Preliminary Findings Report for the Strategic Environmental Assessment in Baffin Bay and Davis Strait

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This report is jointly written by the Nunavut Impact Review Board (NIRB) and the Qikiqtani Inuit Association (QIA) and is equally informed by the Inuit Qaujimajatuqangit, Inuit Qaujimaningit, and western scientific knowledge.

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Nunavut Impact Review Board
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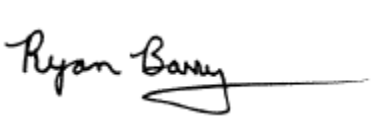
ACKNOWLEDGEMENTS:

The Nunavut Impact Review Board (NIRB or Board) and the Qikiqtani Inuit Association (QIA) would like to thank Crown-Indigenous Relations and Northern Affairs Canada for the funding to support the organizations' respective work for the Strategic Environmental Assessment in Baffin Bay and Davis Strait (the SEA). The NIRB would further like to express its appreciation to Nunami Stantec for their work in developing hypothetical offshore oil and gas scenarios and conducting an associated review of the environment and effects assessment in support of the SEA. The QIA would like to acknowledge the contributions of Heidi Klein at Sanammanga Solutions Inc. for her efforts in assembling the Inuit Qaujimajatuqangit and Inuit Qaujimaningit, as well as assisting with the preparation of the preliminary findings report. The QIA would also like to acknowledge the following staff for their contribution to make the collection of Inuit Qaujimajatuqangit and Inuit Qaujimaningit successful: Steven Lonsdale, Tiivi Qiatsuk, Ross Elgin, Julia Demsheson, Emily Ilnik, and Catriona Popoff.

The SEA process has been successful owing to the participation and assistance of local organizations, community members, government and non-governmental agencies, as well as representatives of the SEA working group: NIRB, Crown-Indigenous Relations and Northern Affairs Canada, Nunavut Tunngavik Incorporated, the QIA, and the Government of Nunavut.

Finally, the NIRB and the QIA would like to especially thank the many Elders and community members who actively participated in the NIRB public meetings and the QIA's Inuit Qaujimajatuqangit and Inuit Qaujimaningit study and shared their Knowledge and input on how Inuit Qaujimajatuqangit should be used in the SEA.

Sincerely,



Ryan Barry
Executive Director
Nunavut Impact Review Board

Rosanne D'Orazio
Director of Lands and Resources
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TABLE OF CONTENTS

1. INTRODUCTION

The Nunavut Impact Review Board (NIRB or Board) is responsible for coordinating the Strategic Environmental Assessment in Baffin Bay and Davis Strait (the SEA) and preparing a final report with recommendations to the Minister of Intergovernmental Affairs, Northern Affairs and Internal Trade by May 2019 for consideration regarding future development of oil and gas related activities in the region. The objective of the SEA is to understand types of offshore oil and gas related activities that could one day be proposed in the Canadian waters of Baffin Bay and Davis Strait outside of the Nunavut Settlement Area and their associated risks, benefits, and management strategies. The SEA will incorporate available scientific information, Inuit Qaujimajatuqangit and Inuit Qaujimaningit, and public feedback.

As part of the SEA, the Board contracted Nunami Stantec Ltd. (Nunami Stantec) to provide specialist consulting services and develop two (2) independent reports: *Oil and Gas Life Cycle Activities and Hypothetical Scenarios* and *Environmental Setting and Review of Potential Effects of Oil and Gas Activities*. The reports were posted online on June 5, 2018 and distributed to communities, organizations, the public, and government for feedback.

Want More Detail?

At the end of each section, look for the blue box for directions to specific sections of the original reports.

- Oil and Gas Life Cycle Activities and Hypothetical Scenarios Report referred to as "*Oil and Gas Hypothetical Scenarios"*
- Environmental Setting and Review of Potential Effects of Oil and Gas Activities Report referred to as "*Environmental Setting and Potential Effects"*
- Qikiqtaaluk Inuit Qaujimajatuqangit and Inuit Qaujimaningit for the Baffin Bay and Davis Strait Marine Environment referred to as *Inuit Qaujimajatuqangit Report*
- Evaluating the Role of Marine-Based Harvesting in Food Security in the Eastern Arctic referred to as *Food Security Report*.

In addition to informing and directly participating in the NIRB's process, the Qikiqtani Inuit Association (QIA) commissioned the collection of Inuit Qaujimajatuqangit and Inuit Qaujimaningit[1] plus information on Inuit food security and harvesting activities from potentially interested communities. The QIA has worked diligently with Inuit and the Inuit Qaujimajatuqangit advisors to maintain the integrity and cultural values that embody the Inuit Qaujimajatuqangit in this report. The value of Inuit Qaujimajatuqangit is not to be understated and is seen as the following: '*Inuit Qaujimajatuqangit is a morality that is the base for Inuit existence. It is the belief system at the core of Inuit identity and governs Inuit society. It is born through a collective effort to survive in extreme conditions where no one else could and there is no other way to do so but together- Inuuqatiriirniq, living through helping each other. It is the Inuit way'.* There is an distinction between Inuit *Qaujimajatuqangit and Inuit Qaujimaningit,* in that the latter refers to what Inuit know now, a collective knowledge that is more recent in nature.

[1] Going forward it will be referenced as, Inuit Qaujimajatuqangit.

This information has been documented in *Qikiqtaaluk Inuit Qaujimajatuqangit and Inuit Qaujimaningit for the Baffin Bay and Davis Strait Marine Environment* and *Evaluating the Role of Marine-Based Harvesting in Food Security in the Eastern Arctic.* The QIA and the NIRB worked together to ensure appropriate use and incorporation of Inuit knowledge throughout this process.

This Preliminary Findings Report is a summary document of the following information:

- Oil and Gas Life Cycle Activities and Hypothetical Scenarios Report;
- Environmental Setting and Review of Potential Effects of Oil and Gas Activities Report;
- Feedback on the two (2) reports received through the public commenting period[2];
- Baseline Inuit Qaujimajatuqangit collected by the QIA; and
- Information on Inuit harvesting activities and food security.

The objective of this Preliminary Findings Report is to summarize and present information in an accessible format for the general public, highlighting what has been discovered through the SEA to date in considering what offshore oil and gas in Baffin Bay and Davis Strait could look like, and the associated potential for positive and negative impacts. This report highlights areas where the knowledge required to understand the environment and potential effects of development is currently available, and where information gaps exist. Finally, this report has been designed to reflect the knowledge shared by community members and interested parties to date, and to serve as a tool for members of the public to further inform themselves and actively participate in the remaining steps of this Strategic Environmental Assessment.

Throughout this Preliminary Findings Report, care has been taken to highlight instances where statements have been directly informed by: community visits undertaken by the NIRB, Inuit Qaujimajatuqangit research included by Sanammanga Solutions Inc. on behalf of the QIA, and/or through direct collection of Inuit Qaujimajatuqangit by the QIA. This was done in part to recognize the importance of this knowledge in this assessment, and also to allow the reader to more easily identify where the report has been informed by knowledge holders throughout the Qikiqtaaluk region; it is hoped that by doing so, Nunavummiut will more clearly see their perspectives reflected.

[2] Full copies of all comment submissions are available on the NIRB's online Public Registry.

2. KEY TERMS

Ballast Water	water carried in special tanks in a ship to improve stability and balance of the vessel.
Bathymetry	the study of water depth: the distance of the seafloor from the water surface.
Benthic flora and fauna	plants and animals on the seafloor.
Bilge Water	wastewater that collects inside the hull of a ship.
Climate Change	changes to weather conditions and climate that may be caused by human activities.
Cumulative Impacts	combined environmental impacts from past, present, and future projects and activities in an area.
Effect	**a** change to a valued component of the environment from an activity.
Delineation Drilling	used to determine whether an oil or gas resource (reservoir) is there and how deep it is.
Exploration Drilling	used to determine how wide the oil or gas resource (reservoir) is.
Global Warming	the warming of the Earth from the release of greenhouse gases, such as carbon dioxide, into the air from human activities.
Greenhouse Gas	a gas that contributes to the warming of the Earth, for example, carbon dioxide.
Iceberg	a large piece of freshwater ice that has broken off a glacier and is floating freely in open water.
Impact	negative or positive influence from an activity and the environment.
Invasive Species	animals and plants that are not naturally found in the area and have been brought from somewhere else.
Inuit Qaujimajatuqangit	a morality that is the base for Inuit existence. It is the belief system at the core of Inuit identity and governs Inuit society.
Inuit Qaujimaningit	What Inuit know and a collective knowledge that is more recent in nature. It can be related to Inuit Qaujimajatuqangit that has evolved or changed in recent times.
Mitigation	**a** plan or an action taken to avoid or reduce a negative effect.
Oil and Gas Field	a location in the seafloor where oil and gas quantities are large enough to support oil and gas production.
Plankton	small (microscopic) plants and animals living in marine water; are a source of food for other animals (for example, fish).
Sediment	a layer of sand particles on the seafloor.
Seismic Activity	earthquakes and resulting tsunamis.
Seismic Survey	the use of sound generating devices to assist in locating oil and gas fields in the seafloor.
Transboundary Effects	environmental impacts that can spread across other territories, provinces, or countries.
Turbot	Commonly used in the communities to refer to Greenland Halibut.
Worst case scenario	refers to the worst possible type of accident with the most negative effects that could potentially occur associated with a development, used for planning and preparing for required responses and prevention.

3. BACKGROUND

3.1. MANDATE

On February 9, 2017 Crown-Indigenous Relations and Northern Affairs Canada (then Indigenous and Northern Affairs Canada) referred the SEA to the NIRB pursuant to section 12.2.4 of the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada* (*Nunavut Agreement*). The NIRB is responsible for coordinating the assessment and preparing a final report with recommendations to the Minister of Intergovernmental Affairs and Northern Affairs and Internal Trade for consideration regarding future development of oil and gas related activities in the region. These recommendations could include:

- Whether offshore oil and gas activity should proceed;
- Specific needs for additional information;
- Location and timing of potential oil and gas activity;
- Actions to prevent or reduce potential effects from offshore oil and gas activities; and
- Options to maximize benefits for Nunavummiut.

Recognizing the need to rely on both traditional knowledge and scientific information, the Minister requested that the NIRB use Inuit Qaujimaningit and Inuit Qaujimajatuqangit collected by the QIA, as well as create opportunities for communities to meaningfully contribute to the assessment. Throughout the process, the NIRB and the QIA have been working closely together to ensure the questions, comments, and knowledge provided are addressed appropriately.

In addition to providing input and directly participating in all phases of the SEA, the specific responsibilities of the SEA Working Group members are summarized in Table 1.

> *Inuit Qaujimajatuqangit refers to traditional values, beliefs, and principles while Inuit Qaujimaningit encompasses Inuit traditional knowledge (and variations thereof) as well as Inuit epistemology as it relates to Inuit Societal Values and Inuit Knowledge (both contemporary and traditional).*
>
> Source: (NIRB, 2018)

Table 1: Working Group Roles and Responsibilities

Working Group Member	Specific Responsibility
Nunavut Impact Review Board	Coordinate the assessment and prepare a final report with recommendations.
Crown-Indigenous Relations and Northern Affairs Canada	Initiate the SEA, provide project support, and coordinate input from federal departments.
Nunavut Tunngavik Incorporated	Ensure the SEA process and resulting government decisions are consistent with the *Nunavut Agreement*.
Qikiqtani Inuit Association	Collect Inuit Qaujimajatuqangit and information on Inuit harvesting activities and work with the NIRB to ensure appropriate use and incorporation of Inuit knowledge throughout the process.
Government of Nunavut	Provide education material on general oil and gas activities to the communities.

3.2. STRATEGIC ENVIRONMENTAL ASSESSMENT PROCESSES

Strategic Environmental Assessments (SEA) and Project Level Environmental Assessments are different processes based on different levels of information, and therefore are used to answer different questions, some of which are listed in Table 2.

Strategic environmental assessments are studies that can be used as planning and decision-making tools to consider the potential outcomes and environmental effects of a policy, plan, or program before any decisions are made. The SEA provides an opportunity for the public to offer input into the decision-making process for whether new offshore oil and gas development should occur, and if so, what the conditions should be. Unlike project-specific assessments undertaken by the NIRB, the SEA is not focused on a proposed development project. Also, undertaking the SEA does not mean that any specific oil and gas activities are currently being planned in Baffin Bay and Davis Strait or will be considered in the future.

As part of the study, the critical stages of oil and gas development that could possibly occur in Baffin Bay and Davis Strait were identified and hypothetical development scenarios created. Potential effects to components of the environment important to the region (for example, marine water, marine mammals, harvesting, and the economy) were examined to better understand the possible impacts and effects of each activity. These results can be used to inform the information requirements of project level environmental assessment and regulatory processes if these types of development were to be considered in the future.

Table 2: Comparing questions that can be answered at an SEA level to a project level

Strategic Environmental Assessment	Project Level Assessment
Should the offshore oil and gas industry be developed in Baffin Bay and Davis Strait?	What are the predicted negative effects of a proposed project on the environment and can these be mitigated? Should a project be approved?
What are the potential types of employment opportunities?	How many jobs are proposed for Nunavut Inuit?
What are the potential types of benefits?	What taxes and benefits would Nunavut receive?
What are the types of oil and gas activities could take place and what equipment could be used?	How deep will drilling go below the seafloor? What is the size of the area that the proposed seismic survey will be undertaken?

3.3. METHODOLOGY

Between September 11, 2017 and March 9, 2018, the NIRB undertook a scoping process to identify the list of topics to be considered within the SEA. The NIRB, accompanied by the SEA Working Group, conducted two (2) rounds of public engagement sessions in the Qikiqtaaluk communities of Clyde River, Arctic Bay, Resolute, Grise Fiord, Pond Inlet, Qikiqtarjuaq, Cape Dorset, Kimmirut, Iqaluit, and Pangnirtung. The NIRB collected available information and input from communities, governments, organizations, and the general public to develop the list of items to be included in the SEA. An essential component of the SEA is to reflect Inuit concerns and traditional use of the associated marine areas, which formed part of the discussions in each community. A summary of the feedback heard during the NIRB's Public Scoping Sessions was used to create Appendix A (full list of comments is available on the NIRB website in the follow-up reports to each public engagement session)[3]. The NIRB also received feedback from the SEA working group and from the following individuals, organizations, the public, and governments:

- Benoit Hudson
- Coastal and Ocean Resources
- Environment and Climate Change Canada
- Fisheries and Oceans Canada
- Government of Nunavut
- Greenpeace Canada
- National Energy Board
- World Wildlife Fund Canada
- Natural Resources Canada
- Parks Canada
- Peter Croal
- The Environmental Agency for Mineral Resource Activities – Government of Greenland; Danish Centre for Environment and Energy; Greenland Institute for Natural Resource

[3] Public Registry IDs: 312016 and 314604.

