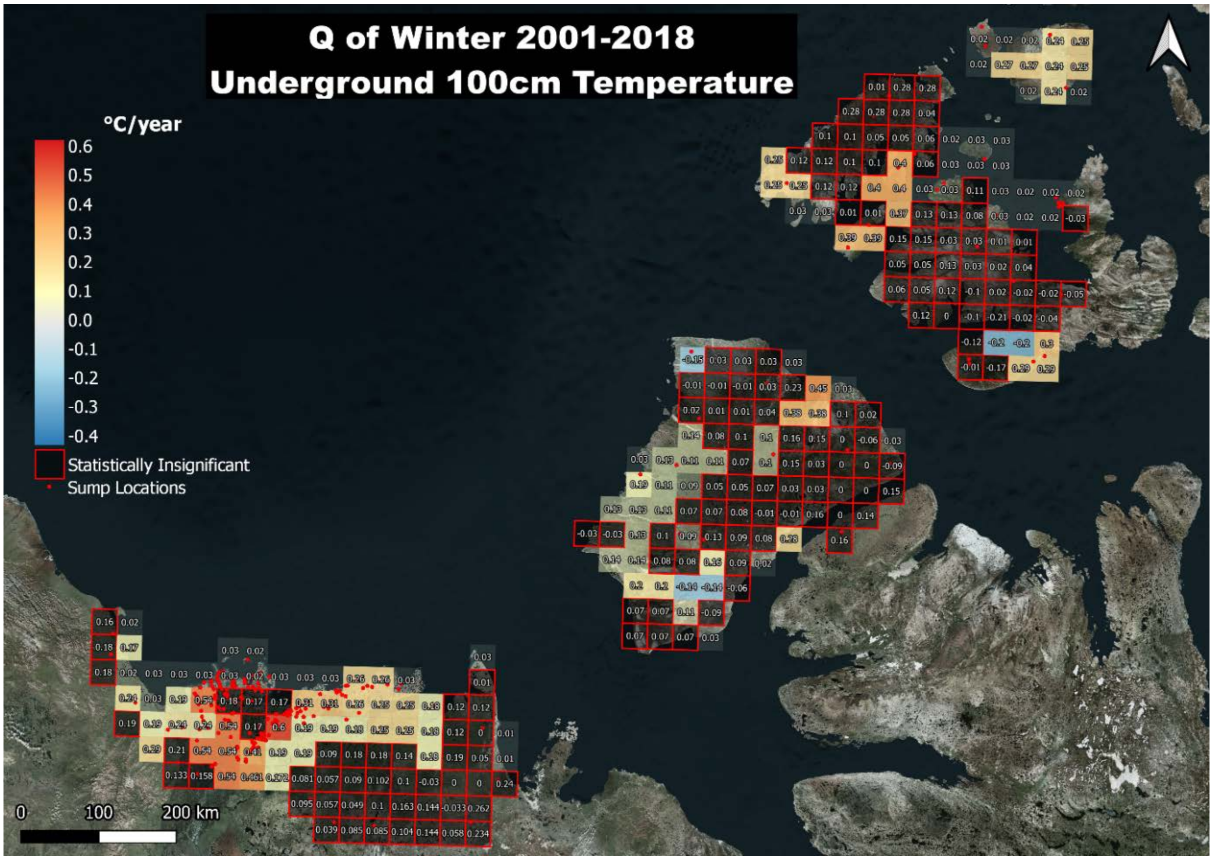

Figure 29: Change in Winter Underground 100cm Temperature Q Rate (°C/Year)

5.6 PRECIPITATION

NARR monthly total precipitation was calculated by summing monthly NARR data from 1979 to 2018 on all NARR grid cells and then converting this data into spreadsheet format. Data was provided earlier to ARKTIS.

5.7 NEAR FUTURE PROJECTIONS (10 YEARS)

The near-future air and ground temperature projections were generated based on Sen's slope of Q_{med} (which was used for trend analysis in previous sections) and 95 percentile of confidence intervals (i.e., Q_{95max} and Q_{95min}). The projection is made for the future year 2019 to 2028 on all the NARR grid sites inside the study area.

The delivery (in MS Excel format) included the projections of:

- Air temperature
- Ground surface temperature
- 0.1 mbg temperature
- 0.4 mbg temperature
- 1 mbg temperature

The recommendation of temperature projection is based on Q_{med}. Projections based on Q_{95max} and Q_{95min} were also provided for consideration of the range of temperature variations.

5.7.1 PREDICTION OF AIR TEMPERATURE AND THE CHANGE IN FUTURE 10 YEARS

Annual air temperature

Figures 30 and **31** show the predicted annual air temperature across the study area, in years 2019 and 2028, respectively. Temperature was projected based on the trend analysis of Sen's slope Q rates and started from 2018 to predict near future air temperature from 2019 to 2028. The results indicate that air temperature is warmer in southern part of study area than central and northern island areas. Moreover, temperature is higher in southern coastal areas from the central and northern islands. All grids passed M-L sensitivity statistical significance tests; therefore, the 2019 to 2028 annual air temperature projection is considered reliable.

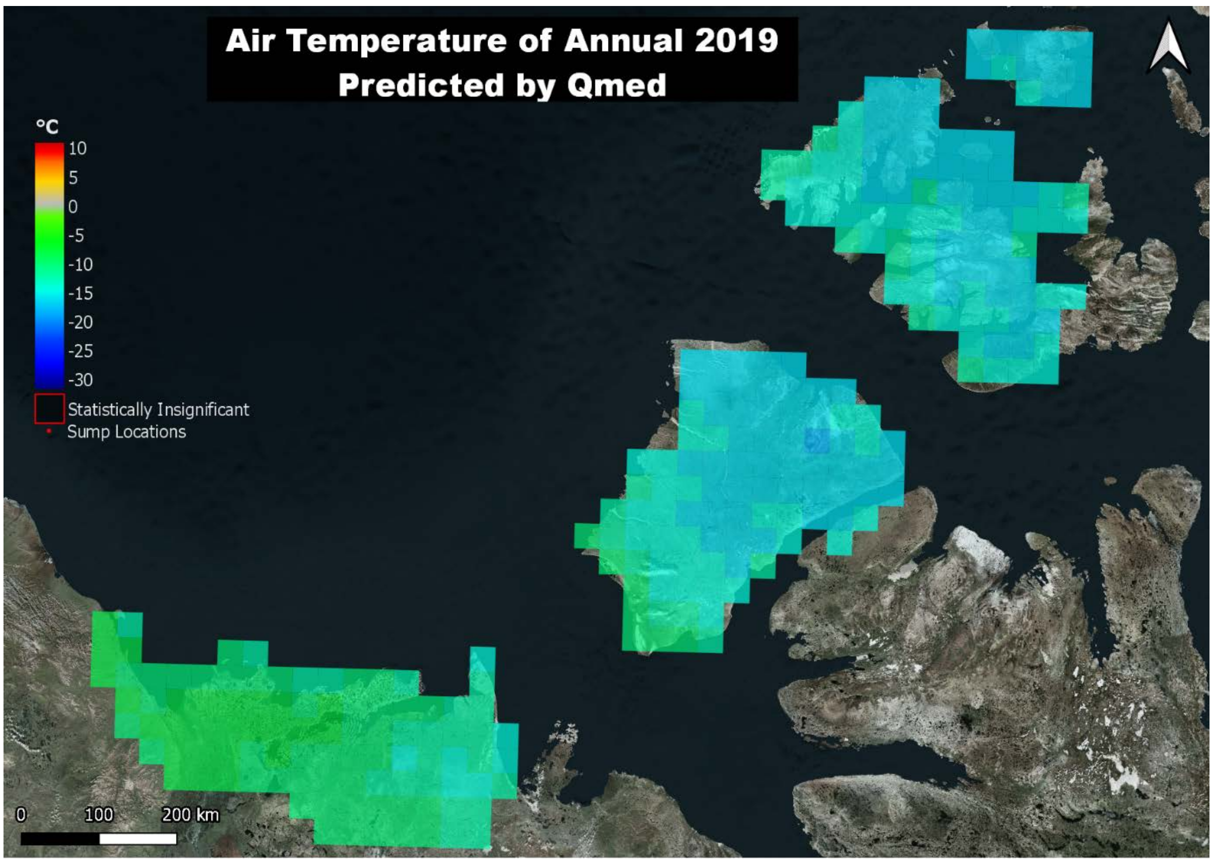

Figure 30: Annual Air Temperature in 2019 (°C)

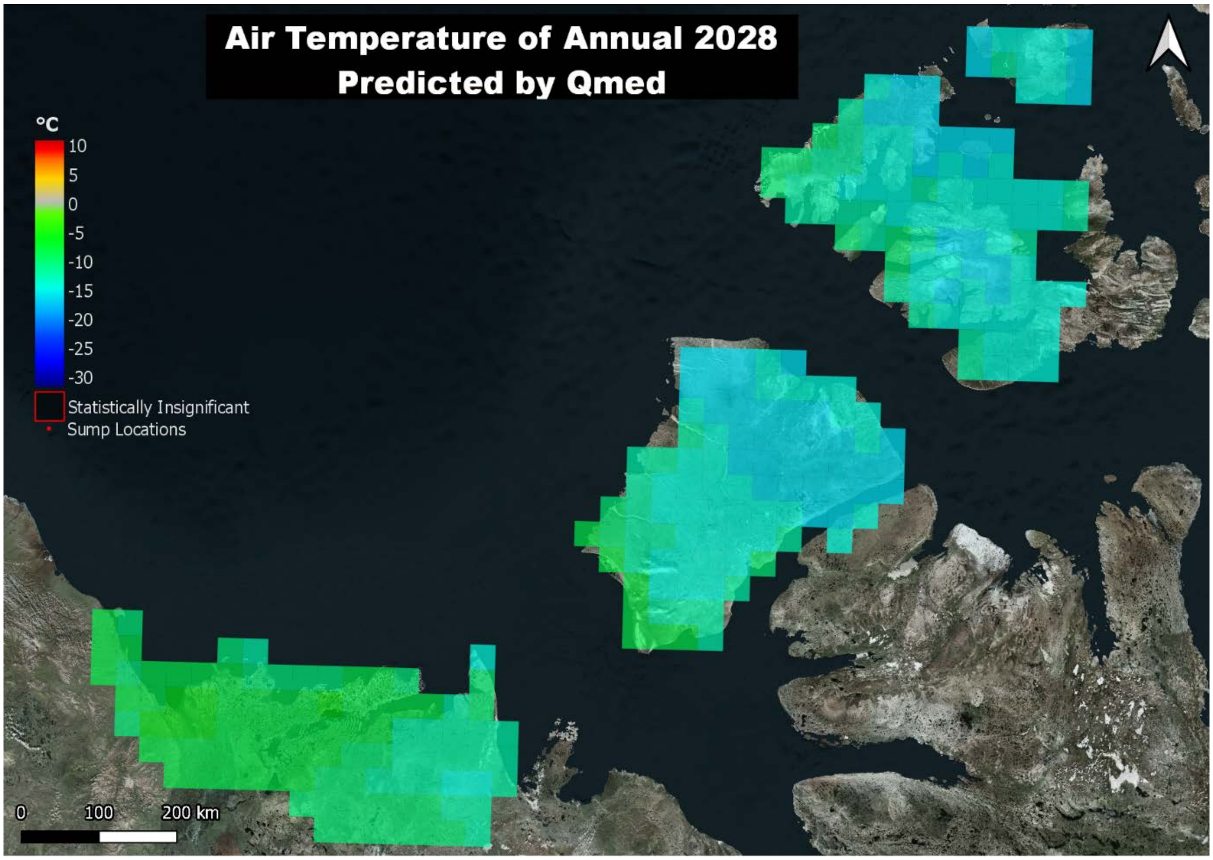

Figure 31: Annual Air Temperature in 2028 (°C)

Figure 32 presents the change in temperature over the 10-year period from 2019 to 2028. The area predicted to have the highest temperature change (>2.0 °C increase) is located in southwest quadrant of the study area along the coastal region, where most of the sump sites are located. Higher temperature increases were also found in the southern coastal areas at the central and northeast islands. Southern inland and the eastern parts of the central island are predicted to experience a minor increase to no change in air temperature. The rest of the region is predicted to have an increase in temperature from 0.5 to 0.75 °C in the future 10-year period.

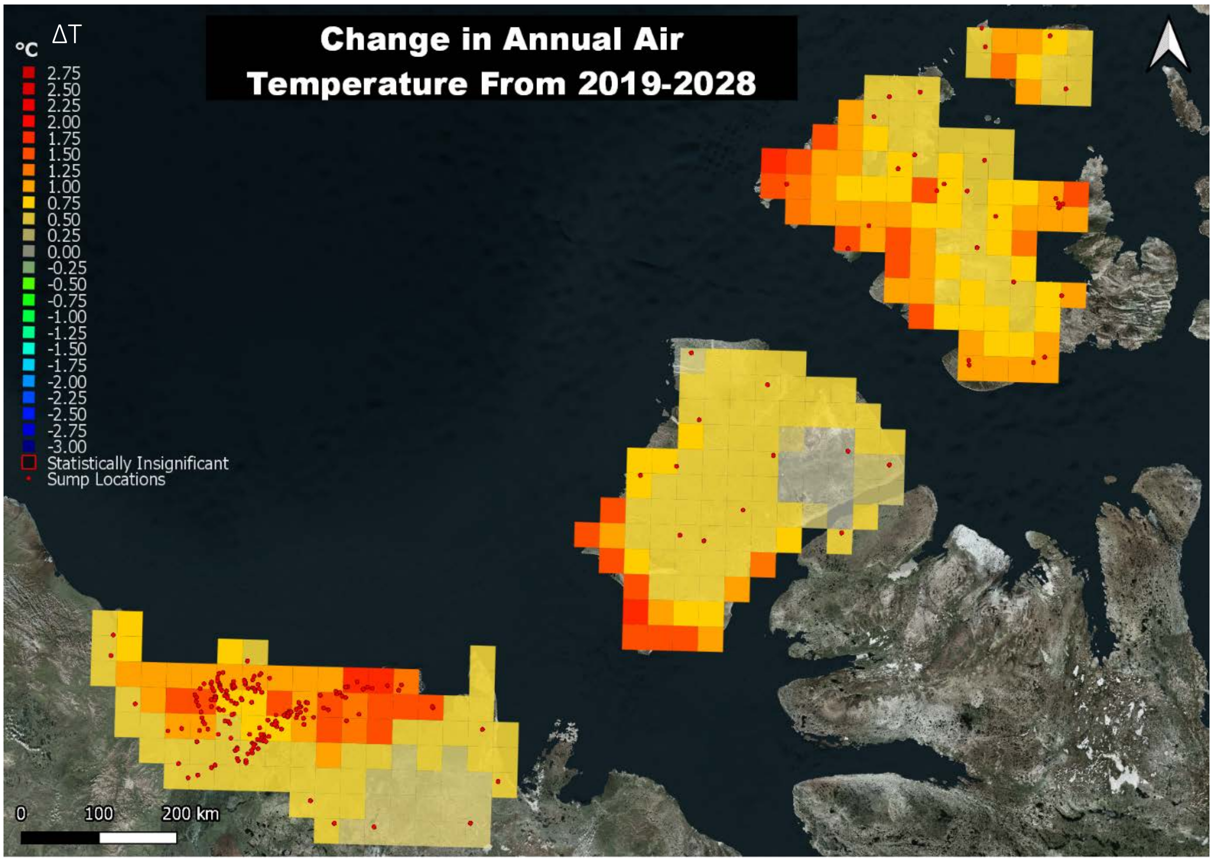

Figure 32: Change in 10-Year Annual Air Temperature (ΔT) From 2019 To 2028 (°C)

Figure 33 summarizes region-wide annual temperature over the 10-year period (2019-2028). The blue line shows the predicted average air temperature values, based on the Q_{med} (50th percentile) from Sen's slope, the orange and grey lines are based on the 95th percentile confidence levels (maximum and minimum) of Q rates. For example, in 2019, the regional average air temperature level is -10.6 °C, with the high bound at -10.0 °C and the low bound at -11.2 °C. After 10 years, in 2028, the regional average air temperature level is -9.8 °C, with the high bound at -9.0 °C and the low bound at -10.7 °C. The average (Q_{med}) temperature increase over the 10-year period is predicted to be 0.8 °C.

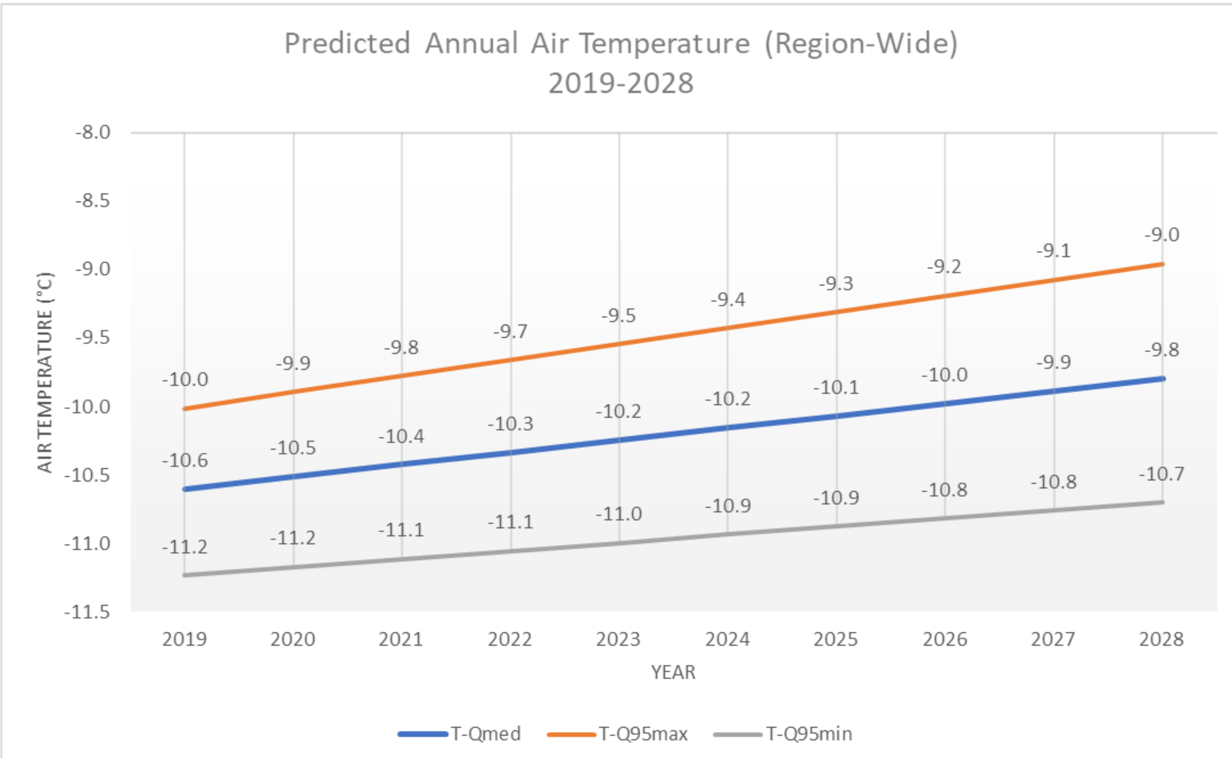

Figure 33: Region-Wide Annual Air Temperature Prediction From 2019 To 2028 (°C).

Seasonal Air Temperature - Spring

Figure 34 summarizes region-wide Spring temperatures over the 10-year period (2019-2028). The blue line is the predicted average air temperature values, based on Q_{med} (50th percentile) from Sen's slope, orange and grey lines are based on 95th percentile confidence levels (maximum and minimum) of Q rates. Spring temperature will increase gradually about 1°C over a 10-year period.

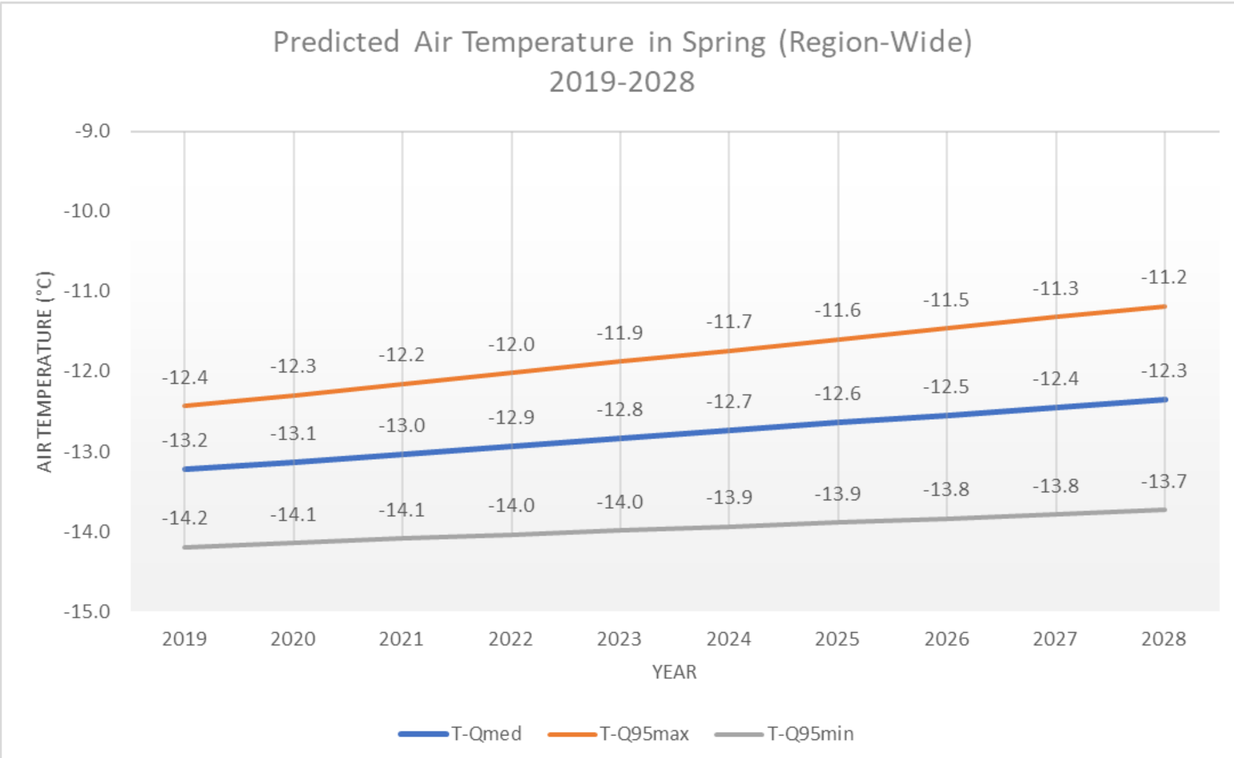

Figure 34: Region-Wide Spring Air Temperature Prediction From 2019 To 2028 (°C).

Figures 35 and **36** present the predicted Spring air temperature across the study area, in year 2019 and 2028, respectively. The results indicate that air temperature is warmer in southern part of study area than central and northern island areas. Moreover, temperature is higher in southern coastal areas from the central and northern islands. Most of the grids passed the M-L sensitivity statistical significance tests, therefore the Spring air temperature projection is considered reliable in most of the study area.

The grids with red boxes shown in the central island and the southern part of study area indicate that the Spring temperature trend analysis didn't pass the statistical significance tests in these grid cells. In other words, although Spring temperature projections (2019-2028) were made through Sen's slope Q rates, the predicted temperature in these "red box" are not reliable (statistically no trend). The region-wide analysis (e.g., **Figure 34**) excluded the grids which were statistically insignificant.