Following the scoping process, the NIRB released the two (2) reports developed by Nunami Stantec:

- *Oil and Gas Life Cycle Activities and Hypothetical Scenarios*: This report describes typical activities and components associated with oil and gas exploration and production and what types of activities and components could one day be proposed in Baffin Bay and Davis Strait (Nunami Stantec, 2018 a).
- *Environmental Setting and Review of Potential Effects of Oil and Gas Activities*: This report describes what is known about the physical, biological, and human environments in Baffin Bay and Davis Strait. The report also discusses the potential impacts and effects that oil and gas activities could have on components of the physical, biological, and human environments.[4] This report includes a summary of information from scientific literature and from published and publicly accessible Inuit Qaujimajatuqangit and Inuit Qaujimaningit reports (Nunami Stantec, 2018 b).

Impact: Negative or positive influence from an activity on the environment. *For example, seismic surveying produces noise*.

Effect: A change to a valued component of the environment from an activity. *For example, noise from seismic surveying could lead to a change in a whale's behaviour.*

Mitigation: A plan or an action taken to avoid or reduce a negative effect. *For example, the gradual increase in sound for seismic surveys.*

In addition to these reports, the QIA has developed two (2) reports and an Inuit Qaujimajatuqangit advisory committee to facilitate the use of Inuit Qaujimajatuqangit in the SEA: an *Inuit Qaujimajatuqangit Report* from Sanammanga Solutions Inc. and a food security report from Impact Economics.

1. *Qikiqtaaluk Inuit Qaujimajatuqangit and Inuit Qaujimaningit for the Baffin Bay and Davis Strait Marine Environment (2018):* This report involved the collection of new Inuit Qaujimajatuqangit specific to the SEA and a review of public reports on Inuit Qaujimajatuqangit and Inuit mythology. The report focused on the marine environment around the Inuit six (6) season calendar year. The knowledge was collected in the communities closest to the Area of Focus: Arctic Bay, Pond Inlet, Clyde River, Qikiqtarjuaq, and Pangnirtung – (see Spatial Boundaries next). Due to weather, researchers and QIA staff were unable to access Grise Fiord (Klein, H. 2018).
2. *Food Security Report*: *Evaluating the Role of the Marine-Based Harvesting in Food Security in the Eastern Arctic (2018).* The report outlined the monetary value of country food and the importance of sharing country

Want more detail?
Look at Report:
- *Environmental Setting and Potential Effects* – Section 2.3: Strategic Environmental Assessment Methodology
- *Inuit Qaujimajatuqangit Report*- Appendix A
- *Food Security Report*

[4] Public Registry IDs: 318009 & 318010

food to explain its importance to Inuit in the event of potential impacts to harvesting/ access to country food (Impacts Economics, 2018).

3. The QIA put together an advisory committee of knowledge holders from the five (5) communities to review Inuit knowledge, discuss effects, and make recommendations. In April 2018, the advisory committee met to confirm the Inuit Qaujimajatuqangit collected, and met with NIRB to present the knowledge to the NIRB staff and its consultants.

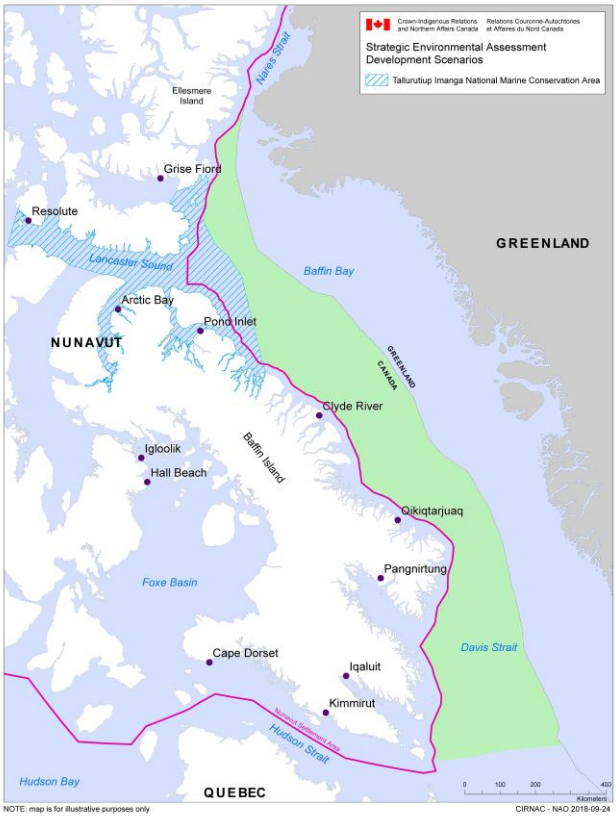
3.4. SPATIAL AND TEMPORAL BOUNDARIES

3.4.1. Spatial Boundaries

There are two (2) marine areas on which the SEA is focused. Figure 1 features the SEA *Area of Focus* in Baffin Bay and Davis Strait and is the greater area used to gather scientific information and Inuit Qaujimajatuqangit on the existing physical, biological, and human environments and to assess the potential positive and negative impacts of the oil and gas development scenarios. The green shaded area in Figure 2 (the Development Scenario Area): Strategic Environmental Assessment Development Scenarios identifies the area of focus for identifying where possible offshore oil and gas activities could occur. The area used for the scenarios lies within the same area used to assess the potential effects of development and represents the Canadian waters outside the Nunavut Settlement Area over which the Government of Canada has lead regulatory responsibilities.

Figure 1: Strategic Environmental Assessment Area of Focus in Baffin Bay and Davis Strait

Figure 2: Strategic Environmental Assessment Oil and Gas Development Scenarios



3.4.2. Temporal Boundaries

General timelines have been assigned to the activities associated with each of the oil and gas scenarios. Recognizing that it can take decades for an offshore oil and gas field to be developed into active production, greater clarity exists regarding how earlier phases of potential development could be designed and carried out, which is reflected in the scenarios.

<u>Exploration to Development (Scenarios A and B): Approximately 15-20 years</u>

Additional data would likely first be acquired through 2D seismic surveying to gain a general understanding of the sea floor geology and associated oil and gas potential in Baffin Bay and Davis Strait. The seasons for undertaking a seismic survey would last for approximately four (4) months (June to September).

Once an Exploration Licence is issued by Crown-Indigenous Relations and Northern Affairs Canada, more detailed 3D seismic surveying, seafloor surveys, and exploratory drilling could then be undertaken to get a better understanding of the oil and gas potential. Once a company has made a discovery of oil and gas that they would like to recover, they can apply for a Significant Discovery Licence. The duration for an

Exploration Licence is currently nine (9) years, and it can take approximately 15-20 years from the time an Exploration Licence is issued to when a Significant Discovery Licence is issued. Project specific timelines can vary widely. Typical timelines associated with specific activities would include, but are not limited to:

- Conduct 3D marine seismic surveys (including hiring a geophysical company and seismic vessel; undertake public consultation; secure authorizations; conduct seismic surveys; analyze and interpret date);
- Analyze the seafloor for hazards before drilling occurs; secure authorizations; and interpret data;
- Undertake drilling activities; analyze results; abandonment and cleanup; and
- Obtain authorizations related to a Significant Discovery.

Development to End of Development (Scenario C): Approximately 30-60 years

Once a Significant Discovery Licence is issued and before a company would consider developing an oil or gas reserve, it would conduct extensive internal reviews to determine if it was financially feasible to do so and then apply for a Commercial Discovery Declaration from Crown-Indigenous Relations and Northern Affairs Canada. This would take approximately 2-4 years to carry out. Project specific timelines can vary widely. Typical timelines associated with specific activities from the time a Significant Discovery Licence was issued, through production activities and then decommissioning would include, but are not limited to:

- Detailed engineering and development studies;
- Additional field work conducted at the site, including analyzing the seafloor, and undertaking environmental studies;
- Development of construction and engineering designs;
- Environmental assessment and regulatory approvals, including public engagement;
- Detailed project design, including training; and
- Issuance of Production Licence, production activities, and decommissioning and cleanup (20-30 years or more).

Want more information?
Look at Report: *Oil and Gas Hypothetical Scenarios* – Section 7: Realistic/Typical Life Cycle Timelines

3.5. REGULATORY ROLES IN THE OFFSHORE OIL AND GAS INDUSTRY

The summary is based on the *Oil and Gas Life Cycle Activities and Hypothetical Scenarios* report provided to the NIRB by Nunami Stantec. Within the Development Scenario Area (Figure 2), there are two (2) main authorities to assess and regulate oil and gas activities in the Canadian Arctic offshore region outside of the Nunavut Settlement Area. These are:

- **Crown-Indigenous Relations and Northern Affairs Canada** – responsible under the *Canada Petroleum Resources Act* for managing oil and gas resources, including: issuing rights to an area;

issuing exploration, significant discovery and production licences if required; and Canada Benefit Plans and royalty management.

- **National Energy Board**—responsible for administering *Canada Oil and Gas Operations Act* and its many technical regulations and guidelines and authorizes oil and gas activities.

Under the current *Canadian Environmental Assessment Act*, 2012, the National Energy Board is the responsible authority for assessing the environmental impacts of oil and gas related activities that are located outside of the Nunavut Settlement Area, including Baffin Bay and Davis Strait. This process is expected to change once the federal *Impact Assessment Act* and *Canada Energy Regulator Act*[5] come into force; details on these changes are subject to final legislative approval. There are multiple federal Acts and Regulations with which a company would need to comply and it is expected that there will be further regulatory, guidelines, and procedural changes in the future.

Crown-Indigenous Relations and Northern Affairs Canada is responsible for managing oil and gas resources in Nunavut, which includes benefits and royalties. The Government of Canada is currently negotiating with the Government of Nunavut and Nunavut Tunngavik Incorporated for the transfer of administrative responsibility for public lands, mineral resources, and rights in Nunavut waters, generally referred to as "devolution". Devolution could also change the royalty and benefits regime in the offshore at some future date (CIRNAC, 2018). Currently, before any oil and gas activity could take place, a company is required to prepare a Benefits Plan for approval by the Minister of Intergovernmental Affairs and Northern Affairs and Internal Trade.

As the possible development scenarios are located outside the Nunavut Settlement Area in Canadian offshore waters and not on Inuit Owned Land, an Inuit Impact and Benefit Agreement would not be required for those activities. For proposed development occurring outside the Nunavut Settlement Area, the *Nunavut Agreement* contains numerous provisions that could be relevant to address effects of development on wildlife harvesting or Inuit.

The *Nunavut Agreement* also provides provisions for the NIRB to review a project proposal that would be located outside the Nunavut Settlement Area if the project proposal may have significant adverse effects within the Nunavut Settlement Area. Any review would also be subject to the *Nunavut Planning and Project Assessment Act*.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* – Section 3: Regulatory Operating Framework

A summary overview comparing relative marine management within and outside the Nunavut Settlement Area is provided in Appendix B.

[5] Bill C-69

The following are summaries of additional information provided or requested in written public comments on the *Oil and Gas Hypothetical Scenarios Report:*

Topic	Commenter
Royalties and benefits in Canadian offshore waters of Baffin Bay and Davis Strait and Newfoundland and Labrador.	Crown-Indigenous Relations and Northern Affairs Canada Canada-Newfoundland and Labrador Offshore Petroleum Board
Rules, regulations, and guidelines including consultation requirements at the project level.	Greenpeace Canada Natural Resources Canada National Energy Board

3.6. PAST OIL AND GAS ACTIVITIES

This section summarizes the oil and gas activities that have occurred in the past within the Area of Focus in Baffin Bay and Davis Strait (Figure 1). The summary is based on *the Oil and Gas Life Cycle Activities and Hypothetical Scenarios* report provided to the NIRB by Nunami Stantec.

Nunavut has had a long history of oil and gas exploration and some limited production has occurred in the high Arctic Islands of the Sverdrup Basin. By comparison, the eastern Arctic region of Nunavut, the focus of this SEA, has had a much smaller level of interest and activity. The earliest data of the geology of the seafloor were collected in Davis Strait and the northern Labrador Shelf in 1969. While some early marine seismic surveys were conducted in the 1970s, mostly in Davis Strait, no wells were drilled in Lancaster Sound Basin and a suspension of activity (moratorium) was put in place in 1978 for that area. No wells have been drilled in the Canadian waters of Baffin Bay. Three (3) wells have been drilled in Davis Strait in the Saglek Basin in the early 1980s. Two (2) of the wells were dry and one (1) discovered natural gas but the volumes were not considered commercially viable at the time. The earlier marine seismic data collected have not been considered of sufficient quality or quantity to accurately map potential hydrocarbon prospects or identify promising drilling locations.

Exploratory drilling has recently occurred on the West Greenland shelf of Baffin Bay. While eight (8) wells were drilled, starting in 2011, the oil and gas reservoirs that were discovered were too small to be commercially attractive to develop under current conditions.

Past exploration has identified the following factors which may influence future interest in the region:

- Sedimentary basins with oil and gas potential underlying Baffin Bay and Davis Strait are largely unexplored;
- Potential recoverable volumes appear fairly small;
- There appears to be more gas than oil in the region; and
- Future exploration activities in the Saglek Basin on the southwest Greenland and on the Labrador shelf could change the picture. If a discovery was large enough, it could lead to interest in exploring Baffin Bay and Davis Strait further.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* – Section 2: Background and History of Oil and Gas in Baffin Bay and Davis Strait

4. DESCRIPTION OF THE ENVIRONMENT

This section summarizes the existing conditions of the physical, biological, and human environments for the Area of Focus in Baffin Bay and Davis Strait (Figure 1) and includes a discussion on climate change. Unless otherwise noted, the summary is based on the *Environmental Setting and Review of Potential Effects of Oil and Gas Activities* (2018) report provided to the NIRB by Nunami Stantec. This section is also based on information provided by the *Qikiqtaaluk Inuit Qaujimajatuqangit and Inuit Qaujimaningit for the Baffin Bay and Davis Strait Marine Environment Report* (2018) developed by the QIA and Sanammanga Solutions Inc. and *Evaluating the Role of Marine-Based Harvesting in Food Security in the Eastern Arctic* provided by Impact Economics. Information gathered during the NIRB's public engagement sessions is also included.