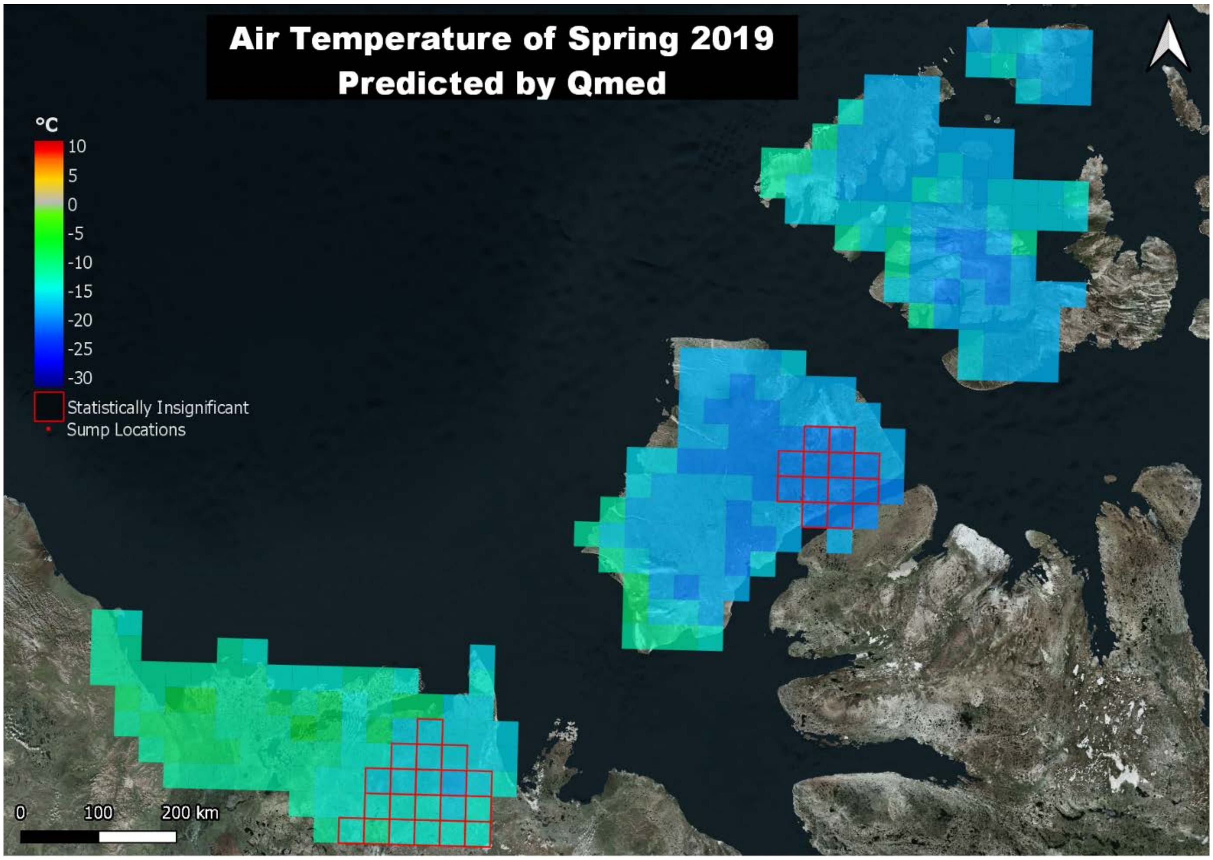

Figure 35: Air Temperature in Spring -2019

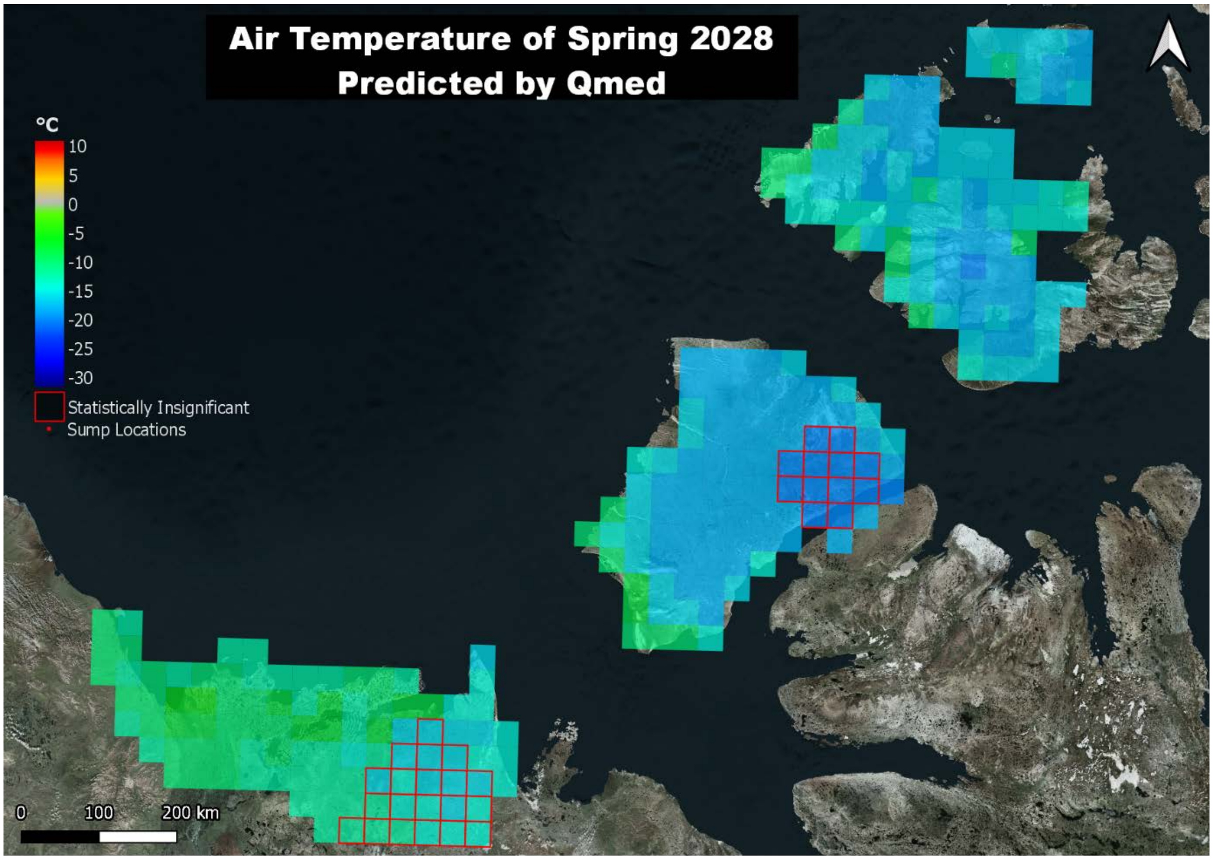

Figure 36: Air Temperature in Spring -2028

Seasonal Air Temperature - Summer

Figure 37 presents the region-wide Summer temperature over the 10-year period (2019-2028). The blue line shows the predicted average air temperature values, based on Q_{med} (50th percentile) from Sen's slope, the orange and grey lines are based on 95th percentile confidence levels (maximum and minimum) of Q rates.

In general, the Q_{med} analysis results indicate the Summer temperature is not expected to increase or decrease over the 10-year study period. Temperature trends show a slight predicted increase in the $Q95_{max}$ and a slight decrease for the $Q95_{min}$.

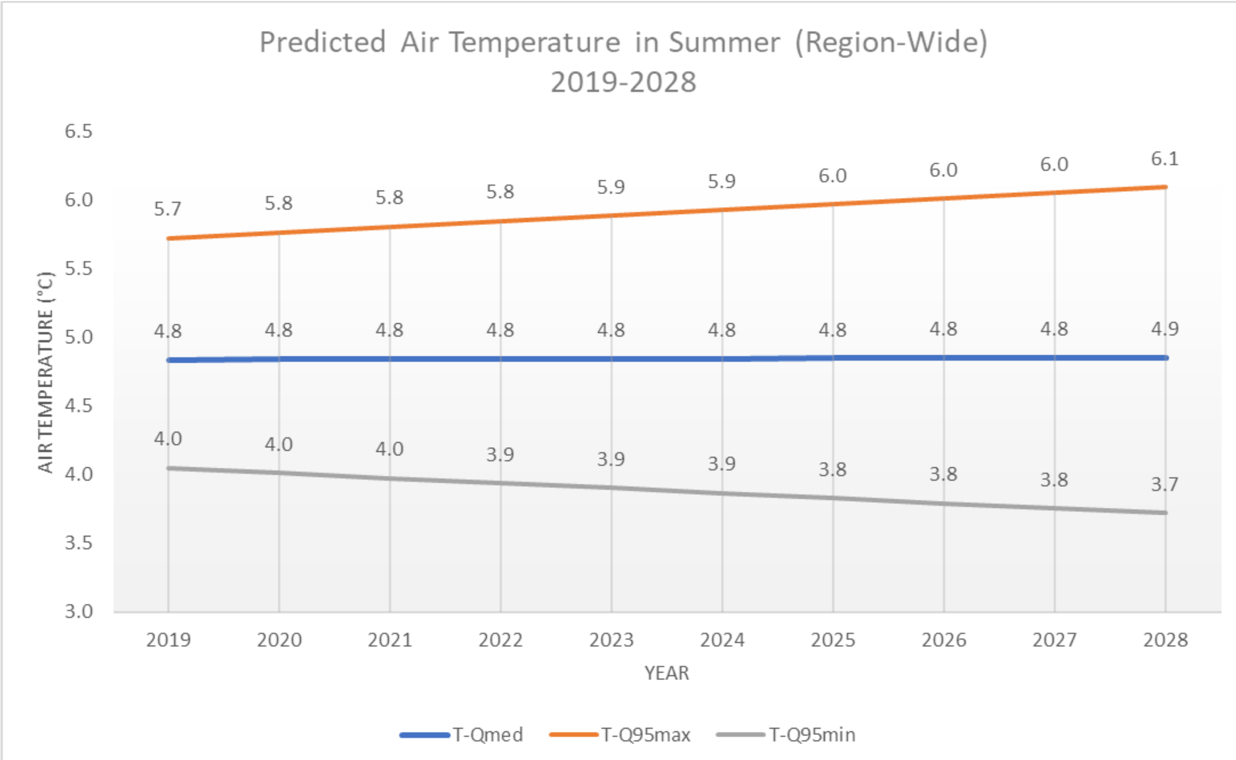

Figure 37: Region-Wide Summer Air Temperature Prediction From 2019 To 2028 (°C).

Figures 38 and **39** present the predicted Summer air temperature across the study area, in year 2019 and 2028, respectively. The results indicate that air temperature is warmer in southern part of study area than central and northern island areas.

The grids with red boxes shown in central/northern islands and the majority of southern part of study area indicate that Summer temperature trend analysis didn't pass the statistical significance tests in these grid cells. In other words, although Summer temperature projections (2019-2028) were made through Sen's slope Q rates, the predicted temperature in these "red box" are not reliable (statistically no trend in Summer).

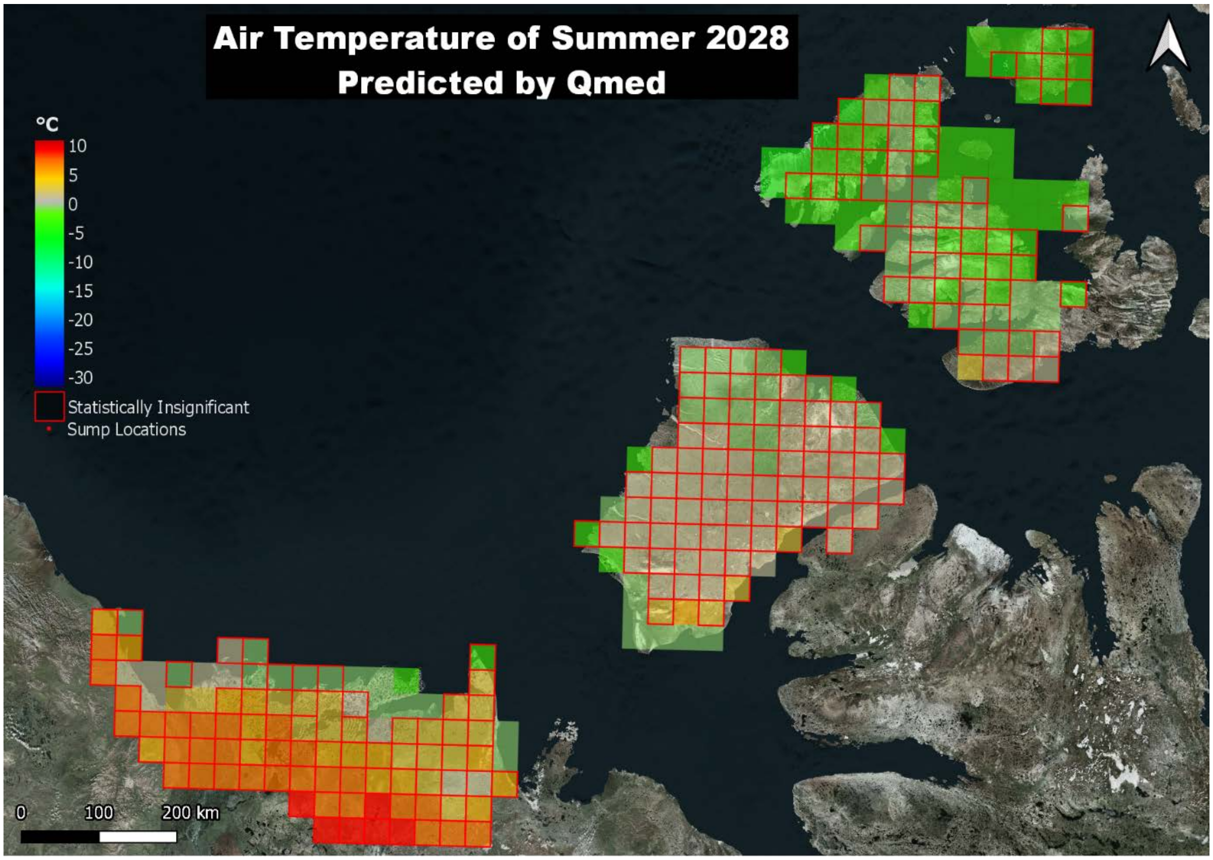

Figure 38: Air Temperature in Summer -2019

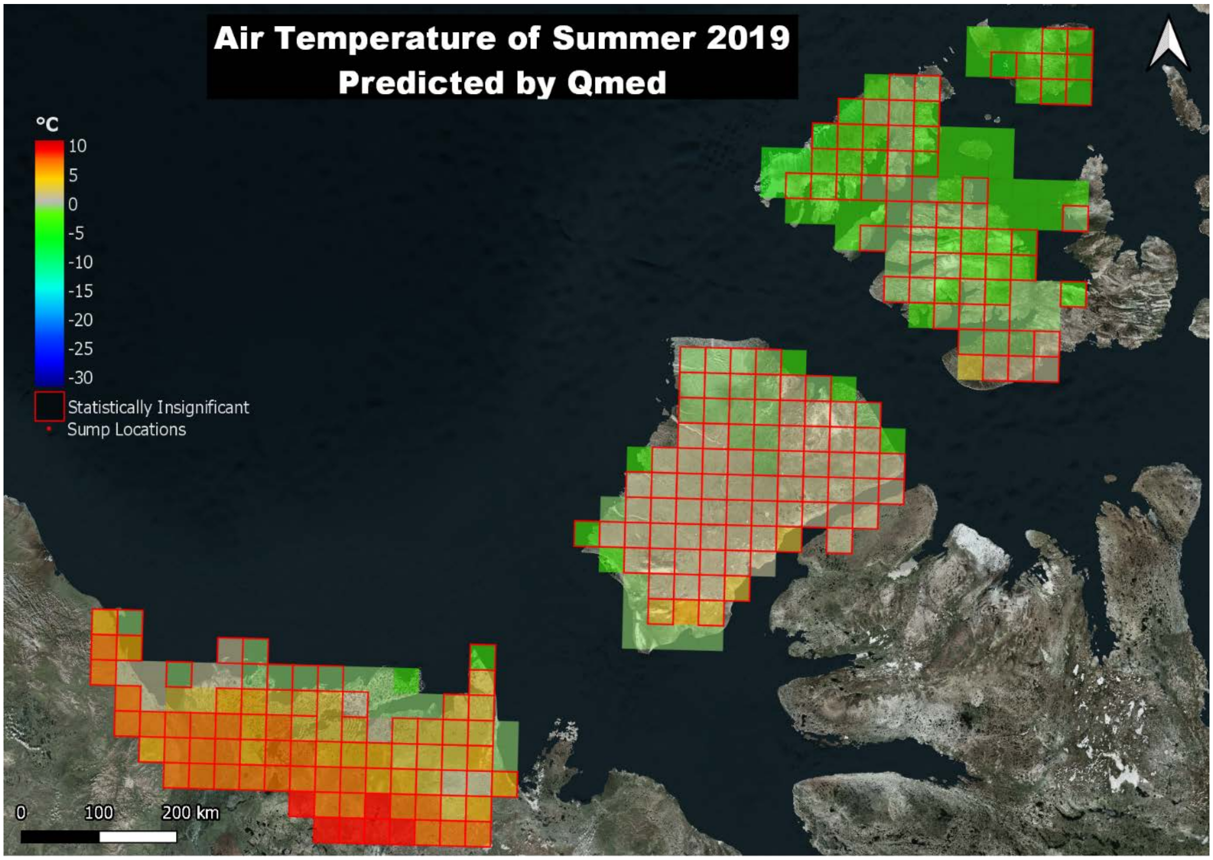

Figure 39: Air Temperature in Summer -2028

Seasonal Air Temperature - Fall

Figure 40 summarizes region-wide Fall temperature over the 10-year period (2019-2028). The blue line shows the predicted average air temperature values, based on Q_{med} (50th percentile) from Sen's slope, the orange and grey lines are based on the 95th percentile confidence levels (maximum and minimum) of Q rates. Summer temperature will increase gradually about 1 °C over the 10-year period.

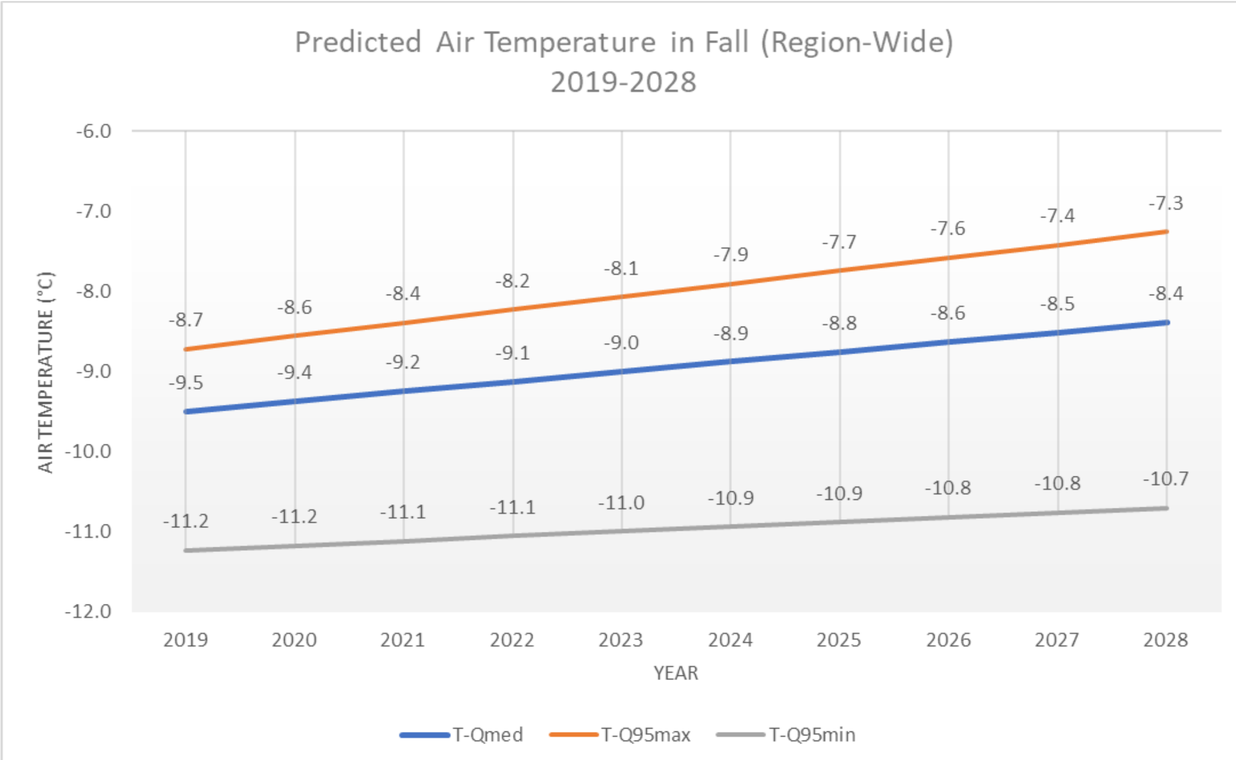

Figure 40: Region-Wide Fall Air Temperature Prediction From 2019 To 2028 (°C).

Figures 41 and **42** present the predicted Fall air temperature across the study area, in year 2019 and 2028, respectively. The results indicate that air temperature is warmer in southern part of study area than central and northern island areas. Moreover, temperature is higher in southern coastal areas from the central and northern islands. All grids passed M-L sensitivity statistical significance tests; therefore, the Fall air temperature projection is considered reliable in the study area.

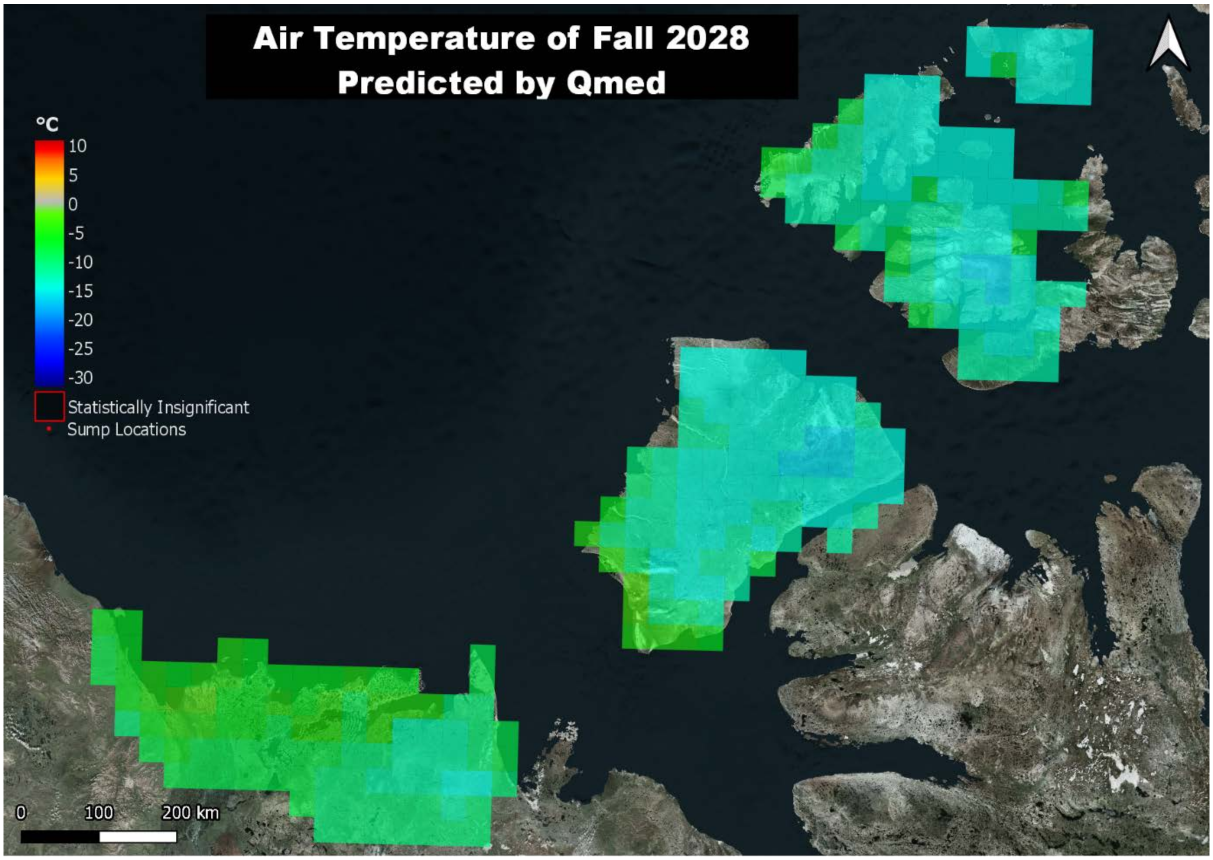

Figure 41: Air Temperature in Fall -2019

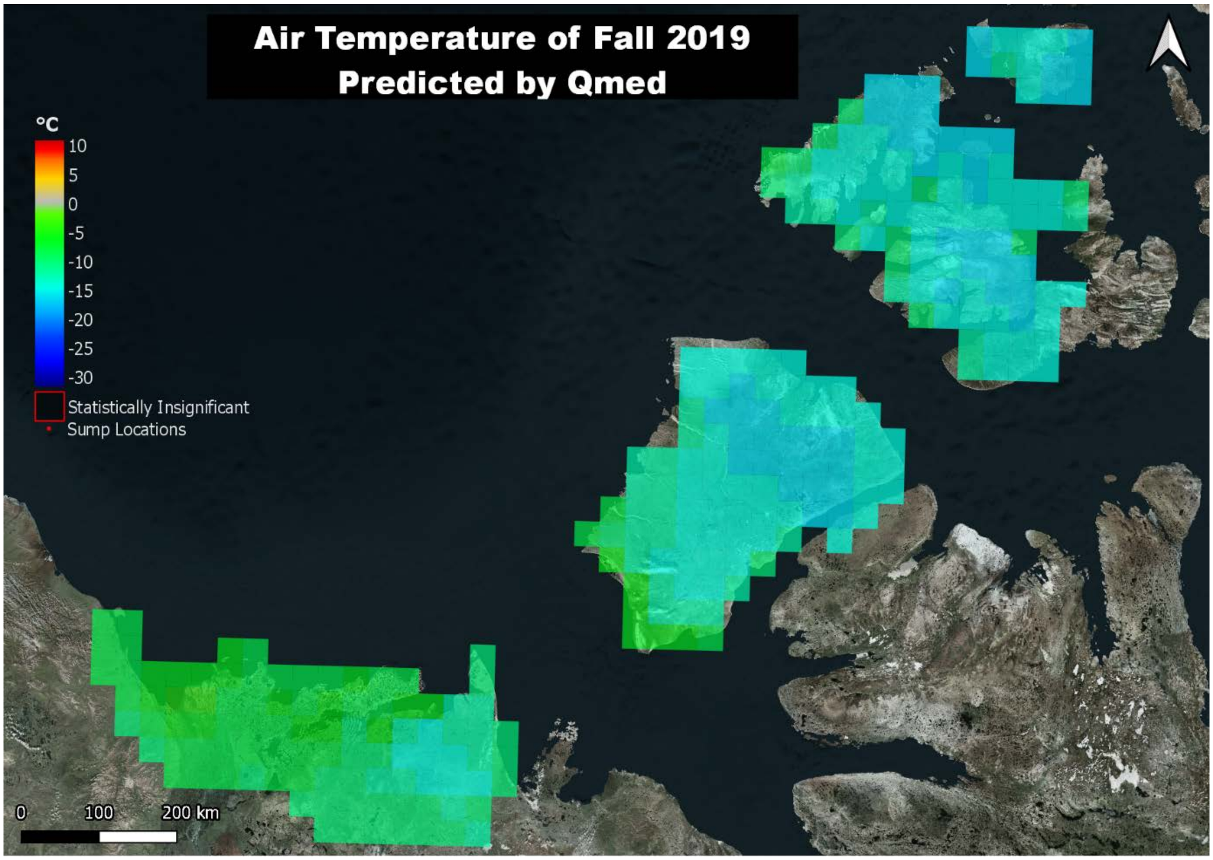

Figure 42: Air Temperature in Fall -2028

Seasonal Air Temperature - Winter

Figure 43 presents the region-wide Winter temperature over the 10-year period (2019-2028). The blue line shows the predicted average air temperature values, based on Q_{med} (50th percentile) from Sen's slope, the orange and grey lines are based on 95th percentile confidence levels (maximum and minimum) of Q rates. Winter temperature is predicted to increase significantly about +1.4 °C over the 10-year period. Among the four seasons, Winter is expected to have the largest temperature increase.

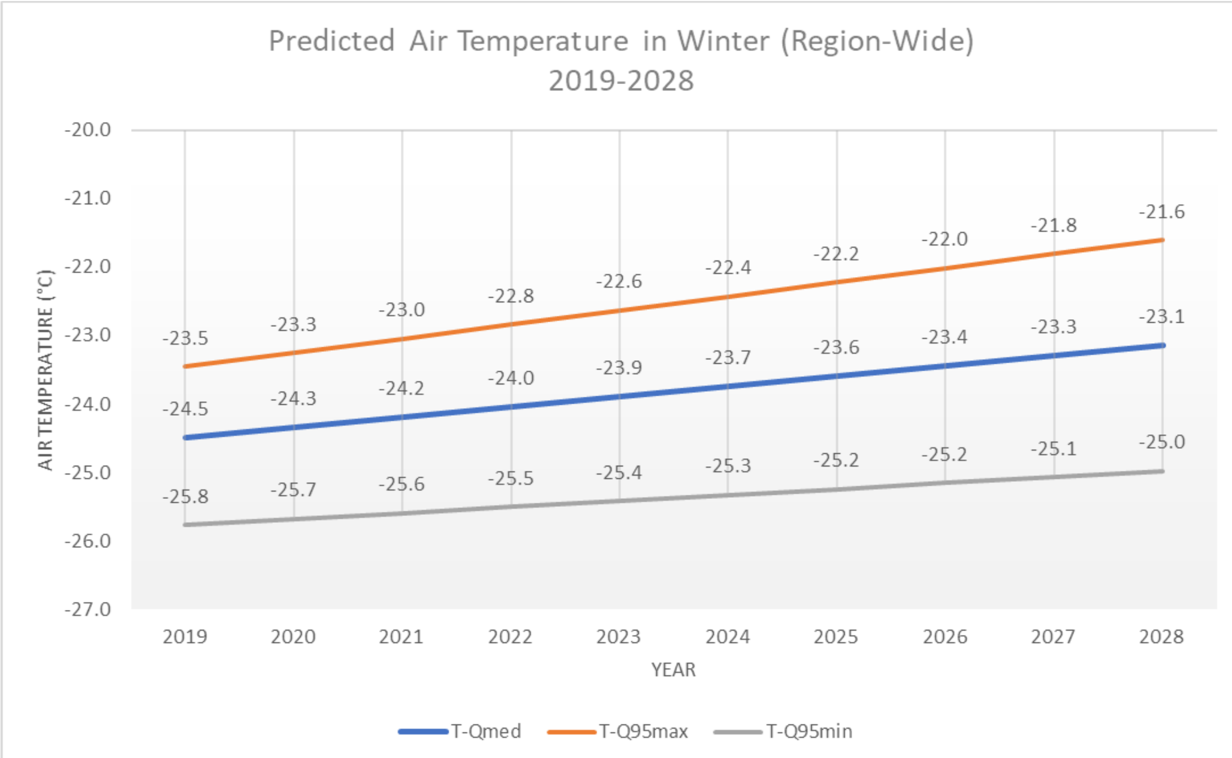

Figure 43: Region-Wide Winter Air Temperature Prediction From 2019 To 2028 (°C).