4.1. PHYSICAL

Baffin Bay is about 1,400 kilometres (870 miles) long and 550 km (342 miles) wide, and its deepest point is more than 2,300 metres (7,546 feet). Davis Strait is smaller than Baffin Bay and is about 300 kilometres (186 miles) wide and has depths up to 1,000 metres (3,281 feet). Many thousands of years ago during the last ice age, part of the area was covered by a glacier. There is evidence that the same was true in even earlier glacial periods. The glaciers have led to some uneven and steeply sloping places on the seafloor. Underwater earthquakes occur regularly within the study area but are mostly low to moderate in magnitude (less than 4.0 on the Richter scale).

There are two (2) confirmed "seeps", places where oil and gas naturally leak up or "seep" through the seafloor. In 1976, an oil slick was observed on the sea surface in Scott Inlet which appeared to be coming from below; different types of surveys later confirmed the presence of a natural oil seep there. Surface oil slicks and an oil seep have also been documented in Lancaster Sound. While Scott Inlet and Lancaster Sound are the only two (2) documented locations of naturally occurring seeps, it is believed that other seeps are likely. Reports published in 2010 note that potential surface oil slicks have been observed along southeast Baffin Island including near the entrances to Cumberland Sound and Frobisher Bay.

Very steep and high fiords and cliffs are common along the eastern side of Baffin Island and the coasts of Lancaster Sound and Nares Strait. Waves in Baffin Bay are normally relatively small, however published reports indicate that community members have noticed larger waves and increased shoreline erosion

around Grise Fiord in recent years. The temperature and saltiness of the water in Baffin Bay and Davis Strait varies by location, depth, and by year. The salt water has further been reported by Inuit Elders to be warmer in recent years.

The average air temperature from 1981-2010 at Clyde River, which is centrally located to Baffin Bay and Davis Strait, ranged from 5 degrees Celsius (41 degrees Fahrenheit) in July to -30 degrees Celsius (-22 degrees Fahrenheit) in February. Most precipitation falls as snow in autumn and winter. Winds in the region are often strong and are mostly from the north, northwest, and west. Published reports state that Inuit from several communities have observed changes in the direction, strength, frequency, and predictability of winds in recent years, and have also noted that there has been less snow. The Inuit seasonal calendar reflects the amount of light and the temperature (Table 3).

Table 3. Qikiqtaaluk seasonal calendar

	ᐅᑭᐅᖅ **Ukiuq** **Winter**	ᐅᐱᖏᓪᓗᓴᖅ **Upirngasaaq** **early spring**	ᐅᐱᖏᓪᓗᖅ **Upirngaaq** **late spring**	ᐊᔾᔨᖅ **Aujaq** **summer**	ᐅᑭᐊᓪᓚᖅ **Ukiassaaq** **early fall**	ᐅᑭᐊᖅ **Ukiaq** **fall, early winter**
Seasonal descriptions	- extensive sea ice which continues to thicken and coalesce - snow on the land and ice - darkest period of the year - solstice to sun crossing horizon and getting higher in sky	- period of maximum ice cover and ice thickness - snow falls - daylight increasing	- progressive snow melt - widening of ice leads - disappearance of ice - 24-hour daylight; ability to travel at night	- open water with some drifting pack ice - daylight period long but decreasing	- when lakes and streams begin to freeze and nights become frosty - open water with ice beginning - snow on the land and ice on the lakes; daylight period short and decreasing	- new ice hardens and thickens to form extensive areas of landfast or drifting pack - sun starts to disappear darkness

Source: *Inuit Qaujimajatuqangit Report*

The region is dominated by two (2) strong currents, the Baffin Island Current and the West Greenland Current, and several smaller currents. As heard during the NIRB Public Scoping Sessions, currents are strong and need to be better understood. In Grise Fiord, it was noted that many items have been found there that have drifted from Greenland. The Baffin Island Current travels north to south along the east coast of Baffin Island, eventually feeding into the Labrador Current. It originates from the West Greenland Current in Nares Strait off the coast of Grise Fiord, and the waters flowing from Lancaster Sound, Jones Sound and Nares Strait. The West Greenland Current runs south to north along the west side of Greenland. Both are cold water currents influenced by freshwater inputs with seasonal variations in the currents and salinity. It was noted during the NIRB's Public Scoping Sessions in Qikiqtarjuaq that the sea

water is different from Pond Inlet in terms of temperature and clarity, and there is less current in the High Arctic. The West Greenland Current loses heat as it moves north. Based on knowledge shared during the QIA Inuit Qaujimajatuqangit workshops, it is understood that currents have a significant influence in wintertime open water areas.

Tides are different depending on location. In most places there are two (2) high-tides and two (2) low-tides daily that are about the same size. In Baffin Bay, the difference between high-tide and low-tide is 2.8 metres (9.2 feet) in the north, 1.4 metres (4.6 feet) near Clyde River, and 3.0 metres (9.8 feet) in the south. The tidal range in Frobisher Bay is up to 11 metres (36 feet). Community members have noted that currents are now stronger, and tides are bigger than in the past.

Polynyas are areas of the ocean that never freeze, or that have thin ice coverage in the winter compared to surrounding areas. Polynyas that occur year-after-year in the same place tend to be associated with many marine mammals and seabirds. There are both shore lead polynyas (next to the coast) and open water polynyas (offshore). All polynyas are the result of tides and currents. Upwelling occurs along the coastline and along the edge of landfast ice. Upwelling is when deep, cold, and nutrient-rich water rises toward the surface. It is one of the processes that can cause polynyas to form. The Pikialasorsuaq (North Water Polynya) is a recurrent polynya located in northern Baffin Bay. It is particularly large and is valued by Inuit as overwintering habitat for marine mammals. Reported Inuit Qaujimajatuqangit has indicated that sea currents are becoming stronger, and therefore polynyas are being found in unusual places and ice is becoming thinner. Polynyas, especially shore lead polynyas, can be essential wintertime harvesting areas according to the *Inuit Qaujimajatuqangit Report*. New polynyas have been observed in recent years, including a small one at Clyde River, which previously was one of the few communities not associated with a polynya according to the *Inuit Qaujimajatuqangit Report*.

Many icebergs drift through the Area of Focus. Most of these have broken off from a larger glacier in Greenland called the Greenland Ice Sheet, however some icebergs also come from glaciers in the Canadian high Arctic. The icebergs follow the direction of the major currents, eventually exiting Baffin Bay to the south through Davis Strait and into the Atlantic Ocean. Clyde River harvesters interviewed as part of the QIA's research reported that icebergs can contact and rub against the ocean floor as they are moved by wind and currents and that icebergs, along with other ice formations, are a form of critical wildlife habitat. These harvesters have observed that seals, walruses, whales, fish, and birds can be found in the wake of large icebergs – drawn to the iceberg's trailing edge where plankton and krill are exposed. The habitat associated with icebergs is similar to that found at the floe edge. For example, walruses can use icebergs as haul outs. Icebergs are also an indicator of the location of the floe edge according to Qikiqtaaluk harvesters and are used as a travel marker.

During the NIRB's Public Scoping Sessions in Resolute, community members commented on the tides and ice flow in Baffin Bay and through Lancaster Sound. Residents in Resolute, Cape Dorset, and Qikiqtarjuaq discussed the characteristics of icebergs. The NIRB also heard in Cape Dorset that icebergs near

Qikiqtarjuaq and Greenland are extremely large and sometimes contain large rocks, which was attributed to climate change.

Sea ice forms through the fall and winter months and is usually at a maximum in March. Sea ice is jammed fast to the coasts and extends over the ocean as a solid sheet. Ice begins to thin and melt in April, and both Baffin Bay and Davis Strait are nearly ice free in *Aujaq* (August to September). Most sea ice in Baffin Bay and Davis Strait is less than one (1) year old, although in some years, multi-year ice forms when all the ice does not melt. The Inuit knowledge shared with the QIA identified that ice is essential habitat to polar bear and to ringed seal for birthing.

In much of the Arctic, including Baffin Bay and Davis Strait, the extent of sea ice has gotten smaller over time, especially the minimum extent (this is the extent of sea ice in September). Reports have noted that Inuit have observed: ice freezing-up later in the year and over a longer period; thinner sea ice conditions; more snow on the ice; new areas of open water; and earlier ice break-up. During the NIRB's Public Scoping Sessions, a community member from Arctic Bay shared knowledge on ice movement through Admiralty Inlet and community members in Grise Fiord and Cape Dorset shared knowledge related to multi-year ice. For example, it was noted in Cape Dorset that there is no more multi-year ice in the area and that ice is thinner and smoother, which was thought to be attributed to climate change.

The *Inuit Qaujimajatuqangit Report* highlights that *Sinaaq* ("floe edge") is a critical part of sea ice conditions, which is at the margin of the seasonal ice and open water that winter and early spring harvesting takes place. It is an active biological area. The QIA research and the NIRB's scoping sessions documented harvesters commenting on the receding sea ice extent. The floe edge is closer to communities than in the past. For example, in Pangnirtung where the QIA interviewed harvesters, the sea ice only extends halfway into Cumberland Sound as compared to the extent in the past. It is also not considered as safe to travel on as previously.

Want more detail?
Look at Report:
- *Environmental Setting and Potential Effects* – Section 3: Environmental Setting – Physical Environment
- *Inuit Qaujimajatuqangit Report* – Section 3: Environnemental Conditions

Natural sources of underwater noise include: ice cracking, melt, breakup, grinding, and iceberg collisions, as well as from wind, waves, rain, and from seals and whales. Marine shipping is the main source of human-caused sound and of air pollution. However, air quality in the area is generally quite good.

The following are summaries of additional information provided or requested in written public comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
Current studies on naturally forming oil seeps.	Crown-Indigenous Relations and Northern Affairs Canada Government of Nunavut

Climate data from more locations in the Area of Focus.	Environment and Climate Change Canada
Sea ice and icebergs.	Environment and Climate Change Canada
Suggested additional reports on topics including: seafloor geology and marine sediment, earthquakes, potential oil and gas potential, and oil and gas seeps.	Natural Resources Canada
Suggested reports on sub-sea methane and permafrost.	Crown-Indigenous Relations and Northern Affairs Canada

4.2. BIOLOGICAL

Species of Cultural Interest

In every community visited during the QIA's Inuit Qaujimajatuqangit research and the NIRB Public Scoping Sessions it was mentioned that marine mammals, birds, and fish are still critical in the lives of Inuit. Inuit Qaujimajatuqangit has shown that the species of primary importance are: Ringed and Bearded Seal, Walrus, Narwhal, Beluga, Polar Bear, Black Guillemot, Thick-billed Murre, various ducks and geese, Char, Arctic Cod, and Greenland halibut (often referred to as "turbot"). These species themselves are supported by seaweed, kelp, clams, mussels, and plankton. The importance of these species in Inuit life are also documented in myths, legends and origin stories. Ringed Seal were especially critical, as they can be found year-round. Inuit Qaujimajatuqangit shows that Ringed Seal formed the basis for food sharing and food sharing rules. The other *puijiit* (marine mammals) migrate from the area as ice forms, largely moving into open water areas of Baffin Bay and Davis Strait, and returning with ice break-up.

Species Conservation

There are species that may occur in or near the Area of Focus that are listed as endangered, threatened, or of special concern under the *Species at Risk Act* (2002) or by the Committee on the Status of Endangered Wildlife in Canada (Table 4). The International Union for Conservation of Nature also tracks Species at Risk. Included on the list are: Yellow-billed Loon, Common Eider, and Long-tailed Duck[6] all of which are hunted by Qikiqtaaluk harvesters according to the QIA's Inuit Qaujimajatuqangit studies. Currently, these birds are not considered at risk in Canada, but are considered at risk in European countries and the United States where they spend their winters.

Threats to Species at Risk may include habitat loss, climate change, noise disturbance, hunting, fishing, and environmental contamination. During the NIRB's Public Scoping Sessions, a community member from Iqaluit shared that previous seismic surveying and drilling from Panarctic Oils Ltd., which was in operations during the 1960s and 1980s, resulted in effects to many sea organisms. In Clyde River, it was noted that wildlife has been known to live in areas where there is no sound and are highly sensitive to noise from

[6] Formerly "Oldsquaw".

seismic surveys and shipping, and even power boats and snow machines. Community members from Pond Inlet commented that wildlife behaviour has changed with increased shipping and that wildlife move away from ships. In Qikiqtarjuaq, it was noted that wildlife population decreases are being seen, but that Elders say that wildlife is renewable and that they will be back.

Table 4. Listed species populations occurring in or near the Area of Focus[7]

Marine Mammals	Waterbirds	Fish
Atlantic Walrus *High Arctic; Central / Low Arctic*	Ivory Gull	Atlantic Wolffish
Beluga Whale *Eastern High Arctic; Baffin Bay; Cumberland Sound*	Red Knot, *rufa* subspecies	Northern Wolffish
Bowhead Whale *Eastern Canada – West Greenland*	Red Knot, *islandica* subspecies	Spotted Wolffish
Fin Whale *Atlantic population*	Buff-breasted Sandpiper	Roundnose Grenadier
Killer Whale *Northwest Atlantic – Eastern Arctic population*	Red-necked Phalarope	Thorny Skate
Narwhal *Baffin Bay*		
Northern Bottlenose Whale *Davis Strait – Baffin Bay – Labrador Sea population*		
Polar Bear		
Harbour porpoise* *Northwest Atlantic**		

Changes made to the table prepared by Nunami Stantec to highlight species in the Area of Focus.
*Identified through the QIA's Inuit Qaujimajatuqangit studies

The Area of Focus contains, or is near, conservation-related designated areas that have various levels of protection (Figure 1):

- 3 National Parks
- 1 National Marine Conservation Area
- 4 National Wildlife Areas
- 7 Territorial Parks
- 2 Migratory Bird Sanctuaries
- 3 Marine Refuges
- 12 Important Bird Areas
- 21 Environmentally and Biologically Significant Areas.