Figures 44 and **45** present the predicted Winter air temperature across the study area, in year 2019 and 2028, respectively. The results indicate that air temperature is warmer in southern part of study area than central and northern island areas. Moreover, temperature is also higher in southern coastal areas from the central and northern islands. Most of the grids passed M-L sensitivity statistical significance tests therefore, the Winter air temperature projection is considered reliable.

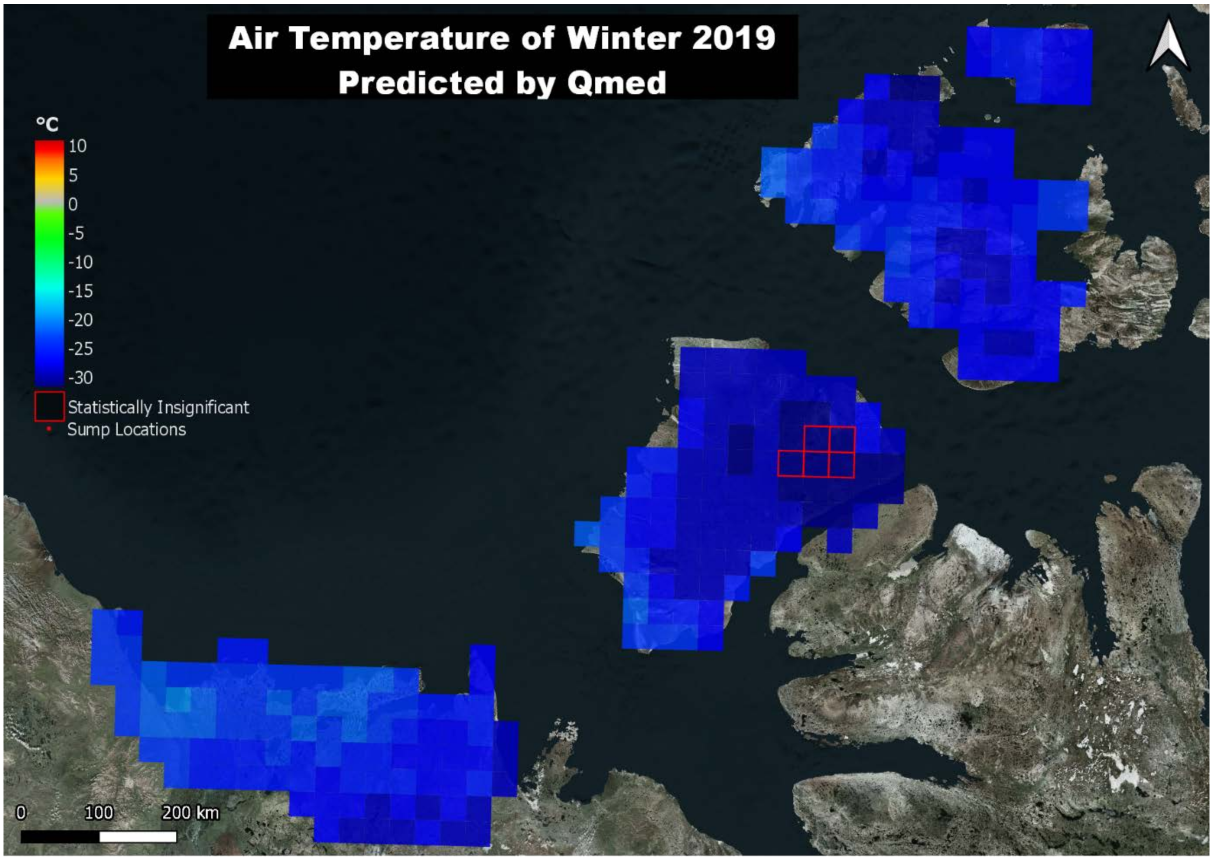

Figure 44: Air Temperature in Winter -2019

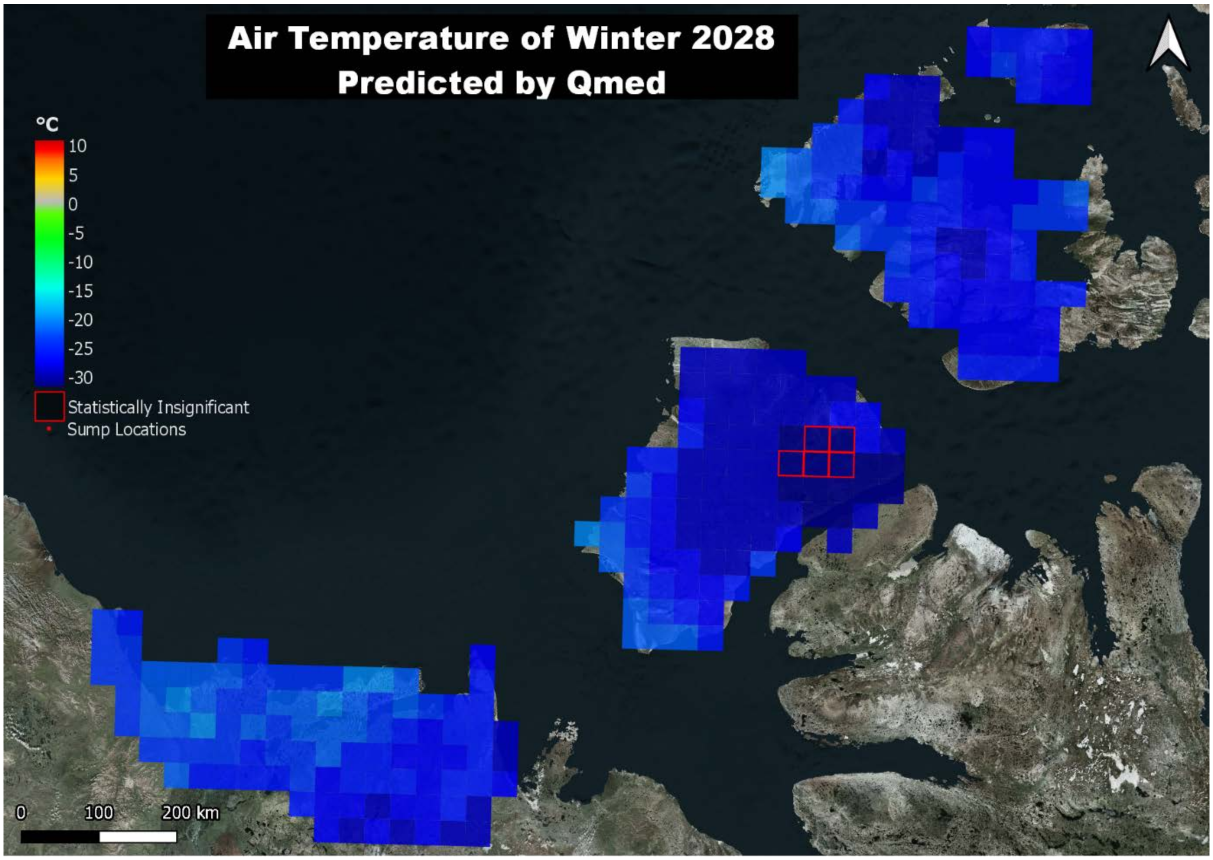

Figure 45: Air Temperature in Winter -2028

Air temperature prediction summary

In general, the predicted air temperature in near future (2019-2028) will increase annually, about +0.9 °C over 10-year period. From a seasonality prospective, the Winter is expected to have the highest increase in temperature, about +1.4 °C over the 10-year period, and the Summer will be expected the least change in temperature (no trend). Spring and Fall are expected to have a moderate increase in temperature.

5.7.2 PREDICTION OF GROUND TEMPERATURE AND THE CHANGE IN FUTURE 10 YEARS

Change in Ground Temperatures

Figure 46 presents the change in ground surface temperature over a 10-year period, from 2019 to 2028. The highest 10-year temperature change (>2.0 °C increase) is located in southwest quadrant of the study area, off the coastal region (slightly inland). Relatively higher temperature increases were also found in the northeast islands. The rest of the region is predicted to have a temperature increase from 0.5 to 1.0 °C.

Most of the central island, the south portion of the northern island, and the east side of southern land didn't pass the significance tests, i.e., are considered statistically insignificant (red boxes in the figure). The southern land where most of the sump sites are located has the most reliable prediction.

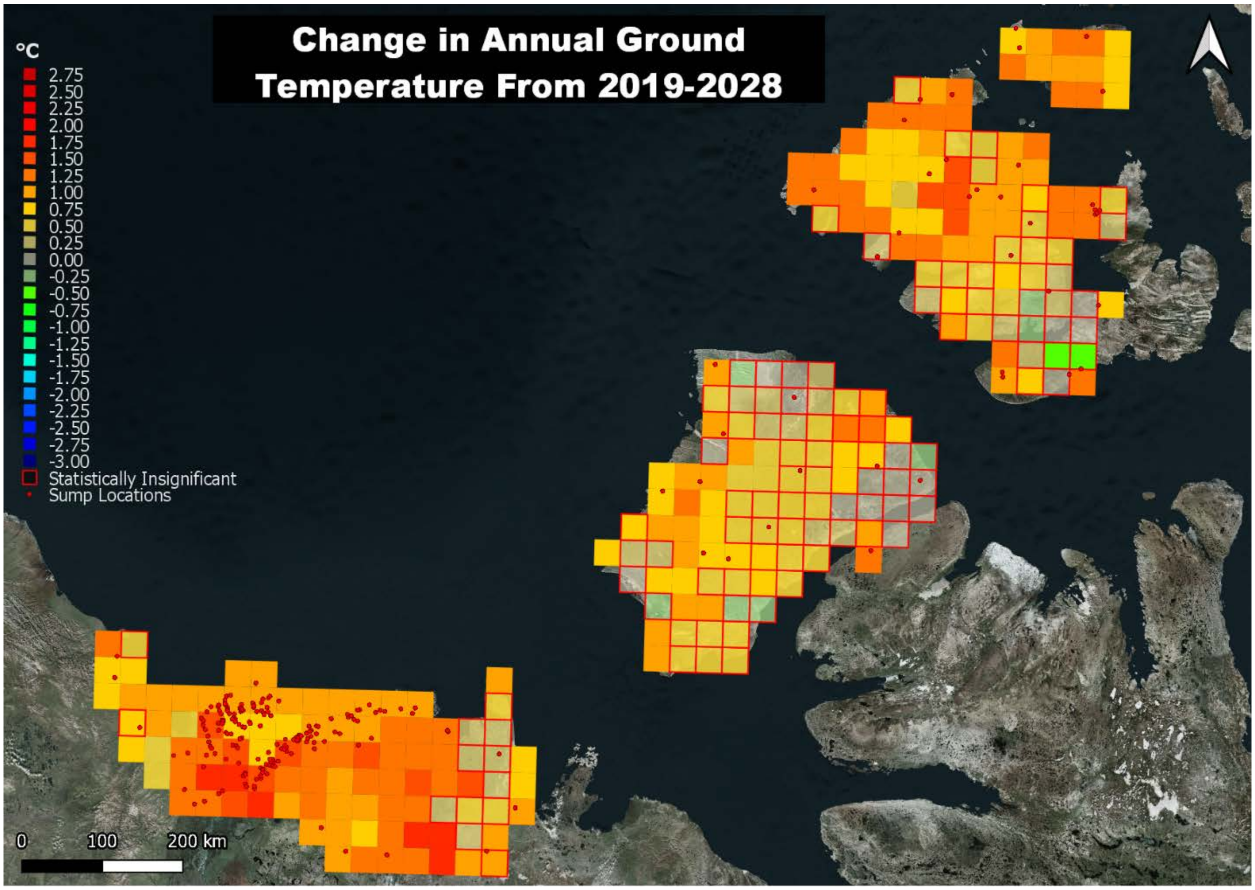

Figure 46: Change in 10-Year Annual Ground Surface Temperature (ΔT) From 2019 To 2028 (°C)

Figures 47 to 49 present the changes in ground temperatures from 0.1m, 0.4m and 1.0m underground over the 10-year period (2019 to 2028).

The highest 10-year temperature change (>2.0 °C increase) is located in southwest quadrant of the study area off the coastal region (slightly inland). Relative higher temperature increases were also found in the northeast islands. The rest of the region is predicted to experience an increase in temperature from 0.5 to 1.0 °C in over the 10-year period. However, there are a number of grids on the central and northeast islands that are predicted to experience decreases in temperature (green cells). Decreases in temperature were more common in the deeper zones such as -1.0m, than at the shallower depths.

The majority of the ground temperature grids didn't pass the statistical significance tests (red boxes in the figure) and are considered statistically insignificant. Thus overall, the prediction of ground temperature trends has low reliability.