While outside the Development Scenario Area (Figure 2), the Tallurutiup Imanga (Lancaster Sound) National Marine Protected Area protects one of the most ecologically significant areas in the Arctic. Processes such as currents, tides, and upwelling result in polynyas and high productivity in Lancaster Sound, and the area provides critical habitat for seabirds, Polar Bear, Bowhead Whale, Narwhal, Beluga Whale, and Ringed Seals.

[7] *Species at Risk Act* and / or Committee on the Status of Endangered Wildlife in Canada.

The Pikialasorsuaq (North Water Polynya) is the largest and most productive polynya in the Arctic and is an important area for Beluga, Narwhal, Bowhead Whale, Ringed and Bearded Seals, Polar Bear, and many seabirds. The Pikialasorsuaq Commission is recommending protection and special management for the North Water Polynya and surrounding waters.

Fish

There are 182 marine fish species found in Nunavut marine waters. An important and abundant species is Arctic Char, which has cultural, nutritional, and economic value to northern communities. A Government of Nunavut report indicated that community members in Qikiqtarjuaq have noted that the abundance of char in that area varies year by year. Some community members in Grise Fiord have observed more char in the area, while others have observed less char near town. In Pond Inlet, community members have harvested char with very thick skin.

The QIA's Inuit Qaujimajatuqangit studies identified that *iqaluk* is both a general term for fish, and a specific term for "char". Key harvesting species today are char, cod, sculpin, and Greenland halibut. These same species have also been found in the stomachs of seals, narwhal, and beluga harvested by Inuit confirming their necessity to marine mammals, too.

Arctic Cod are another abundant fish species. The *Environmental Setting and Potential Effects Report* and the *Inuit Qaujimajatuqangit Report* identify Arctic Cod as having high ecological value because they are an important prey species for seabirds, whales, and other fish species. Arctic Cod are fished locally in subsistence fisheries. Some hunters in Kimmirut believe there has been a decline in Arctic Cod in the area, or that the fish have moved to another area. Inuit in Iqaluit have noticed that large schools of Arctic Cod are no longer found in Frobisher Bay. During the NIRB's Public Scoping Sessions in Clyde River, the NIRB heard that seismic activity conducted in the past near Pond Inlet caused cod to die-off there.

Greenland Halibut are very abundant. There has been a winter fishery for Greenland Halibut in Cumberland Sound since 1986 and interest in developing a summer fishery in the area. Inuit Qaujimajatuqangit collected in Pangnirtung by the Government of Nunavut indicates that in the 1990s there were less Greenland Halibut and more Greenland Shark early in the winter. Community members in Pangnirtung also noted concerns that changes in sea ice patterns are affecting the winter fishing seasons.

Capelin and fourhorn Sculpin are abundant and Capelin is a local food source and also important for seabirds, whales, and other fish. Fourhorn Sculpin is occasionally caught for food throughout coastal Nunavut. Squid and Northern Shrimp are also common. Squid are sometimes used as bait in fisheries for Greenland halibut, and there is a year-round fishery for Northern Shrimp off the east coast of Baffin Island and in Hudson Strait.

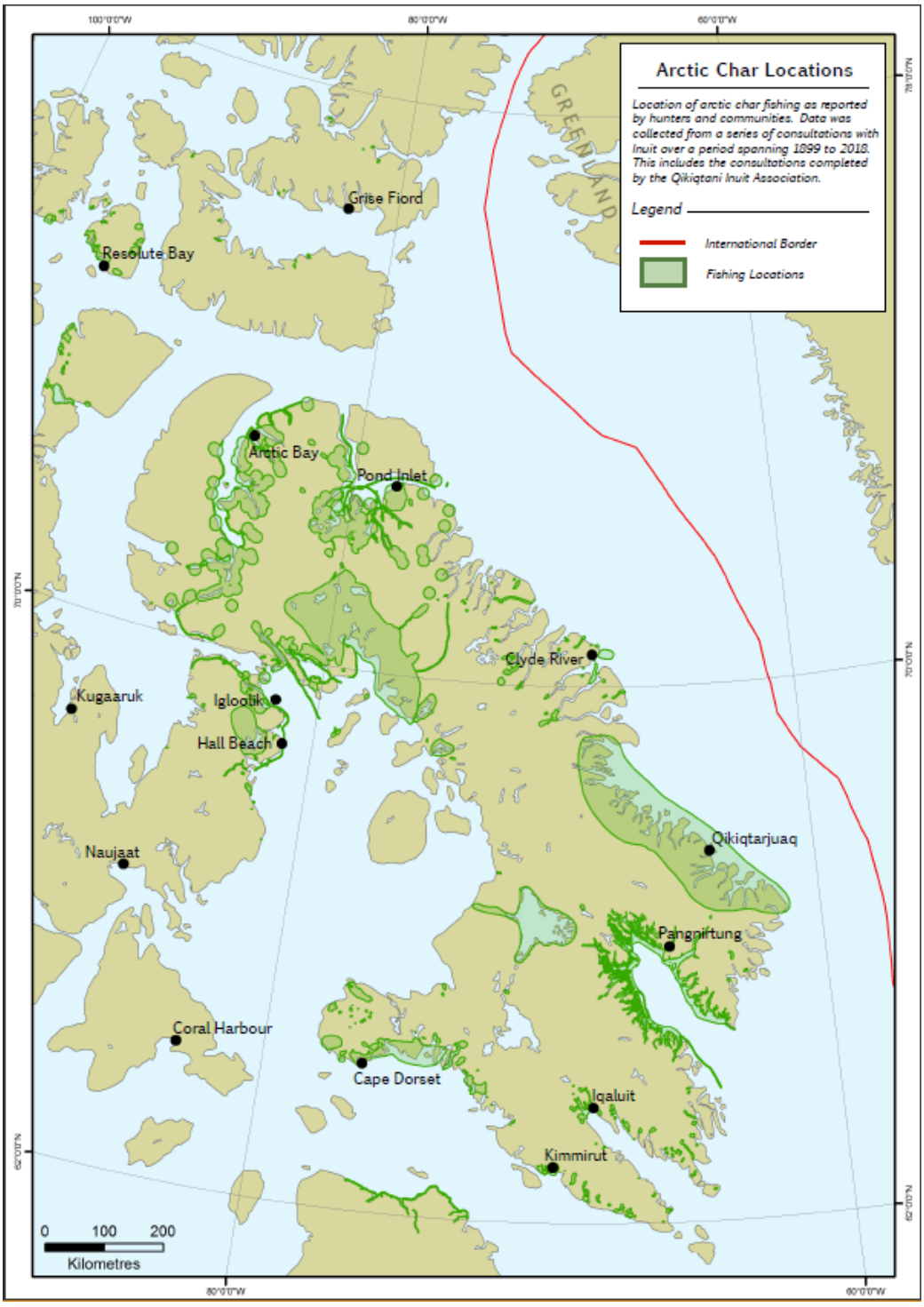


Figure 3: Inuit Qaujimajatuqangit for locations where char has been harvested (Source: QIA)

Birds

The coastal and offshore areas in Baffin Bay and Davis Strait regularly provide habitats for 40 species of coastal waterfowl, seabirds, and shorebirds. Some species use the area year-round, and many other species pass through the area on their way to and from breeding grounds in other places in the Arctic.

> "I know that we did not follow the European months; there was a saying from the people before us: "*Tannaguuq mitiqat sajjuraslalippun taimaguuq nunaliannasivuq miqungillu naamasilutik*". The eider ducklings have now started for the sea, it is now the right time to head for the inland as the thickness of the hairs on caribou are just right for clothing."
>
> Zacharias Panikpakuttuk, Amitturmuit as reported in (Bennett, 2004)

Seabirds are found throughout the Area of Focus, breeding on rocky cliffs and islands. Up to 350,000 pairs of Thick-billed Murre and 30 million Dovekies nest near the Pikialasorsuaq (North Water Polynya). An additional 160,000 Thick-billed Murre breed on Coburg Island, with another 386,000 pairs within eastern Lancaster Sound. Other large colonies are found in Cumberland Sound and other locations on the east coast of Baffin Island. Northern Fulmar breed throughout the Area, with the largest colony (more than 100,000 pairs) located at Cape Searle and Reid Bay on the east coast of Baffin Island. Large breeding colonies of Northern Fulmar are also located on Coburg Island and in eastern Lancaster Sound. Inuit Qaujimajatuqangit shared with the QIA points to both Thick-billed Murre and Black Guillemot wintering in the offshore east of Baffin Island. Guillemot are considered the birds on which the Inuit youth could learn how to hunt birds. Clyde River hunters did not consider the meat to be very tasty, but did say that it was eaten when nothing else was available.

Waterfowl species are also found, and Frobisher Bay has been identified as an important area for Canada Goose, Harlequin Duck, and Long-tailed Duck. Frobisher Bay, Cumberland Sound, eastern Jones Sound, and eastern Lancaster Sound provide key breeding habitat for Common Eiders. Nearly 25,000 migrating eiders have been recorded on the east side of Bylot Island. Inuit have observed that Canada Goose and Common Eider are breeding more often now near Pangnirtung. Grise Fiord has been identified as an important area for Cackling Goose. Coastal waterfowl also group together in large numbers on polynyas during winter and migration periods.

Coastal waterfowl and seabirds are used for subsistence by Inuit across Nunavut. One study noted that about 6,000 Common and King Eiders are harvested each year in Nunavut. During the QIA's Inuit Qaujimajatuqangit work in the communities, community members said that collection of goose and duck eggs would take place as soon as laying was finished. Every community had their favourite collecting spots. Egg collecting was one of the first chores that children would learn when going on the land. The skin and feathers have featured in clothing in the past but is not popular now. Waterfowl and seabirds have strong cultural significance and are often featured in soapstone carvings. Finally, within the Area of Focus, there are no places of especially large aggregations of breeding shorebirds, and no nationally or globally recognized significant shorebird habitat.

Marine Mammals

The Area of Focus provides habitat for 12 different marine mammals, including Walrus, Polar Bear, and several species of seals and whales. Some of these species have been designated as endangered, threatened, vulnerable, or of special concern (see Table 4 above).

Seals, especially Ringed Seals, are very important to Inuit and provide oil, meat, and skins. Seals use snow and dense pack ice to build lairs for pupping and nursing, and at other times they use open water, including polynyas. The *Inuit Qaujimajatuqangit Report* identified that Ringed Seals are unique compared to most other seals in that they have the ability to scrape *aglu,* or breathing holes, in the winter. That means they could be hunted year-round. Ringed Seals are completely essential to Polar Bears.

Ringed Seals and Bearded Seals are found year-round. Harp Seals tend to overwinter further south and are found in the Area of Focus mostly in the summer. A report from the Government of Nunavut noted that Inuit in Grise Fiord have observed fewer Ringed Seals compared to previous years, and noted that seals were generally smaller, while Inuit in Qikiqtarjuaq have seen more seals. The QIA's Inuit Qaujimajatuqangit community research identified that Bearded Seals have started remaining year-round more recently, when in the past they would have left. It was also noted that Harp Seals are considered the dog team of narwhal as they return just before the whales and are an indication that whales will be coming.

Conservation assessments show that Bearded Seals and Harp Seals appear to have a large population with no clear evidence of decline, although there are no estimates of Harp Seal numbers for Baffin Bay and surrounding waters. A study from the Government of Nunavut noted that that community members from Grise Fiord have seen more Bearded Seals and fewer Harp Seals in recent years. In Qikiqtarjuaq, community members have reportedly seen fewer Bearded Seals, and both an increase and a decrease in Harp Seals. Reports note that Inuit from Kimmirut and Pond Inlet have seen an increase in Harp Seal. During the NIRB's Public Scoping Sessions, a community member from Resolute noted that about three (3) years earlier there had been no seals there, and then there was a sudden increase in Baffin Bay.

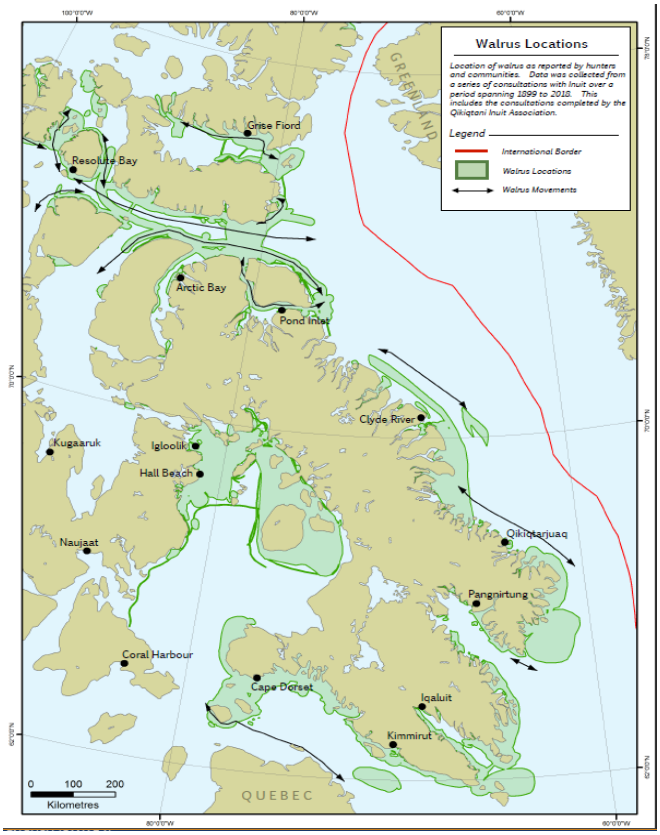


Figure 4: Inuit Qaujimajatuqangit locations for walrus (Source: QIA)

Atlantic Walrus are also important to Inuit and are hunted for their meat and ivory (Figure 4). The research completed by Sanammanga Solutions Inc. for the QIA and knowledge shared with the NIRB during the scoping sessions identified that walrus have predictable habitat needs. They need shallow waters with clams and mussels as well as places to haul out including ice pans and icebergs. The QIA documented their seasonal distribution in their research (Table 5). The Baffin Bay (High Arctic) winter population is about 1,500 animals. In winter, Atlantic Walrus haul onto ice floes. The North Water Polynya is important winter habitat for feeding. In summer and fall, walrus haul-out on land in a few specific locations, including along the southeast coast of Baffin Bay. They can also be found on icebergs. Inuit in Grise Fiord have recently seen more walrus along the south side of Jones Sound, and fewer on the north side.

Table 5. Seasonal distribution of walrus

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᓂᖏᖅ Upirngasaaq	ᐅᐱᕐᓂᖅ Upirngaaq	ᐊᔾᔨᖅ Aujaq	ᐅᑭᐊᖏᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	**early spring**	**late spring**	**summer**	**early fall**	**fall, early winter**
Grise Fiord	north water polynya; pack ice in Davis Strait	north water polynya; pack ice in Davis Strait	floe edge	open water; inlets and fiords	departing for wintering grounds	north water polynya; pack ice in Davis Strait
Arctic Bay	pack ice in Davis Strait	pack ice in Davis Strait	floe edge	open water; inlets and fiords	departing for wintering grounds	pack ice in Davis Strait
Pond Inlet	pack ice and open water	pack ice and open water	floe edge	open water; inlets and fiords; start birthing in July	departing for wintering grounds	pack ice and open water
Clyde River	not present	start spotting walrus with pups south of Clyde Inlet; floe edge	floe edge	open water; inlets and fiords; haul-out in Isabella Bay	departing for wintering grounds	not present
Qikiqtarjuaq	not present	not present	not present	haul-outs to the north and south of Qikiqtarjuaq	not present	not present
Pangnirtung	outside Cumberland Sound in Davis Strait	floe edge; will create breathing holes in areas of thin ice	move to west side of Cumberland Sound as ice disappears; clamming areas	haul-outs and open water in Cumberland Sound	departing for wintering grounds	outside Cumberland Sound in Davis Strait

Source: *Inuit Qaujimajatuqangit Report*

Narwhal are common, and the Baffin Bay population consists of about 45,000 animals. Inuit say the population is healthy and growing, and community members in Grise Fiord have noted an increase in narwhal sightings in recent years. Narwhal migrate seasonally throughout the area (Figure 5), and rely on pack ice, as well as open water (Table 6). The North Water Polynya is important winter habitat for narwhal as are other ice-free areas of Davis Strait and Baffin Bay. Both Arctic Bay and Pond Inlet harvesters mentioned the North Water Polynya during the collection of Inuit Qaujimajatuqangit by the QIA. As well, Fisheries and Oceans Canada have identified an area east of Qikiqtarjuaq as critical overwintering habitat for Narwhal (Narwhal Overwintering and Coldwater Coral Zone). The Zone was established as a marine refuge to protect concentrations of corals and to minimize the impacts on food sources used by Narwhals in the winter. Narwhal are harvested by Inuit for their meat, and narwhal *maktak* provides an important source of vitamin C. Harvesters have all remarked to the QIA and the NIRB on the sensitivity to noise of narwhal. Noise sensitivity was so well understood, it affected how Inuit harvested Narwhal in the past. While interviewing harvesters for the *Inuit Qaujimajatuqangit Report*, they told the interviewers of the need to be quiet on the ice. In particular, children should not run and make noise so that they do not scare the narwhal away.

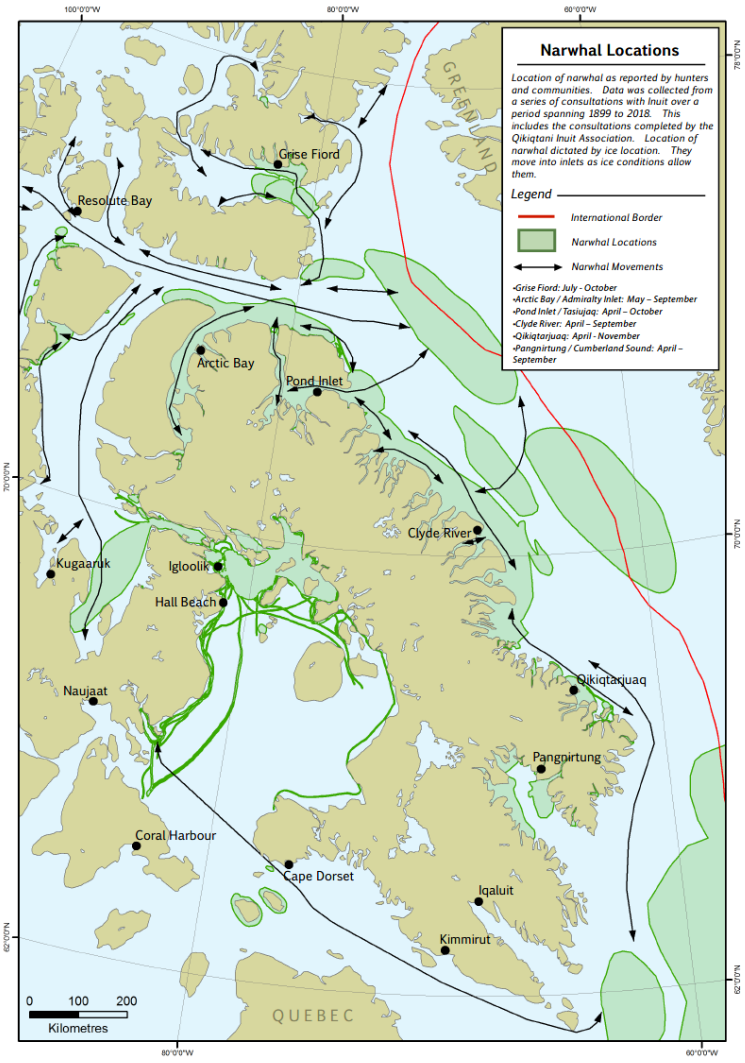


Figure 5: Inuit Qaujimajatuqangit locations for narwhal (Source: QIA)

Table 6. Seasonal distribution of narwhal based on IQ

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᖓᓵᖅ Upirngasaaq	ᐅᐱᕐᖔᖅ Upirngaaq	ᐊᐅᔭᖅ Aujaq	ᐅᑭᐊᔅᓵᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	early spring	late spring	summer	early fall	fall, early winter
Grise Fiord	Not present		Floe edge	Coast / open water		Not present
Arctic Bay	Not present	Floe edge		Coast	Moving to open water	Not present
Pond Inlet	In deep water at floe edge in Baffin Bay. Occasionally, Tremblay Sound and Milne Inlet	Arrive at floe in April	Moving towards Arctic Bay	In inlets and fiords	Moving back to open water before freeze up	Not present
Clyde River	Not present.	Floe edge; breathing holes and other openings in the ice; some birthing noted as there are young in the area	Moving into inlets and fiords	Inlets and fiords	Leaving for open water; Also see Pond Inlet whales	Not present
Qikiqtarjuaq	Not present. In deep water at floe edge in Baffin Bay	Migrating north in April	At floe edge; migrating northward	Migrating south along with other whales	Migrating south along with other whales; Gone by November	Not present
Pangnirtung	Not present	Cluster at floe edge under the right conditions in April	Move from floe edge into fiords, especially north side of Cumberland Sound	Occasionally seen. Starting to leave.	Not present	Not present

Source: *Inuit Qaujimajatuqangit Report*

Beluga whales can be found (Figure 6, Table 7), and are valued by Inuit for meat, fat, oil, leather, tools, and materials. Inuit from Iqaluit, Grise Fiord, and Qikiqtarjuaq have noted few or decreasing beluga whales. Inuit from Kimmirut and Iqaluit have said that beluga whales spend little time in the area during the summer months and some Inuit from Kimmirut have observed more whales in other areas. It has also been noted that beluga whales are smaller now, and Elders from multiple communities have observed changes in fins, teeth, and flippers. While the species was hunted a lot in the past, current hunting levels are lower. Belugas migrate seasonally throughout the Area of Focus, and it is thought that many spend the winter in the North Water Polynya like narwhal as mentioned above. Inuit hunters from Iqaluit, Pangnirtung, and Kimmirut believe that some belugas spend the winter near the mouth of Frobisher Bay.

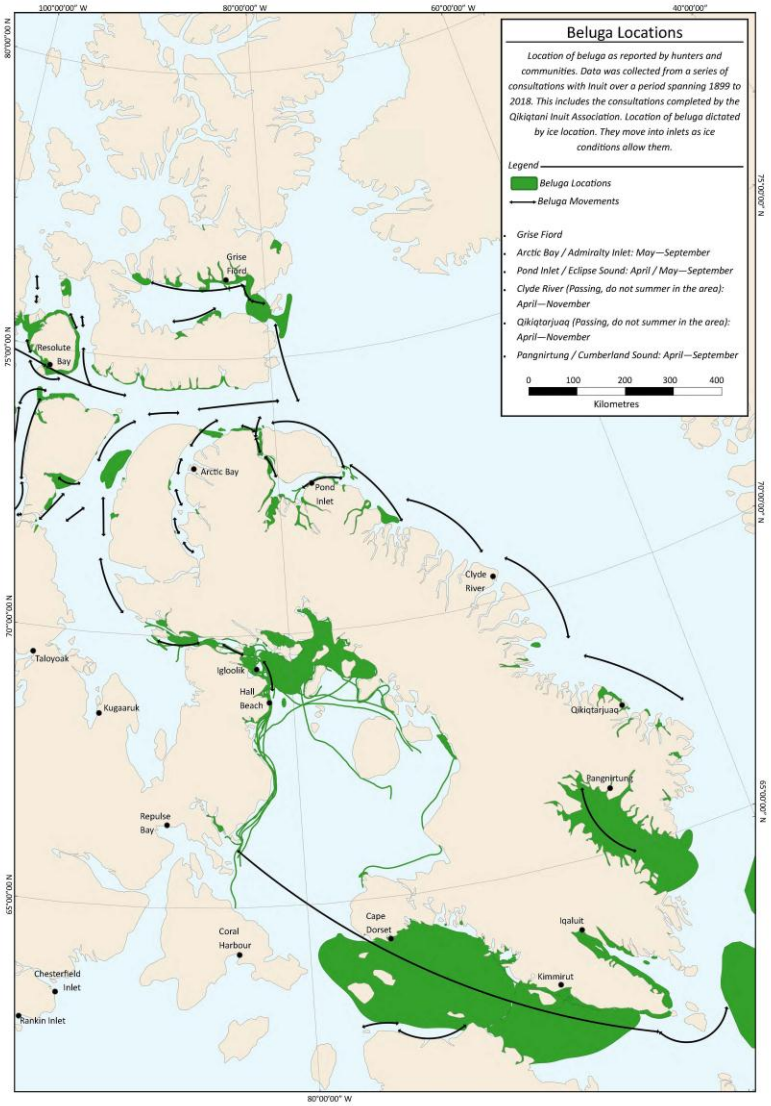


Figure 6: Inuit Qaujimajatuqangit locations for beluga (Source: QIA)

Elders and hunters from Kimmirut said that belugas visit Kimmirut in the spring when feeding off Arctic Cod or when following the currents while searching for cod in the summer. According to the literature review of Inuit Qaujimajatuqangit collected by *Sanammanga Solutions Inc.* for the QIA, Narwhal feed on Arctic Cod, Char, and Squid.

Table 7. Seasonal location of beluga based on Inuit Qaujimajatuqangit

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᓚᖏᖅ Upirngasaaq	ᐅᐱᕐᓇᖅ Upirngaaq	ᐊᐅᔪᖅ Aujaq	ᐅᑭᐊᖏᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	**early spring**	**late spring**	**summer**	**early fall**	**fall, early winter**
Grise Fiord	Floe edge; eastern Jones Sound keeping to open water as ice conditions change			Coast / open water		Present at polynyas
Arctic Bay	Not present	Floe edge		Open water; calving in fiords and inlets	Open water; departing fiords and inlets	Not present; observed in Baffin Bay
Pond Inlet	Not present.	Floe edge; moving northward		Rare	Rare	Rare. Migrating past before freeze up
Clyde River	Not present	Floe edge; moving northward	Rare. Moving northward in summer and southward in fall			Not present
Qikiqtarjuaq	Not present. In deep water		Rare. Passing northward	Seldom seen. Maybe be seen in Merchants Bay and Padle Fiord.		Not present
Pangnirtung	Not present	Arriving in Cumberland Sound in deeper water	Arriving in Clearwater Fiord to calve; slough skin	Calving in Clearwater Fiord in August; Still in area	Not present	

Source: Source: *Inuit Qaujimajatuqangit Report*

The population of Killer Whale occurring (Table 8) is estimated to be small (Inuit have suggested 12 to 500 individuals), and they migrate through the area seasonally after the ice has gone. Inuit Knowledge shared during the preparation of the *Inuit Qaujimajatuqangit Report* says that their dorsal fin inhibits travel through ice. The Inuit Qaujimajatuqangit literature research found that Inuit generally considered killer whales to be beneficial as they were used as spotters to locate other whales and seals.

Table 8. Seasonal location of killer whale based on Inuit Qaujimajatuqangit

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᖏᓱᓴᖅ Upirngasaaq	ᐅᐱᖏᓂᖅ Upirngaaq	ᐊᔪᖅ Aujaq	ᐅᑭᐊᓴᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	early spring	late spring	summer	early fall	fall, early winter
Grise Fiord	Not present	Not present	Arriving in July	Present	Leave the area in September	Not present
Arctic Bay	Not present	Not present	Arriving in July	Present and leave by September	Not present	Not present
Pond Inlet	Not present	Not present	Arriving in July	Present and leave by September	Not present	Not present
Clyde River	Not present	Not present	Arriving in July	Present and leave by September	Not present	Not present
Qikiqtarjuaq	Not present	Not present	Arriving in July	Present	Leave the area in September	Not present
Pangnirtung	Not present	Not present	Arriving in July	Present and leave by September	Not present	Not present

Source: *Inuit Qaujimajatuqangit Report*

The other species of whale occurring are the Northern Bottlenose Whale, Bowhead Whale, and Fin Whale. These whales were subject to intense commercial whaling in the past, which significantly reduced their population numbers. Bowhead whales were also traditionally harvested by Inuit (Table 9). Now Inuit in Nunavut hunt only one (1) to three (3) bowhead whales each year. Inuit from many communities have seen an increase in bowhead whale populations, but some in Pangnirtung also reported a decline. Noise has been noted to disturb whales, and in one report it was stated that a community member from Pangnirtung noted that there are less bowhead whales there since the introduction of motorized boats. During the NIRB's community scoping sessions, an individual from Pangnirtung also stated that when animals hear too much noise they leave and sometimes come back. In the scoping sessions in Iqaluit, a community member noted that there are many marine mammals in Baffin Bay and Davis Strait and that bowhead whales migrate north in the spring and south in the fall. The Ninginganiq National Wildlife Area on the northeast coast of Baffin Island supports the largest known concentrations of bowhead whales in Canada.