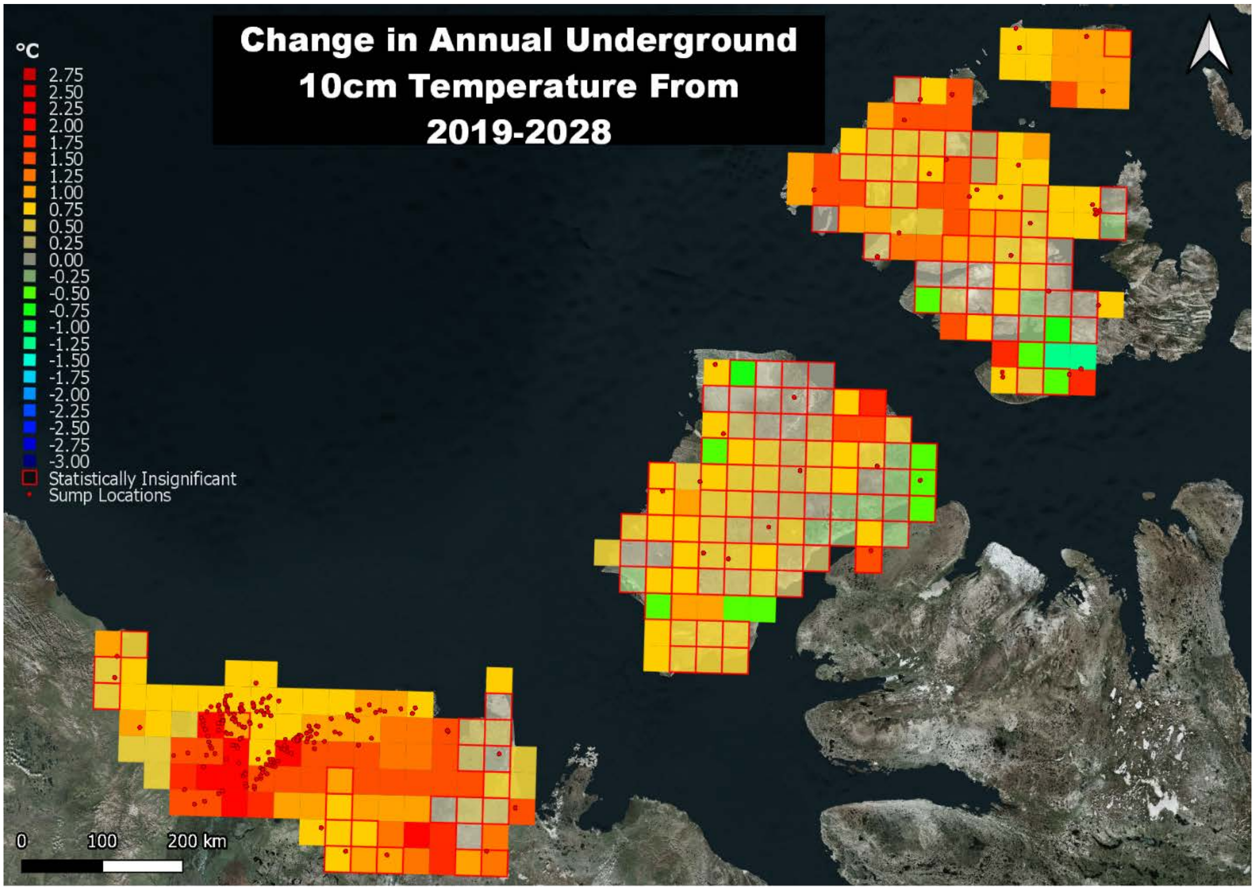

Figure 47: Change in 10-Year Annual Underground 10 Cm Temperature (ΔT) From 2019 To 2028 (°C)

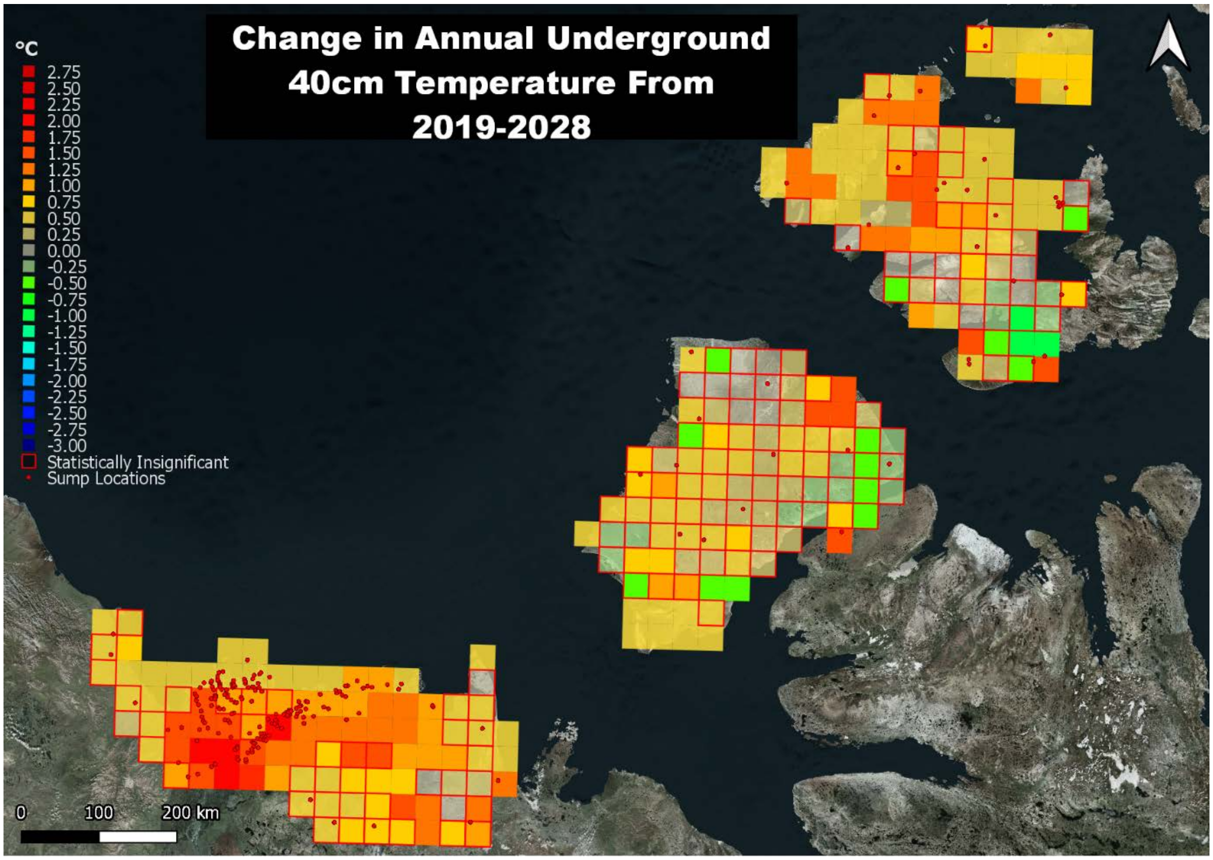

Figure 48: Change in 10-Year Annual Underground 40 Cm Temperature (ΔT) From 2019 To 2028 (°C)

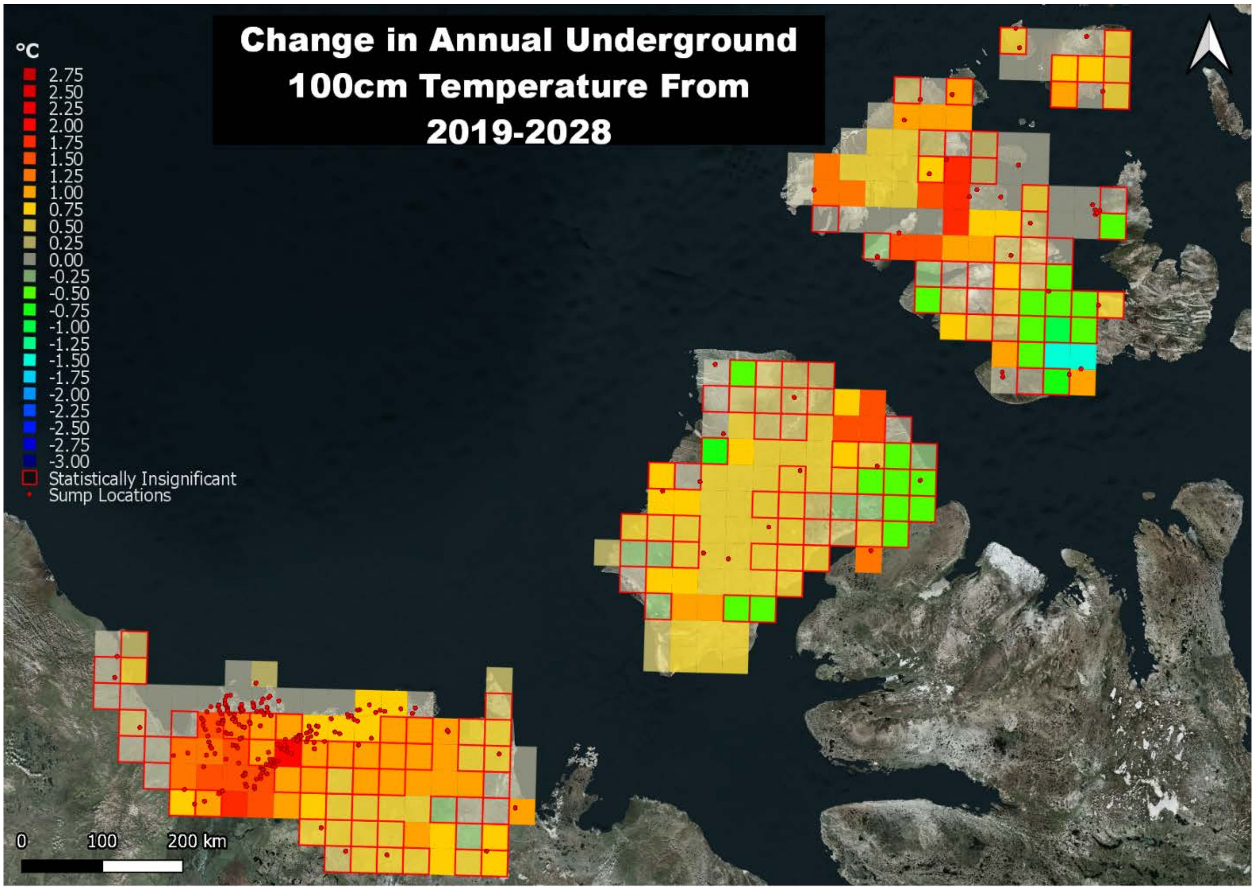

Figure 49: Change in 10-Year Annual Underground 100 Cm Temperature (ΔT) From 2019 To 2028 (°C)

The ground temperature prediction data for all ground layers has been provided in Excel spreadsheet format in a separate submission.

6. CONCLUSIONS

The potential for degrading permafrost containing drilling waste sumps is of high concern to the Inuvialuit Regional Corporation and stakeholders in the Inuvialuit Settlement Region (ISR). The potential failure of the drilling waste sumps could result in flooding, erosion and further degradation of permafrost and/or a discharge of contaminated materials in areas throughout the ISR and Mackenzie Delta region.

To address the concerns of the Inuvialuit residents, SLR has completed this study by conducting a drilling waste sump risk evaluation and climate change assessment for ARKTIS Solutions Inc. (ARKTIS). The deliverables of gridded climate data for this project was submitted to ARKTIS.

This study evaluates the annual and seasonal air/ground temperatures and precipitation in the region and the predicted changes of these parameters. The study estimates the warming effect on the long-term stability of the permafrost and the potential impact on the sump sites. Air and ground temperatures and precipitation trends were analyzed for the observation period 1979-2018 but were focused on recent 2001 to 2018 period to reflect recent warming trends in the region. Climate trends (air and ground temperature) were studied by nonparametric Mann-Kendall test (M-K test) and Sen's slope methods.

Through the analysis, SLR concluded the following:

- There are obvious warming trends of air temperature in the ISR, on annual basis (Q rate at °C/year). The higher Q rate (>0.2 °C/year) is located in the southwest quadrant of the ISR along the coastal region, where most of the sump sites are located. Relatively higher Q rates are also found from the southern coastal areas of the central and northeast islands.
- There are seasonal variations of the Q rates, which indicates that not all seasons have a warming trend. Winter and Spring show the most significant warming trends, while Summer air temperature has no statistical significance, as such its Summer has no trend of warming or cooling.
- Warming trends are also discovered for ground temperature (0, 0.1, 0.4 to 1 mbg), but these trends are not correlated to the air temperature trends. For example, Summer cooling trends were found in some areas, but there were no trends in other areas, which is not the same as the air temperature trends. Warming trends were mostly found during the Winter and Spring seasons; while Fall was statistically insignificant (no change).
- The southwest study area, where most of the sumps are located, is exposed to the highest potential of warming trends, for both air and ground temperatures. This area should be considered a higher risk for permafrost degradation and sump failure.
- Near future (2019-2028, 10 years) annual projection of air temperature based on the Q rates on all NARR grids inside the project domain were generated and provided to ARKTIS. Three temperature project profiles, Q_{med}, Q_{95max} and Q_{95min} in which Q_{med} is 50^{th} percentile prediction and the most likely the case were provided. The future prediction of air temperature based on Q_{med} is a warming trend, varying by locations. The main concern is the area of southwest part of study area, where most of the sumps are located. The 2019 to 2028 annual air temperature projection is considered reliable based on the results that all grids passed M-L sensitivity statistical significance tests.
- Future air temperature is predicted to be warmer in southern part of study area than the central and northern island areas. Moreover, temperature is predicted to be higher in southern coastal areas from the central and northern islands.

- The change in 10-year annual temperature from 2019 to 2028 suggests a warming trend in air temperature over the study area. The highest 10-year temperature change (>2.0 °C increase) is located in the southwest quadrant of the study area along the coastal region, where most of the sump sites are located. Relatively higher temperature increases were also predicted in the southern coastal areas at the central and northeast islands. Southern inland and the eastern part of central island is predicted to experience a minor increase to no change in air temperature. The rest of the region is predicted to experience an increase in temperature from 0.5 to 0.75 °C in the future 10-year period.
- Changes in near-future air temperature presented a strong seasonality – a stronger increase in air temperature in the Winter and no increase in temperature in the Summer. Moderate increases in temperature were found in the Spring and Fall.
- The near-future ground temperature is also following the warming trend, for all four levels (0m, 0.1m, 0.4m and 1.0m underground) with some of the deeper profiles showing a cooling trend. The highest 10-year temperature change (>2.0 °C increase) is located in southwest quadrant of the ISR off the coastal region (slightly inland). Relatively higher temperature increases were also found in the northeast islands. The rest of region is predicted to experience an increase in temperature from 0.5 to 1.0 °C in future 10-year period.
- From statistical significance tests for ground temperature, most of the central island, the south portion of the northern island, and the east side of southern land didn't pass the tests. The southern land where most of the sump sites are located has relatively reliable prediction, while most areas are considered statistically insignificant, hence the changes in temperature are not considered reliable.