Table 9: Seasonal location of Bowhead Whale based on Inuit Qaujimajatuqangit

	ᐅᑭᐅᖅ Ukiuq	ᐅᐱᕐᖓᔅᓵᖅ Upirngasaaq	ᐅᐱᕐᖔᖅ Upirngaaq	ᐊᐅᔭᖅ Aujaq	ᐅᑭᐊᔅᓵᖅ Ukiassaaq	ᐅᑭᐊᖅ Ukiaq
	winter	**early spring**	**late spring**	**summer**	**early fall**	**fall, early winter**
Grise Fiord	Not present	Not present	Arrive at floe edge and movement in Lancaster Sound	Present in small numbers	Move out of area. Some winter in North Water Polynya	Some winter in North Water Polynya
Arctic Bay	Not Present	Floe edge off Admiralty Inlet		Moving to open water before freeze	Not present	
Pond Inlet	Not present	Not present	Present at flow edge; mating	Present in Eclipse Sound and Navy Board	Most move southward, but some move northward	Not present
Clyde River	Not present	Floe edge	Deep water preparing to enter inlets	Feeding in Isabella Bay before heading south	Not present	Not present
Qikiqtarjuaq	Not present	Not present	Arrive in the area	Abundant in near shore waters	Whales from the north passing by Qikiqtarjuaq	Not present
Pangnirtung	Not present	Arrive in March at floe edge	Southern shore to Cumberland Sound. Break thin ice to make breathing holes.	In Cumberland Sound is dispersed small groups	Departing may stay until early December depending on ice conditions	Not present

Source: *Inuit Qaujimajatuqangit Report*

Polar Bears are found throughout the Area of Focus and Lancaster Sound has the highest polar bear density in the Canadian Arctic. Polar bears are traditionally an important source of protein and clothing for Inuit. At least two (2) of the three (3) subpopulations of polar bears that occur appear to be stable or increasing. Inuit from Grise Fiord, Qikiqtarjuaq, Pond Inlet, and Clyde River have reported more polar bears in recent years, however some believe this increase in sightings may be due to more contact with humans. Inuit in Grise Fiord have noted that larger bears are no longer seen. Polar bears rely on the sea ice for hunting and travel, and coastal areas with steep slopes in the winter for denning. In recent years, polar bears on Baffin Island have been denning at higher elevations in areas of steeper slopes, are entering dens later, and leaving dens sooner. Inuit from Pond Inlet and Clyde River noted that bears may be moving

further inland and explained that if there is less snow or if polar bear populations increase, polar bears will travel higher into fiords where there is more snow and fewer bears.

During the NIRB Public Scoping Sessions, community members from Qikiqtarjuaq, Resolute, and Pond Inlet discussed the marine mammal distribution and noted differences in fish and marine mammals between communities along Baffin Bay and Davis Strait as well as between Canada and Greenland. In Iqaluit, it was shared that the leader of any pack or herd of mammals or fish will check to see if the environment is safe when migration and communicate this with the pack before proceeding together.

Other marine plants and animals

There is a diversity of other marine life occurring throughout the Area of Focus. The QIA organized Inuit Qaujimajatuqangit research found that all communities harvested kelp and seaweed and it was a critical part of the diet.

There is generally a large phytoplankton bloom in the Arctic after the sea ice breaks up in spring. Areas of upwelling, including polynyas, are very productive areas attracting fish, birds, and marine mammals. Benthic invertebrates are species that live at the bottom of the ocean and have no backbone, including mussels, clams, scallops, urchins, crabs, corals, and sea slugs. The Davis Strait Conservation Area, the Disko Fan Conservation Area, and the Hatton Basin Conservation Area were created to protect significant concentrations of sponges and cold-water corals in the offshore environment. While clams and mussels are not harvested commercially, they are occasionally harvested for local consumption. According to the Inuit Qaujimajatuqangit research for the SEA, clam beds are a good way to locate walrus given the importance of clams to them as a food source. Shrimp is also becoming a popular food source in the communities. Where shrimp pots are available, community members actively harvest them. Partially digested shrimp and other small invertebrates in the stomachs of seals is considered a delicacy in Pond Inlet.

Want more detail?
Look at Report:
- *Environmental Setting and Potential Effects* – Section 4: Environmental Setting – Biological Environment
- *Inuit Qaujimajatuqangit Report* – Section 4

The following are summaries of additional information provided or requested in written public comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
• Importance of Polynyas and potential effects from climate change. • Information on the Pikialasorsuaq (North Water Polynya), Inuit Circumpolar Council and the Pikialasorsuaq Commission • Geographic area of the Pikialasorsuaq (North Water Polynya).	Inuit Circumpolar Council Fisheries and Oceans Canada and the Canadian Coast Guard Environment and Climate Change Canada

Topic	Commenter
• Fog near ice edges and over polynyas.	
• Information on special and sensitive areas including National Parks, including boundaries. • Information on sensitive species, including sponges, corals, and sea pens.	Parks Canada Fisheries and Oceans Canada and the Canadian Coast Guard
• Suggested literature on policy development, mitigation, and marine biodiversity from the Arctic Council through the Arctic Monitoring and Assessment Programme. • Additional reports identified on wildlife, including Greenland Shark and Narwhal movements.	Fisheries and Oceans Canada and the Canadian Coast Guard

4.3. HUMAN

The populations of most communities in the Qikiqtaaluk Region is increasing, although according to 2012 Statistics Canada information, the populations of Kimmirut, Resolute, and Grise Fiord both decreased between 2011 and 2016 (Statistics Canada, 2012 and 2017 in Nunami Stantec 2018 b). Throughout the region there are more young people than there are old. The median age in the Qikiqtaaluk is 26.3. In 2016, almost half (46%) of the population in the Qikiqtaaluk Region had no certificate, diploma, or degree. However, attendance and enrollment rates at schools and college programs has been increasing. The unemployment rate in 2016 for the Qikiqtaaluk Region ranged from 9.6% in Iqaluit, to 40.2% in Clyde River. A 2009-2010 survey showed that approximately 20% of housing in the region needed major repairs, and about 30% of houses were overcrowded.

Low education and employment levels, along with a lack of housing and overcrowding, are some of the factors identified that cause poor health and well-being. Suicide rates are high in Nunavut and are highest in the Qikiqtaaluk Region. Statistics show that the number of people in Nunavut that perceive they have good physical health and mental health is lower than in the rest of Canada.

“Sales and Service” and “Education, Law and Social, Community, and Government Services” are the two (2) highest sectors of employment in the Qikiqtaaluk Region. Iqaluit has the largest and most diverse economy and is and the centre of commercial and government activity in the region. Tourism is a large part of the economy in Pangnirtung due to its proximity to Auyuittuq National Park and other parks. Nearby parks also bring tourists to communities such as Kimmirut, Qikiqtarjuaq, and Pond Inlet. Tourism is high in Cape Dorset, which has a thriving and world-renowned arts and crafts community, and arts and crafts are also important to the economies of Qikiqtarjuaq, Kimmirut, and other communities. Limited guide outfitting services are provided in many communities, and the commercial recreational polar bear hunt is important to Resolute and Grise Fiord. Resolute is also a research, transportation, and logistics

hub and has an Arctic military training centre. Baffinland's Mary River Iron Ore Project employs residents from Arctic Bay, Pond Inlet, and Clyde River. There are commercial fishing operations in Pangnirtung and Qikiqtarjuaq. People in all communities still participate in the traditional economy and rely on subsistence hunting and fishing.

Food costs are much higher in Nunavut than in southern Canada and consuming country foods helps offset the cost of food bought in stores. Recent reports identified that the weekly cost of groceries for a family of four would be $398 in Iqaluit, $395 in Kimmirut, and $460 in Pangnirtung, compared to $225 in Ottawa (Council of Canadian Academies and 2014; Government of Canada, 2017 in Nunami Stantec 2018 b; Impact Economics). Despite this, it is becoming more and more common to consume market foods, especially among the younger population. Traditional hunting, fishing, gathering, and consuming of country foods provides a vital connection to the land and promotes and maintains Inuit culture.

The QIA's food security study completed by Impact Economics identified that harvesting and food sharing continues to be an important factor in offsetting high food costs. According to the research undertaken for the QIA, the value of the harvest in the six (6) communities[8] closest to the Area of Focus is $3.3 million annually. For the 5,700 people in these communities, this amounts to $580 of food per person per year. Sharing continues to be a big part of the culture. According to surveys completed by the QIA, 60% of country food is shared beyond the harvesters' household, and in 90% of the households, country food is still consumed.

Large numbers of Ringed Seal, Arctic Char, Goose, Eider Ducks, and Clams are harvested. Polar Bears, Beluga Whales, Narwhal, and other types of seals and waterbirds are also harvested. Harvesting occurs year-round in terrestrial lowlands, along the shores, on landfast ice, at the floe edge, and in open water. The Inuit Qaujimajatuqangit literature search undertaken for the QIA found that within the Area of Focus there are many traditional harvesting sites, camping areas, areas of archaeological importance, and travelways, especially along the coast of Baffin Island. Inuit Qaujimajatuqangit interviews recorded that older Inuit still try and instruct youth on the right way to hunt, such as not hunting the leaders in a whale pod since they are the ones who know the places to go. They also say not to leave a wounded animal. In all the communities there are programs to teach youth how to hunt. The importance of country foods and concern about food security was heard in many communities during the NIRB's Public Scoping Sessions. Community members shared information on harvesting, including hunting areas and differences in wildlife distribution and availability.

Want more detail?
Look at Report:
- *Environmental Setting and Potential Effects* – Section 5: Environmental Setting – Human Environment
- *Food Security Report* – Understanding the economics of marine-based harvesting
- *Inuit Qaujimajatuqangit Report* – Section 4

[8] Grise Fiord, Arctic Bay, Pond Inlet, Clyde River, Qikiqtarjuaq, Pangnirtung.

There are no roads connecting communities in Nunavut and travel by plane is the most common and only year-round method. All communities rely on annual sealifts during the ice-free season to bring in goods. Cruise ships and pleasure crafts are increasingly common in Nunavut because of thinner ice and longer ice-free seasons. The number of ships passing through the Northwest Passage are increasing and the number of marine vessels passing by Pond Inlet nearly tripled between 1990 and 2015 due to an increase in tourism, along with traffic related to the Mary River Iron Ore Project (Dawson, Copeland, et al. 2017 in Nunami Stantec 2018 b). During that same time, the number of ships in Resolute and Arctic Bay decreased, likely due to closures of the Polaris and Nanisivik Mines. There are currently no deep-sea ports in Nunavut, however, one is planned for Iqaluit and should be operational in 2020. There is a dock facility at Nanisivik, a small craft harbour in Pangnirtung, and another small craft harbour planned for Pond Inlet.

The following are summaries of additional information provided or requested in written public comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
Health status and the health care system in Nunavut.	Crown-Indigenous Relations and Northern Affairs Canada
Community harvesting and commercial fishing and related monetary values and fish populations.	Fisheries and Oceans Canada and the Canadian Coast Guard

4.4. CLIMATE CHANGE

The average global temperature is increasing, and climate change is already very noticeable in the Arctic. Signs of climate change observed in the Arctic and in the Area of Focus include changes to temperature and precipitation. Nunami Stantec reviewed multiple studies identifying observations by Inuit of climate change. Inuit from Qikiqtarjuaq, Pangnirtung, and Iqaluit observed warmer winter temperatures than in the past and Inuit from Pangnirtung also noted that winter is becoming shorter and the sun hotter. The Inuit Qaujimajatuqangit research completed for the QIA recorded comments related to changing freeze up times and not being able to get onto the ice as early as in the past. Fall freeze-up is occurring a month later than historically. They also heard harvesters say that landfast ice does not extend as in the past and its condition is less secure.

Changes to sea ice and glaciers have also been observed. Glaciers in some areas have noticeably grown smaller, which has caused lower water levels in rivers. Some community members in Grise Fiord have observed less run-off from glaciers in the summer and glaciers breaking off. They also reported a longer open-water season, with sea ice melting sooner and breaking up faster than before, and less summer ice. In Qikiqtarjuaq, Iqaluit, and Pangnirtung, Inuit have also noticed thinner sea ice and ice forming later and breaking up or melting earlier.

Climate change has also impacted traditional practices such as hunting and fishing. Changes in snow, ice, and water conditions, and generally less predictable weather, make travel and being out on the land more

difficult and dangerous. Some hunters have reportedly stopped narwhal hunting at the floe-edge owing to the unpredictability of the local climate and associated dangers and community members from Pangnirtung have noticed changes in snow, which has made it harder to make igloos. Climate change is also affecting the timing of traditional activities. For example, warmer temperatures affect the ability to cache food in the summer and some Inuit have noted that community freezers must be used until traditional caching (without freezers) can be done in the late fall.

Scientists use models to predict what could happen to the climate in the future. The models are used to produce a range of different outcomes because the actual change will depend partly on how much humans continue to pollute (that is, how much they continue to emit carbon dioxide and other greenhouse gases), and what kind of mitigation measures to prevent or reduce negative effects are implemented. Overall, scientific models predict that Arctic will warm considerably more than other regions of the globe.

For the Clyde River area, models run by Nunami Stantec for the SEA predict that in the 2080s, the average temperature during the winter in the Area of Focus could be as much as 12.1 degrees Celsius (53.8 degrees Fahrenheit) higher than the average from 1981-2010. An intermediate projection is that it could be 5.5 degrees Celsius (42 degrees Fahrenheit) higher. Precipitation could change by as much as 60% in the winter by the 2080s. Snow cover may decrease by 9% to 33%. Changes to the average temperature and precipitation levels will not be as large in the summer as in the winter (Nunami Stantec, 2018 b).

Another potential future change predicted is an increase in the number of frost-free days. Also, the sea ice extent is expected to decrease across the Arctic by 34% in February and 94% in September, although in Baffin Bay and Davis Strait the waters are already nearly ice-free in September. As temperatures increase and glaciers melt, more icebergs are expected in the Area of Focus in the short-term, and the number may decrease in the long-term. Populations of species such as seals and polar bears that rely on sea ice as part of their habitat are likely to be adversely affected as the climate warms and levels of ice continue to decrease.

Want more detail?
Look at Report: *Environmental Setting and Potential Effects* – Section 6: Environmental Setting – Climate Change

4.5. INFORMATION GAPS

Nunami Stantec concluded that more baseline information is needed to improve the understanding of the physical, biological, and human environments in the Area of Focus. The QIA *Inuit Qaujimajatuqangit Report* highlights some of the limits in available information in the Development Scenario Area. Much of the baseline information summarized above is relevant to the area inside the landfast ice zone and related to summer. Little is known about winter conditions.

Among the limitations identified is the lack of weather and climate monitoring stations in the area. Weather forecasting and climate change modelling is more accurate in areas where there is an

observation station than in areas where there is no observation station. There is also a lack of air quality data for areas over the water in the Area of Focus. Baseline information is needed on the amount of greenhouse gases such as methane under the sea ice and within the terrestrial environment, and the likelihood of those gases being released as the climate changes. More climate change modelling is also needed to improve predictions of how big and how often storms will occur, and how they will move. It is also not clear exactly how the number of icebergs in the Area of Focus will change in the long term.

Some areas within the Area of Focus have not been adequately surveyed and so there is a lack of detail in those areas about the depth of the ocean and characteristics of the seafloor. During the NIRB's Public Scoping Sessions, community members recommended that tornadoes, earthquakes, and tsunamis be considered in the assessment. It should be noted that there are knowledge gaps about potential geohazards in the Area of Focus. For example, there are knowledge gaps regarding the cause of underwater earthquakes in the area, ocean sediment types and thicknesses, the stability of the seafloor, and tsunamis. The role of ocean currents and tides in sediment movement and in underwater slope stability is not well understood, and the rate of iceberg scour (scraping of the seafloor) is not known. More information is also needed to better understand the naturally occurring oil seeps.

In terms of the biological environment, there is little known about the distribution, abundance, migratory patterns, and key habitat availability and quality for many species. For example, the migratory patterns of eastern King Eiders and Eastern Canadian Arctic Puffins are not well known. During the NIRB's Public Scoping Sessions, a community member from Pangnirtung noted that wildlife migration routes are changing. According to the QIA's *Inuit Qaujimajatuqangit Report*, these changes, such as wintering habitat and habits of marine mammals, is not well documented. Community members mention that marine mammals vacated the coast for open waters of the North Water Polynya and other parts of Baffin Bay and Davis Strait, and according to Inuit Qaujimajatuqangit are expected to return under certain ice and light conditions. However, there is little Inuit Qaujimajatuqangit known about the wintering activities of marine mammal while in open waters.

Another gap is that population estimates for the Arctic subpopulation of ringed seals are not available and there is limited published information about the distribution and seasonal movements of bearded seals in the eastern Canadian Arctic. Levels and trends of the Baffin Bay narwhal and beluga populations are also uncertain. Information about the distribution of fin whales mostly relates to summer feeding grounds, and less is known about winter grounds and the location of calving and breeding areas. The winter distribution of beluga whales is also not well known. In addition, the trends for all the Polar Bear subpopulations within the Area of Focus are not clear, as the conclusions made by Inuit Qaujimajatuqangit and scientific studies differ. For these and many other species, more data collection and monitoring are required to better understand their current status.

There is also limited information about how birds, marine mammals, and invertebrates respond to in-air and underwater noise, and there is limited information about current sound levels and how sound travels in the Arctic. Baseline noise monitoring and wildlife behavioural monitoring would be required to

understand this. During the NIRB's Public Scoping Sessions, community members commented that more Inuit Qaujimajatuqangit studies are needed on the potential impacts of noise on marine mammals.

The sensitivity of marine species and habitats to marine pollution and potential spills is also not completely understood and should be further studied. A coastal sensitivity atlas for the Area of Focus would help prioritize and coordinate response in case of a spill.

Some of the statistics presented in the summary of the Human Environment are becoming out of date. For example, some information was taken from the Nunavut Housing Survey which was conducted in 2009 and 2010. Also, there is some uncertainty about some of the statistics because different sources identified different numbers. For example, labour force statistics from the Government of Nunavut Bureau of Statistics were different from those reported by Statistics Canada. It is also recognized that collection of information from public information sessions would improve the understanding of perceived health and well-being.

According to the Impact Economics food security report, food security and food sharing is still a critical part of Inuit lives. This relationship has been well studied in some of the Qikiqtaaluk communities, and not in others. More research will be needed to understand what influence oil and gas development may have on food insecurity, and if a disruption to an important food source (such as seals and whales) will disable those currently engaged in its production.

Want more detail?
Look at Report: *Environmental Setting and Potential Effects* – Section 8: Information Gaps and Recommendations

The following are summaries of additional information provided or requested in written public comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
Limited information on Sensitive Benthic Areas and Vulnerable Marine Ecosystems.	Fisheries and Oceans Canada and the Canadian Coast Guard

5. ADDITIONAL FACTORS TO CONSIDER TO POSSIBLE OIL AND GAS DEVELOPMENT

This section summarizes the potential challenges and factors to consider for possible oil and gas development in the Development Scenarios Area in Baffin Bay and Davis Strait (Figure 2). Factors considering the Inuit Qaujimajatuqangit collected by QIA will be assessed separately; this summary is based on the *Oil and Gas Life Cycle Activities and Hypothetical Scenarios* Report provided to the NIRB by Nunami Stantec.

Among the many factors that an operator would have to consider when deciding to develop an oil and gas project are the potential environmental challenges, particularly as this industry operates offshore and often in extreme conditions. Some of the potential environmental challenges that proponents may face

that may cause long or repeated delays to marine seismic or exploration drilling from weather conditions include:

- Icebergs, sea ice, and ice packs migrating south along the coast of Baffin Island:
    - Management for icebergs, sea ice, or ice packs that may calve off the Greenland, Baffin Island, and Canadian Arctic Island glaciers that may migrate south along the coast of Baffin Island would be required and proponents/operators would be required to have sound and flexible ice management plans in place;
- Lack of shore-based infrastructure and remoteness:
    - Offshore fields would need to be self-reliant and cannot rely on large shore-based infrastructure; and
- Impacts from climate change in the Arctic:
    - Climate change could lead to less icebergs and ice packs that can allow for longer open water seasons and extended summer drilling seasons. However, climate change can also increase the frequency and severity of open water storms and severe fog, which could result in restriction to aircraft operations and vessel traffic from shore base to offshore facilities.

In addition to the environmental factors above, proponents/operators would also have to consider the following when considering possible offshore oil and gas development in the region:

1) The potential for new discoveries in the region could increase level of production resulting in reduced costs, especially if additional exploration and development of new oil and gas reserves occur next to existing development which could then increase production and maximize the use and lifespan of project infrastructure. New discoveries can lead to the expansion of commercial satellite fields (small oil and gas pools near a larger resource), which could tie into an anchor field and be cost-effective.

2) New technologies could improve operating practices, especially in the fields of how to collect marine seismic data and in new types of drilling methods and tools. In addition, the global trend in offshore development is underwater (submerged) production at the seafloor to a floating vessel. This improved technology has significantly reduced or avoided onshore footprint and increased the ability to shut down the seafloor wellhead flow in the event of iceberg presence.

3) Maximizing local and national benefits and reducing environmental impacts, as current cost estimates for offshore exploration and development in Arctic waters is almost two (2) times higher compared to other regions. Arctic developments will have to compete with lower-cost and more accessible discoveries in other parts of the world.

4) Finally, in the case of Canada's Arctic offshore, the impact of political and regulatory stability and predictability can be a large risk to the oil and gas industry. As this would be a new industry in the region, planning and policy is still developing and may change, causing uncertainty for oil and gas development to move forward.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* – Section 6: Additional Factors to Consider

6. POSSIBLE DEVELOPMENT SCENARIOS IN BAFFIN BAY AND DAVIS STRAIT

The possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait are not tied to a specific company and do not predict what could happen in the future. Details such as the depth of drilling, area to be surveyed, or number of people to be employed would be available during project level assessment and regulatory phases should a project be proposed.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios*.

Also look at Section 8 of *Oil and Gas Hypothetical Scenarios*: Examples of Global Arctic Offshore Exploration/Developments for oil and gas examples from other Arctic areas.

The scenarios are not associated with a specific location and represent activities, components, and infrastructure, based on current technology at the time of the report, that could be used in development throughout the Canadian waters of Baffin Bay and Davis Strait, outside of the Nunavut Settlement Area and the Tallurutiup Imanga (Lancaster Sound) National Marine Conservation Area (see Figure 2). The activities and infrastructure described within the hypothetical scenarios would be similar throughout the area.

A specific project would not necessarily advance through each of these scenarios. For example, even if a company received the rights to conduct seismic surveys, this does not guarantee it would conduct exploration drilling. This could be for multiple reasons, including: not enough oil and gas resources were identified; it is not economically feasible for the company to continue; or a licence was not granted.

It is assumed that as new information becomes available, the scenarios and the SEA should be adjusted.

6.1. SCENARIO A: EXPLORATION WITH OFFSHORE SEISMIC SURVEYS

6.1.1. Purpose of Seismic Surveys

There is limited information on the geology of the earth's crust below the seafloor and the potential for oil and gas reservoirs (crude oil or natural gas trapped in the sediment) in the Canadian waters of Baffin Bay and Davis Strait. This information would need to be collected before companies would consider undertaking exploration activities and potentially developing the area. Seismic surveys are used to

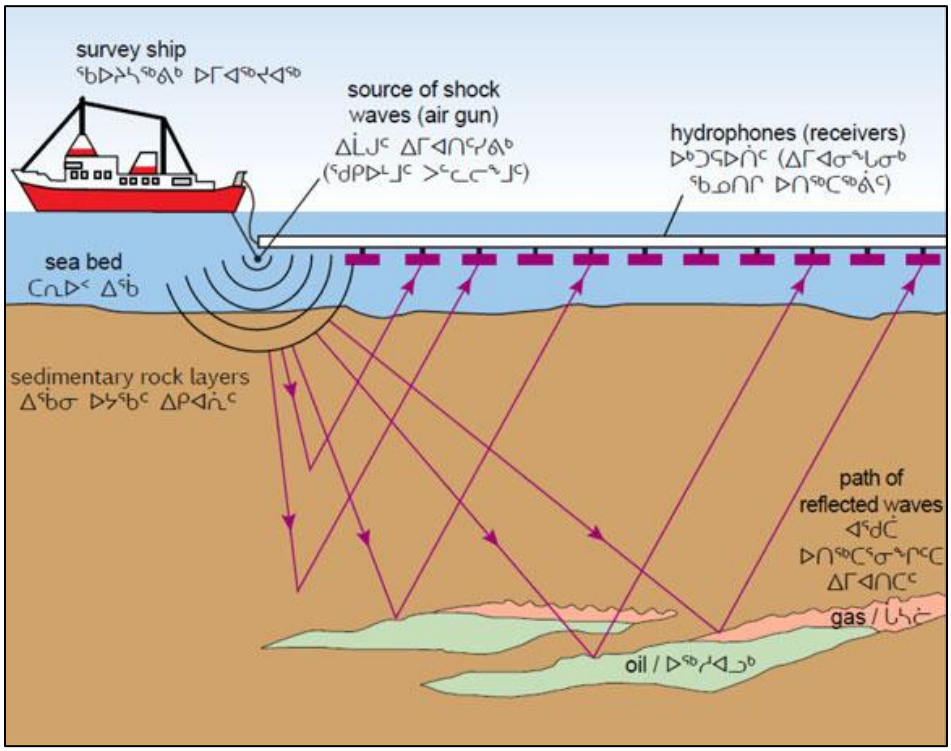
determine if oil and gas could be present and to get information on the characteristics of potential oil and gas resources. Two dimensional (2D) marine seismic surveys can be used to gain a general understanding of a region's geological structure. Three dimensional (3D) marine seismic surveys are designed to cover a specific area to support the selection of drilling locations.

Oil and gas reservoirs will be referred to as oil and gas resources in this report.

6.1.2. Description of Seismic Surveys

During a seismic survey, an air gun uses compressed air to generate sound waves at the water's surface which travel down below the seafloor and some of that energy bounces back from different layers of rock below the surface (see Figure 7). The waves sent back will be different depending on how compact and thick the rock layers are. The strength of these waves and the amount of time it takes for them to travel through the layers of the Earth's crust and return are recorded by receiving devices called hydrophones. Seismic surveys may use multiple air guns called air source arrays and could have multiple hydrophones arranged along cables made of steel or Kevlar, called streamers. This information is then used to make an image that gives a picture of the structure of the rock layers as well as the location and depth of potential oil and gas resources. A seismic survey requires open water and good weather, typically from June to September, as rough water can affect the quality of the information collected.

Figure 7: Seismic Survey Components (Source: National Energy Board)



Although explosives were used in the past before airguns, they are not used in present day operations as the sound produced by airguns is more targeted and less disruptive to marine wildlife. While waterguns and vibrators are other types of seismic sources, airguns are typically used for marine seismic surveys as they can send sound waves deeper below the seafloor than other existing technologies. New and emerging technologies are being developed to collect the same type of information with less noise lost under water, including using underwater vehicles that would operate closer to the seafloor.

More than 95% of marine seismic data is collected using 3D seismic surveys (Figure 8). A comparison of two dimensional (2D) and three dimensional (3D) seismic surveys is provided in Table 10.

Table 10: Comparison of 2D and 3D Seismic Surveys

Two-Dimensional (2D) Seismic Surveys	Three-Dimensional (3D) Seismic Surveys
Provide general understanding over a large are of the geological structure below the seafloor	Provide detailed information over a small area and used to identify if and where exploration drilling should occur
1 seismic cable and 1 airgun	2 airguns
1 cable (streamer) with hydrophones	6-24 streamers with hydrophones spaced 25-50 metres apart
Ship sails over a wide grid pattern several kilometres apart	Ship sails over racetrack pattern spaced 200-400 metres apart
Could require multiple survey seasons to collect sufficient data	Completed in 1 open water season and would likely take 2-3 years to get the information required
Both 2D and 3D Seismic Surveys	
Constant towing speed during seismic surveys of approximately 9 kilometres an hour, or 5 knots	
Streamers are typically 5,000-6,000 metres or longer and in deeper water like Baffin Bay and Davis Strait, streamers will float 8-15 metres below the water surface.	