The statistical models M-K testing and Sen's slope provide statistical significance tests. Although Q rates were provided on each of the grids, some of them didn't pass the significance testing, which means no trend has been found or the trend is inconclusive. We provided all data including the significance testing indicators in Table 3.

Data deliverables pertinent to this study included:

- Gridded air and ground temperature by annual and seasons
- Gridded bias-corrected daily temperature and ground temperature
- Precipitation data from NARR processed by months from 1979 to 2018
- Near future air temperature by grids
- Digital maps and tables

7. STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for ARKTIS Solutions Inc. Any conclusions or recommendations made in this report reflect SLR's professional opinion.

Information contained within this report may have been provided to SLR from third party sources. This information may not have been verified by a third party and/or updated since the date of issuance of the external report and cannot be warranted by SLR. SLR is entitled to rely on the accuracy and completeness of the information provided from third party sources and no obligation to update such information.

Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations or policies established by federal, provincial or local government bodies. Revisions to the scientific standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary.

8. REFERENCES

ESRF 2005: AMEC Earth & Environmental, Inuvialuit Settlement Region Drilling Waste Disposal Sumps Study, February 2005, *Environmental Studies Research Funds Report* No. 154, Calgary, 260 p.

Dyke, L.D., 2000: Shoreline permafrost along the Mackenzie River; in The Physical Environment of the Mackenzie Valley, Northwest Territories: a Base Line for the Assessment of Environmental Change, (ed.) L.D. Dyke and G.R. Brooks; *Geological Survey of Canada,* Bulletin 547, p. 143–151.

Harris, Stuart ,1987, Influence of organic (Of) layer thickness on active-layer thickness at two sites in the Western Canadian Arctic and Subarctic. Erdkunde, v41, 10.3112/erdkunde.1987.04.02

Milan, G. and Slavisa, T. 2013: Analysis of changes in meteorological variables using Mann-Kendall and Sen’s slope estimator statistical tests in Serbia. Global and Planetary Change, Vol. 100, pp. 172-182, 2013.

Yours sincerely,

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APPENDIX D: GROUND-TEMPERATURE MODELLING FOR SUMPS WITHIN THE INUVIALUIT SETTLEMENT REGION

ProFound Engineering Ltd.

Dr. Jamie Van Gulck
ARKTIS Solutions Inc.
Kingston, ON

19 February 2020

Attention: Dr. Jamie Van Gulck, P.Eng.

Re: Ground-temperature modelling for Tuktoyaktuk-area drilling-mud sumps.

Dear Dr. Van Gulck:

At your request, Profound Engineering Ltd has conducted ground-temperature modelling for a typical drilling-mud disposal sump near Tuktoyaktuk, NT. The purpose of the modelling exercise was to simulate recent ground temperature conditions in and around a hypothetical drilling-mud sump, and to evaluate first-order simulations of long-term ground temperature evolution under future climate projections.

Ground temperatures for the time period between 2005 and 2095 were simulated for two locations: 1. Sump centreline and 2. Shoulder area adjacent to the sump. Following initial models to simulate current and future climate-equilibrium ground temperatures, a series of transient analyses were performed to investigate increase in mean annual ground temperature (MAGT) and progressive deepening of the active layer. The transient analysis accounted for the predicted change in air temperature with time due to climate change.

This report summarizes the modelling methodology, assumptions, results and limitations.

Methodology:

The Tuktoyaktuk area was chosen for the first-order ground temperature simulations because it represents the approximate geographic mid-latitude for the drilling-mud sumps, and because complete historical climate data were available at Tuktoyaktuk.

Ground temperature modelling was conducted using the thermal numerical modelling software TEMP/W, developed by GeoSlope International, Ltd. The software solves the differential equations of conductive heat transfer in soils, including phase change, and employs a surface-energy-balance surface boundary condition using measured or projected climate inputs. A heat-flux of 0.05 W/m^2 was applied at the base of each model to represent the geothermal energy gradient; consistent with the Geothermal Map of North America[1] and other modelling studies in the western Arctic[2].

[1] Blackwell & Richards. 2004. Geothermal Map of North America. AAPG Map, scale 1:6,500,000.
[2] Burn & Zhang. 2009. Permafrost and climate change at Herschel Island. J Geop Res: Earth Surf, 114(2),1-16.

Model Profile and Properties

One-dimensional subsurface models were developed for typical (hypothetical) drilling-mud sumps. Subsurface stratigraphy, sump geometry, and soil thermophysical properties applied in the models were gathered from a previous study by Kokelj et al. (2010)[3]. Two, 10 m deep models were developed to represent the centreline profile of the drilling-mud sump and the undisturbed sump shoulder (Figure 1). A uniform profile of sandy silt soil was used to represent the mineral soil in both models and a 0.2 m layer of peat was added at the surface of the shoulder profile, consistent with Kokelj et al (2010). Freezing-point depression was not applied to the waste materials within the sump.

Material properties applied in the models are presented in Table 1. Available properties were obtained or calculated from the data and methods presented by Kokelj et al. (2010). The sump centreline model used a uniform, saturated sandy silt soil profile, while the shoulder model replaced the upper 0.2 m with saturated peat.

***Table 1** – Soil thermophysical properties applied in the models (after Kokelj et al., 2010)*

Soil Name	**VWC*** (m^3/m^3)	**Thermal K** (W/m/°C)		**Heat Cap.** (kJ/m^3/°C)		**Unfrozen WC function**
		Thawed	Frozen	Thawed	Frozen	
Sandy silt	0.4	1.50	2.00	2870	2030	$w_u = 0.08(-T)^{-0.8}$
Peat	0.85	0.35	1.00	4230	2470	$w_u = 0.10 (-T)^{-0.7}$

*volumetric water content

Climate Inputs

Climate inputs to the model included monthly averages of air temperature, wind speed, snowcover, albedo, and vegetation thickness; and a built-in diurnal estimate of daily solar radiation based on latitude and date. The air temperature function, snowcover function, and timing of the albedo function varied between analyses, while all other functions were consistent. Albedo functions were assumed to alternate between 0.8 during winter and 0.15 in summer, synchronized with the onset and ablation of snowcover. Vegetation was assumed to have negligible height during winter, and reach 1 m in height by late summer[4] (Johnstone & Kokelj, 2008). Wind has only a small influence on the surface energy balance and thus an available function of monthly mean windspeed from nearby Shingle Point, YK was used in all analyses.

A number of analyses were performed to simulate the ground thermal regime in equilibrium with the recent (i.e. 2005) climate, in equilibrium with a projected 2095 climate under RCP8.5, as well as for a 90-year transient analysis of projected RCP8.5 monthly air temperatures between 2005

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[3] Kokelj,…, Kanigan. 2010. Permafrost and terrain conditions…implications. Cold Regions Sci & Tech. 64:46-56.
[4] Johnstone & Kokelj. 2008. Environmental conditions…Mackenzie Delta region, NWT. Arctic 61(2):199–211.

to 2095. The 2005 and 2095 climate-equilibrium analyses were conducted for the sump centreline model only, and transient analyses were conducted for both the centreline and shoulder models. The 2005 climate-equilibrium model was calibrated to obtain a mean annual ground temperature (MAGT) of - 6.0°C for consistency with the Tuktoyaktuk-area models of Kokelj et al. (2010) by iteratively adjusting the thermal conductivity of snow between analyses. A snow thermal conductivity of 0.25 W/m/°C was obtained and used for all subsequent analyses. The transient analyses for the centreline and shoulder were initiated with the results of the 2005 climate-equilibrium analysis. Transient analyses were conducted with two snowcover functions to simulate the range of possible outcomes.

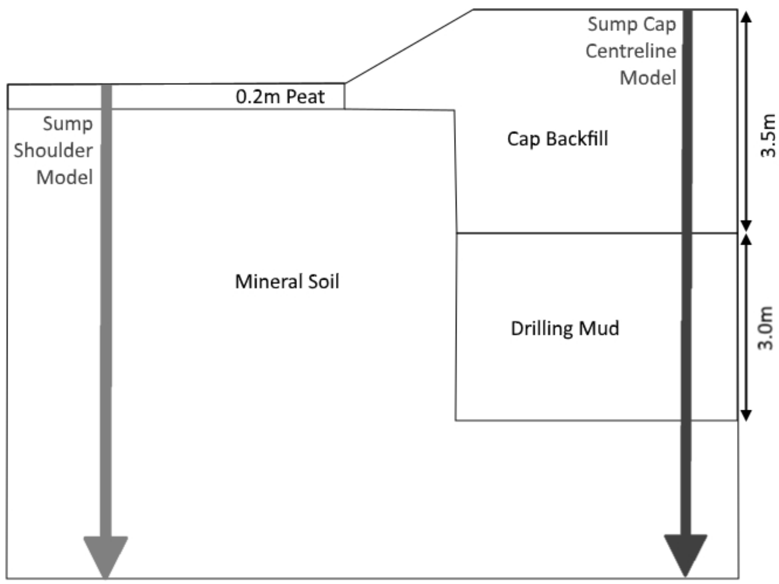

***Figure 1** – 1D model profiles developed to represent the sump cap centreline (uniform mineral soil) and the sump shoulder (uniform mineral soil overlain with 0.2m peat) (after Kokelj et al., 2010).*

For the '2005' climate-equilibrium analysis, a record of 1976 to 2005 monthly average air temperatures at Tuktoyaktuk were used from Tuktoyaktuk A weather station[5], along with monthly average snow depths for the 1970 to 2010 climate normal period obtained from Environment and Climate Change Canada (ECCC). Mean Annual Air Temperature for this period was -9.4 °C.

For the 2095 climate-equilibrium analysis, RCP8.5 ensemble monthly mean temperature and total precipitation projections for 2095 (MAAT -0.6 °C) were obtained using Pacific Climates Impacts Consortium (PCIC) Climate Explorer[6]. An estimated snowcover function for 2095 was developed by multiplying the RCP8.5 projected monthly total precipitation values during months

[5] Environment and Climate Change Canada. 2020. Historical Climate Data for Tuktoyaktuk "A" Meteorological Station.
[6] Pacific Climates Impacts Cons. 2014. Statistically Downscaled Climate Scenarios, U Victoria. https://climateatlas.ca/

of sub-zero temperature by a snowcover factor. The snowcover factor was obtained by comparing monthly total precipitation amounts to snow-on-ground depths during the 1971-2000 climate normal period obtained with published data ECCC[7]. Additional 2095 climate-equilibrium analyses were also conducted with a multiplier applied to the snowcover of either 2x (high) or 0.5x (low).

For the transient analyses, RCP8.5 ensemble monthly mean temperatures for each year between 2005 and 2095 were used in conjunction with either the 2005 or 2095 snowcover function and associated albedo function. All other climate functions were unchanged.

Model Results:

Results of the model analyses are presented as MAGT versus MAAT (Figure 2), MAGT versus time (Figure 3), maximum thaw depth versus MAAT (Figure 4) and maximum thaw depth versus time (Figure 5). The 2005 and 2095 snowcover models are the projected extreme (maximum and minimum) snow depths.

Figure 2 displays both the climate-equilibrium analysis results for 2005 and 2095 as well as transient results for the centreline and shoulder models in terms of increasing MAAT. Climate-equilibrium analysis results for 2005 (MAAT -9.4 °C) obtained a MAGT of -6 °C. Climate equilibrium analyses for 2095 (MAAT -0.6 °C) showed a range of MAGT from +2.1 °C to +5.1 °C associated with the range of snowcover functions.

In the transient analyses, modeled MAGT generally increased with increasing MAAT (Figure 2) and year (Figure 3) for the centreline model and shoulder model with both 2005 and 2095 snowcover functions. In all cases, the 10 m MAGT asymptotically approached 0 °C towards the end of the transient period (>2090, >1 °C MAAT); an indication that the permafrost in the upper 10 m had become isothermal.

Simulated transient ground temperatures in the centreline model warmed and approached 0 °C sooner than in the shoulder model. The shoulder model maintained cooler ground temperatures by about 2 to 3 °C at 10 m below grade for much of the model due to the insulative cover of peat that reduces heat absorption during summer months. Initial cooling in the shoulder model (square symbols, Figure 2 and 3) at the start of transient analyses was the result of using the single-soil climate-equilibrium model as the baseline before introducing the peat layer. Nevertheless, the shoulder model MAGT catches up to the centreline model after year 2080 (>-2 °C MAAT) as the permafrost becomes isothermal near 0 °C.

[7] Environment and Climate Change Canada. 2020. Canadian Climate Normals or Averages 1971 to 2000.

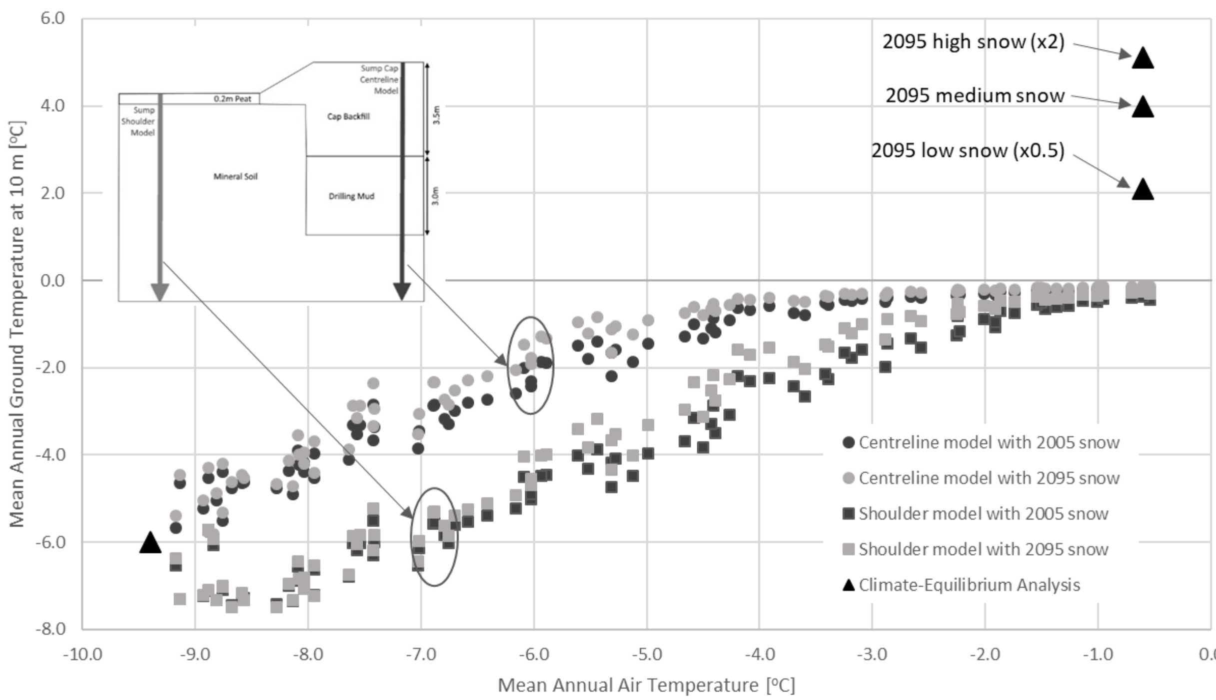

Figure 2 *– Modelled mean annual ground temperature results, calculated at 10 m depth, as a function of mean annual air temperature for the climate-equilibrium analyses, as well as for the transient analyses at the sump centreline and shoulder under the 2005 and 2095 snowcover functions.*

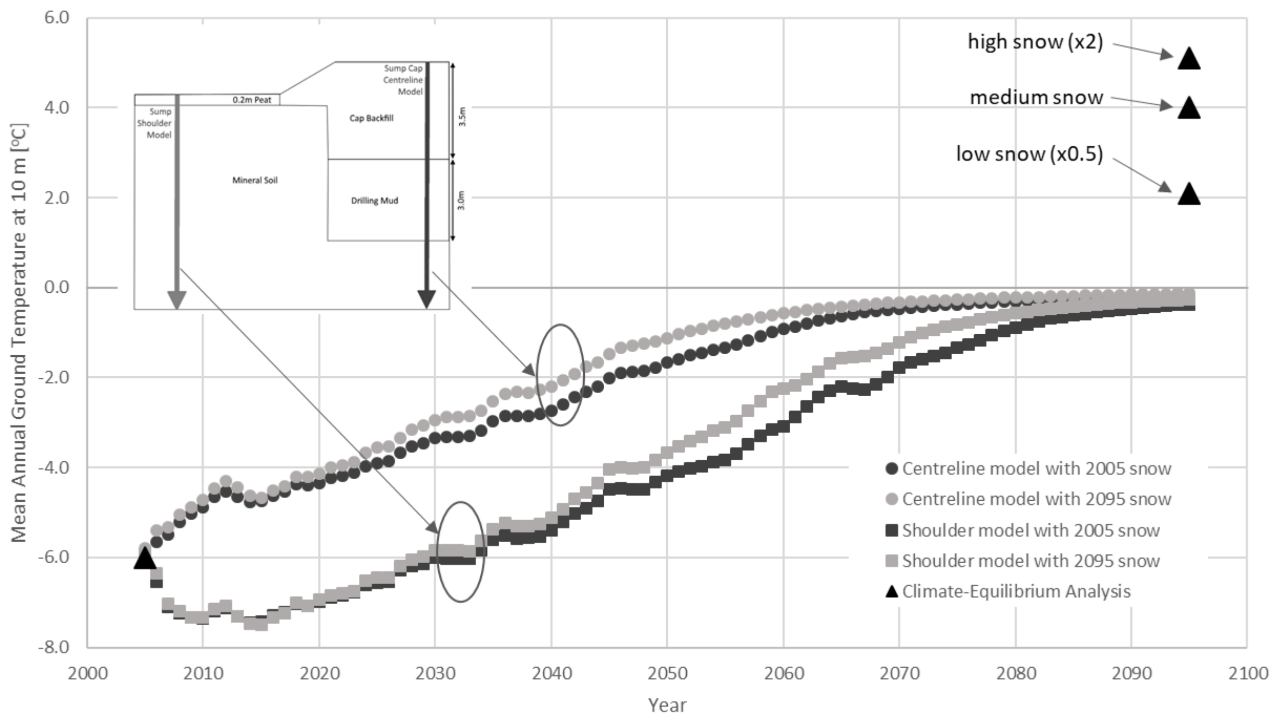

***Figure 3** – Modelled mean annual ground temperature results, calculated at 10 m depth, by year for the climate-equilibrium analyses, as well as for the transient analyses at the sump centreline and shoulder under the 2005 and 2095 snowcover functions.*

In both models, the 2095 snowcover function generates warmer ground temperatures over the course of the transient analyses (Figures 2 and 3, light grey symbols). However, the difference in MAGT simulated with the two snowcover functions (dark vs light symbols) was minimal, peaking near 0.7 ^{o}C in mid-century (Figure 3).

As expected, the 2095 climate-equilibrium analyses (triangle symbols) produced greater ground temperature increase by 2095 for all snowcover scenarios compared to the transient analyses. This was the result of the 2095 climate-equilibrium analyses cycling the warmest year (2095) of temperatures until an equilibrium was established.

Modeled maximum annual thaw depth beneath the sump centreline and the shoulder under the 2005 and 2095 snowcover functions are presented as a function of MAAT in Figure 4 and by year in Figure 5. In 2005, the modelled active layer was approximately 0.5 m thick in the shoulder model where peat was present, and 1.0 m thick at the centreline. Results show an increase in thaw depth in the centreline model, particularly after mid-century, as the full 10 m profile warms toward 0 ^{o}C.

By 2095, model results show the maximum annual thaw depth at the sump centreline reached between 5.5 m and 7.8 m below the sump cap surface, depending on the snowcover (Figure 4 and 5, circle symbols). In the shoulder model (square symbols), maximum thaw depth was less, with a range between 1.6 m and 3.5 m below grade. With reference to Figure 3, annual thaw depth in both models increased gradually as simulated ground temperature increased until the 10 m MAGT approached 0 ºC, after which the annual thaw depth in the near-isothermal permafrost began to increase rapidly. This occurred after ~2065 in the centreline model and ~2080 in the shoulder model.

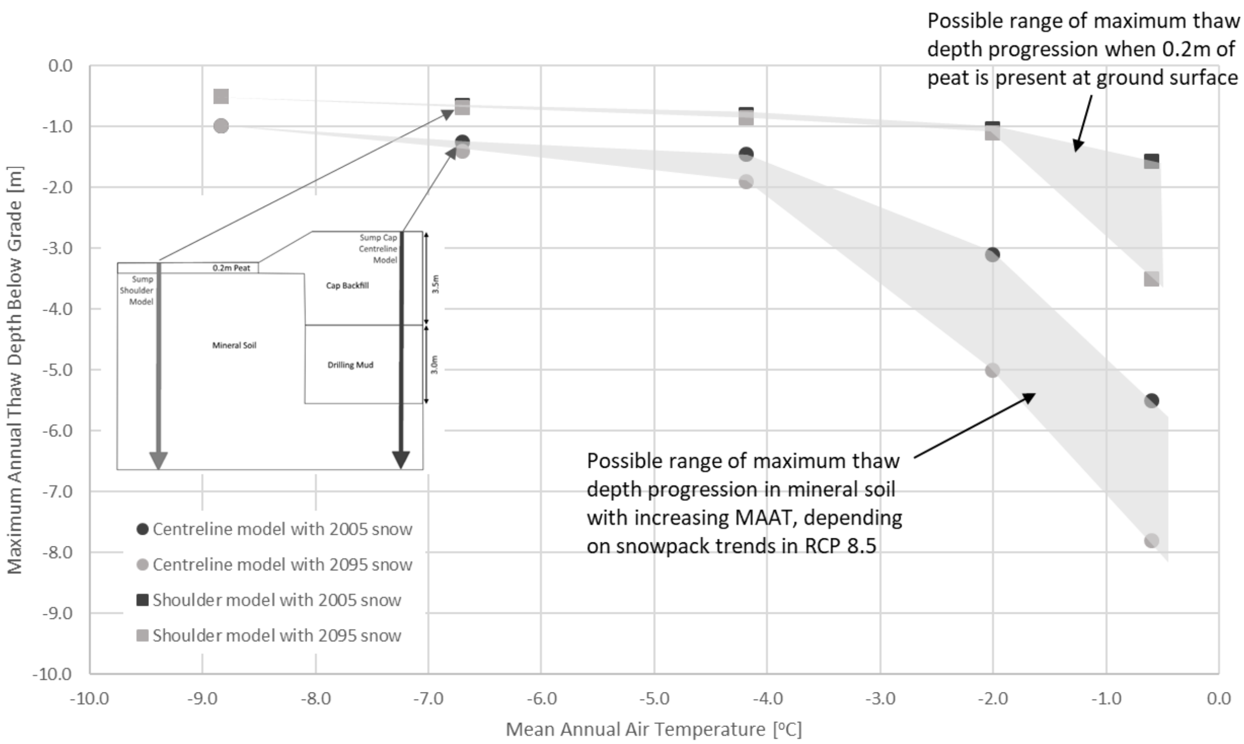

Figure 4 *– Modelled maximum annual thaw depth as a function of mean annual air temperature for the transient analyses at the sump centreline and shoulder under the 2005 and 2095 snowcover functions.*

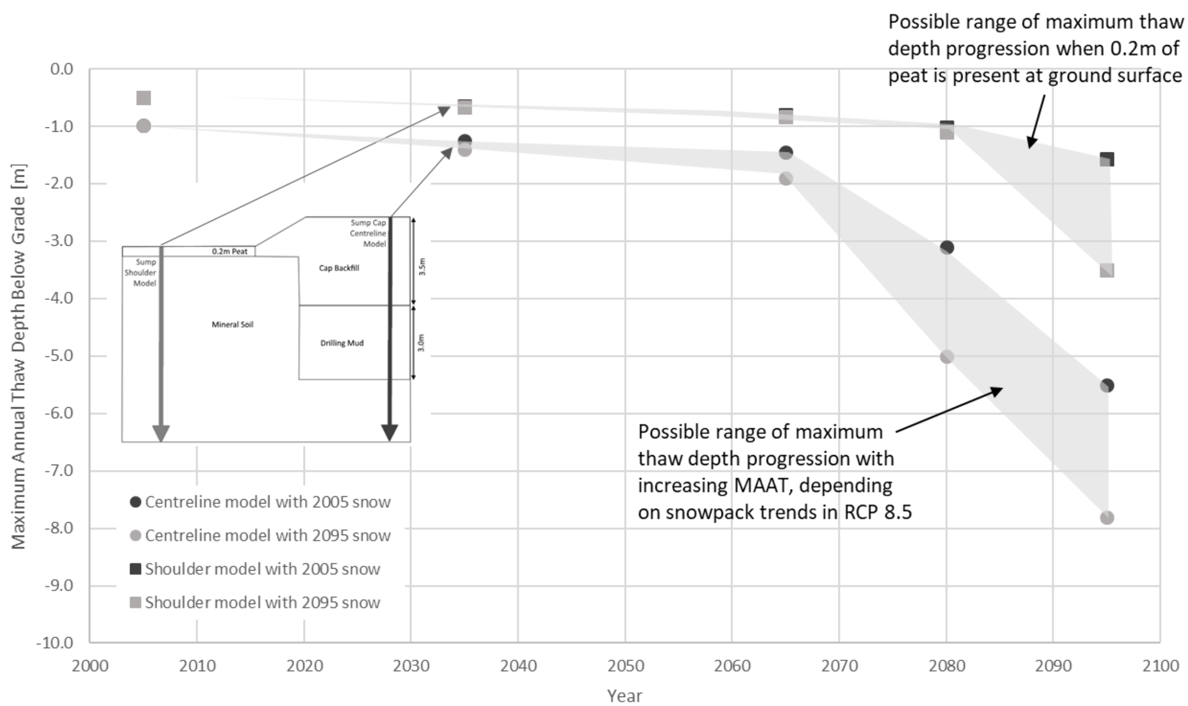

***Figure 5** – Modelled maximum annual thaw depth by year for the transient analyses at the sump centreline and shoulder under the 2005 and 2095 snowcover functions.*

Assumptions and Limitations:

The results given in this report are only valid for the model geometry, inputs, and assumptions therein. Assumptions of the models include the one-dimensional geometry, soil type, and the development of climate functions for the climate-equilibrium and transient models. Results are based on calibrating the thermal conductivity of snow in the 2005 climate-equilibrium analysis to obtain a MAGT of -6°C in a uniform soil with no peat at the surface. A two-dimensional geometry model would allow for development of a spatial snowcover model to achieve the target MAGT, which would allow for further investigation of the spatial distribution of subsurface temperatures.

Conclusions:

Two ground temperature models representing an existing drilling sump centreline and peat-covered shoulder were analysed using projected RCP8.5 air temperature increases through 2095 and multiple possible snowcover functions in order to investigate resulting ground temperature increase at 10 m depth and annual thaw depth within the existing permafrost. The results indicate that in each model scenario, MAGT at 10 m increased steadily until the permafrost reached an isothermal state of thaw in the later half of the century, between roughly 2060 and 2090.

We trust the model results provided in this report meet your present requirements. Should you require additional information or further testing, please feel free to contact the undersigned

Sincerely,

Cameron Ross, MSc, P.Eng.

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