Did you know?
180 decibels is similar to the noise made on the surface from cracking and breakup of sea ice.

Typical air source arrays produce a sound ranging from 220-260 decibels one (1) metre from the airgun and lasting approximately 0.1 seconds, repeated every 10-15 seconds. The sound level decreases away from the airgun to 180 decibels at 500 metres and about 170 decibels 1 kilometre away. How sound moves through water depends on many factors, including: water depth; seafloor sediment properties; ice coverage; speed of the sound at different depths; water salinity and temperature; airgun size; and rate the sound is produced. Nunami Stantec noted that modelling sound is difficult and is best done at a project level assessment with information such as the proposed seismic survey plan, location, and equipment to be used. In Canada, marine seismic companies commonly follow guidelines produced by Fisheries and Oceans Canada within the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment.*

6.1.3. Equipment and Infrastructure

For both 2D and 3D seismic surveys, one (1) seismic vessel and one (1) or two (2) ice capable support vessels would be required (Figures 9 and 10). Support vessels would be used to provide supplies for the seismic vessel. Support vessels would also travel in front of a seismic vessel when surveying to warn other vessels. Requirements for onshore support, such as a base for crew transfer, would be limited. Helicopter support would be limited and likely provided from Nuuk, Greenland or Newfoundland and Labrador where appropriate infrastructure is already in place. Crew transfers could be based from the Iqaluit airport or any of the communities in the region if feasible and closer to the survey location.

Figure 8 3D Seismic Survey, Offshore China (Source: Empyrean Energy)

Figure 9 Support Vessels Assisting Seismic Survey in West Greenland (Source: Cairn Energy)

6.1.4. Financial and Human Resources

The cost to complete both a 2D survey and a 3D survey could range from USD $7 million to $18.5 million.

A seismic survey needs fully trained and experienced workers. The contracted vessels typically come fully staffed and very little onshore support would be needed. Local employment opportunities in the Qikiqtaaluk Region might include 6–10 seasonal positions as Marine Wildlife Observers on board seismic vessels to implement and monitor mitigation commitments. There could also be indirect employment opportunities associated with supplies and services from local sources.

6.1.5. Potential Accidents and Malfunctions

Potential accidents and malfunctions associated with offshore seismic surveys include:

- Fire and explosions
- Loss of life (falling off the vessel)
- Downed aircraft (helicopter)
- Vessel collisions
- Major weather and sea ice conditions
- Vessel strike with marine mammals

- Batch spill

Accidents and malfunctions during seismic surveys are not common as the seismic vessels travel at slow speeds and there are international safety standards that the vessels must follow.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* –
Section 4.1: Offshore Seismic Survey
Section 9.1: Exploration with Offshore Seismic Surveys

6.2. SCENARIO B: EXPLORATION DRILLING

6.2.1. Purpose of Exploration Drilling

If a 3D seismic survey identifies the potential for oil and gas, the next step would be to drill a well below the seafloor and into the resource to confirm if oil or gas is present and how deep and wide the reservoir is. Drilling wells and collecting rock and liquid samples is the only way to confirm the presence of oil and gas in an area. There are two (2) types of exploration drilling:

- *Exploratory drilling* to determine whether the resource is oil or natural gas, and how deep the resource goes below the seafloor (the vertical extent); and
- *Delineation drilling* to determine how wide the oil and gas resource is (the horizontal extent).

6.2.2. Description of Drilling

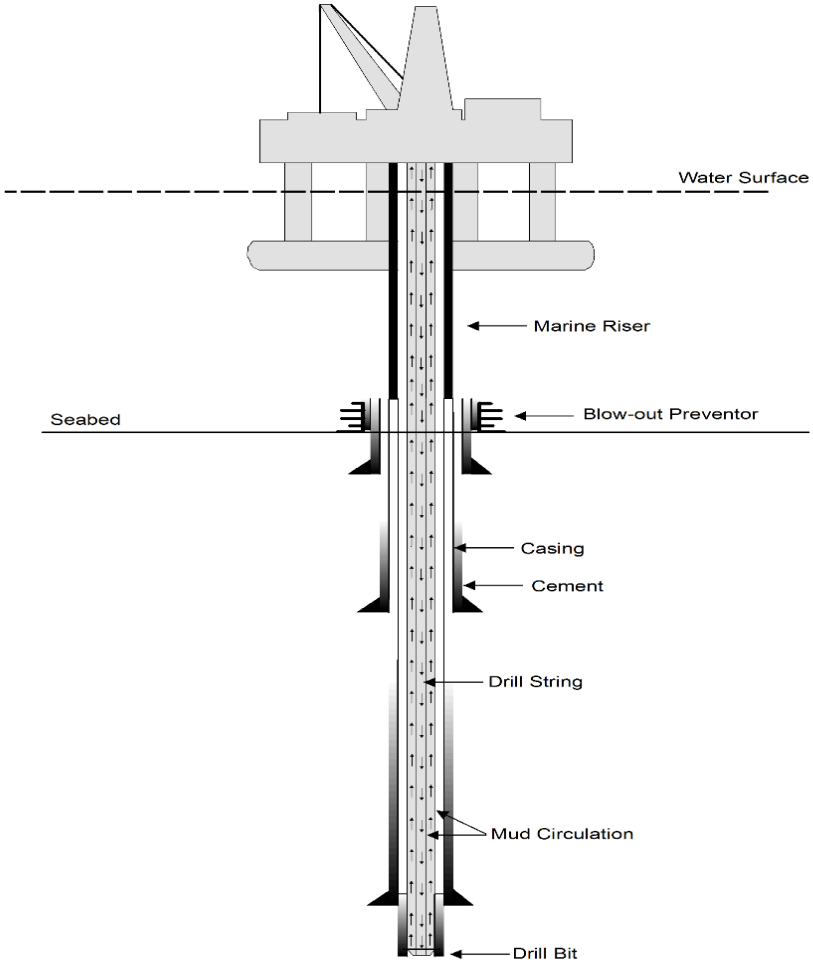
Before drilling begins, geotechnical and geohazard surveys of the seafloor and the layers below are used to determine where exactly the well should be located and if it would be safe to drill. A well-specific drilling program would be designed to select the appropriate equipment and materials. The equipment, materials, and environment would be tested and monitored to ensure effective and safe operations. During drilling, the properties of the rock cuttings and fluid encountered would frequently be evaluated to determine if oil or gas is encountered. This is referred to as formation evaluation, evaluating the 'form' of the oil and gas resources.

Geotechnical surveys identify characteristics of the rocks and materials on the seabed and layers below, such as strength, material type, and how compact the material is.

Geohazard surveys look at natural risks, such as landslides, earthquakes, or icebergs.

The time it takes to drill a well depends on multiple factors, including: water depth, well design, depth of the oil or gas resource, weather, ice conditions, and various technical, safety, and operating conditions. Based on timelines to drill wells in offshore Newfoundland, it is assumed a well would take 35-65 days to drill. While exploration drilling could be conducted year-round, it is typically conducted in open water over a 1-2 month period.

Figure 10: Figure of a Typical Offshore Well (Not to Scale)



The typical components associated with drilling identified in Figure 11 are

- Drill rig: a stable platform from which to drill a well
- Marine riser: tubing attached to the blow-out preventer to bring drilling muds and cuttings back up to the drill ship or semisubmersible
- Blow-out preventer: large piece of equipment that sits on top of the well with a valve that can be closed to prevent an uncontrolled release of oil or gas
- Casing: pipe placed into the hole drilled (called a wellbore) and which provides main structural support
- Drill String: drill pipe that transmits drilling fluid to the drill bit
- Drilling mud: drilling fluids formed of a mixture of clay and minerals to make it heavier and denser.
- Drill bit: a drill pipe with the drill bit on the end is used to drill into the seafloor.

When drilling the first few sections of the hole (wellbore), water-based drilling fluids are used to cool and lubricate the drill bit and bring the rock cuttings from the bottom of the hole up to the vessels designed for offshore drilling (drillship or semi-submersible; see Figures 13 and 14) so they do not fill the hole back in. Drilling fluids are the key component of the well design and are typically designed to prevent harmful effects to the environment and have low toxicity, and most are highly biodegradable. The cuttings brought to the top are non-toxic and typically discharged into the ocean without treatment.

The casing is then installed and cemented to hold it in place. The casing is used to prevent the sides from caving into the wellbore and to stop fluid or gases from one (1) layer of rock flowing into a different layer of rock. Once the casing is installed, the blowout preventer and drilling riser are installed. For deeper well sections, synthetic oil-based drilling fluids are used because they are designed for higher temperatures and to slow down or prevent gas hydrates from forming. These drilling fluids may be toxic and harmful to the environment and are therefore not discharged into the surrounding water. They can be cleaned and reused, and any rock cuttings that come in contact with the fluids must be treated before they can be discharged into the ocean, as per the National Energy Board's *Offshore Waste Treatment Guidelines.*

> *Gas-hydrate* is a solid ice-like form of water that contains gas inside its cavities. The gas is mostly methane. It can form in pipelines and pose problems, so a substance is used to slow down or prevent gas-hydrates from forming.

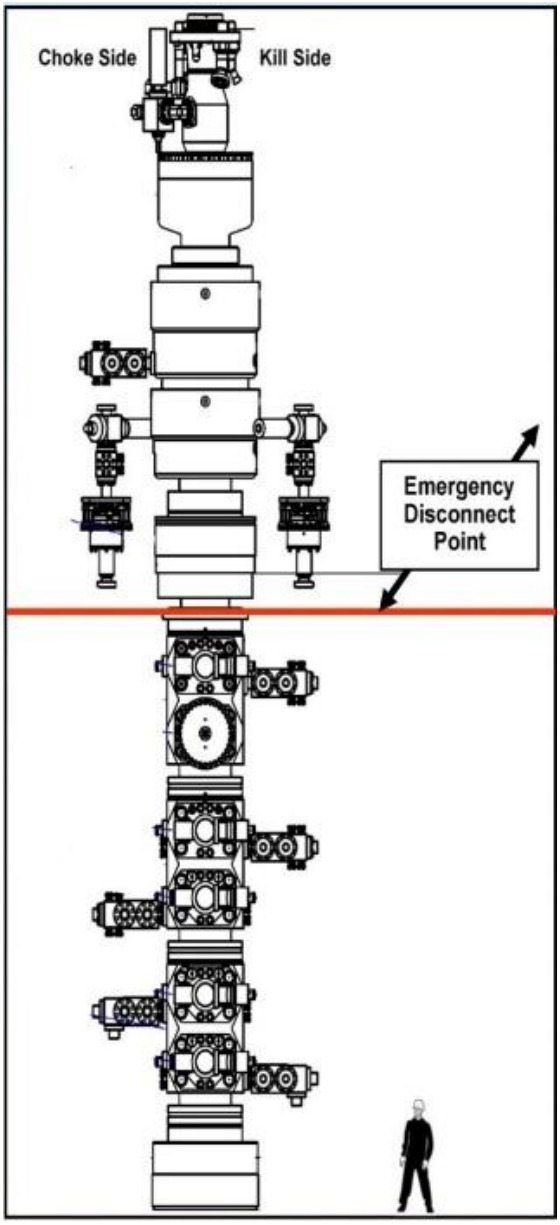
Wells are designed to prevent an uncontrolled escape of oil or gas through the following steps:

- Design wells to handle all identifiable risks (for example, ice or equipment failure);
- Establish and follow detailed procedures;
- Build multiple safeguards into the design of well and drilling systems;
- Inspect and maintain all equipment according to specified schedules;
- Properly train all equipment operators;
- Conduct on-going testing and emergency response drills prior to and throughout drilling;
- Use drilling fluids that are denser than oil, gas, and water to keep those from uncontrollably flowing up and out of the well; and
- Monitor the drill hole and adjust the drilling fluid if needed.

Every so often during drilling it is necessary to measure the properties of the rock and the fluid of the resources to determine whether there is a discovery or if the well should be abandoned. This can be done by looking at what is coming to the surface, lowering instruments down into the well, or by doing vertical seismic surveys. Vertical seismic profiling provides more detailed information on the structural geology at the drilling location. Testing the flow of oil and gas at the surface, and potential use of flaring, is not included in this scenario. However, it can be used in operations and is included in the assessment of potential effects.

A blowout preventer (Figure 12) is designed to close off a well to stop further loss of pressure and fluids if there is an uncontrolled flow. Drilling operators are certified and trained to quickly activate the blowout preventer to stop and manage the flow of oil, gas, or drilling fluids. All drilling programs are required to have many contingency plans, including a Well Control Plan and an Emergency Response Plan.

Figure 11: Typical Subsea Blowout Preventer for Offshore Drilling (Source: ExxonMobile)



At the end of each drilling season, drilling activities would be suspended and the well secured to prevent an uncontrolled flow of oil or gas. Once a well is no longer needed, it would be plugged and abandoned to meet National Energy Board regulations. Cement and steel plugs are typically set at specific points along the drill hole and the cement is tested ensure it is properly sealed. After the last plug is set and tested, the blowout preventer is removed, and a cap is installed over the wellhead. Monitoring an abandoned well may be required by the National Energy Board.

6.2.3. Equipment and Infrastructure

The major components of an Arctic offshore drilling program in Baffin Bay/Davis Strait would be expected to include:

- Arctic class drilling platform (drillship or semi-submersible; Table 11).
- 1–2 icebreaker support vessels
- 1–2 wareships, any anchored vessel for offshore storage, if no deep-water port is available to: carry fuel, drilling materials and other supplies; store and ship waste products; provide maintenance and repair operations, and support helicopter, well control, and oil spill response operations
- 2–3 supply vessels to transport fuel, drilling materials, other supplies, waste products, personnel between drilling unit vessels and the wareship or shore facilities. If required, these would support well control operations and oil spill response operations
- 1–5 fuel tankers to supply fuel for the drilling unit and support vessels
- Helicopters and aircraft to transport workers and supplies
- Onshore storage facilities in coastal communities for emergency equipment such as oil spill response equipment and other emergency equipment

Table 11: Two types of drilling platforms that could be used for exploration drilling in Baffin Bay and Davis Strait.

Drillship	Semi-submersibles
Operates in water depths ranging from 600-3,000 metres and drilling depths of more than 12,000 metres below the seafloor.	Operational at water depths of 500–3,000 metres.
Can be over 200 metres long and more than 40 metres wide.	Can be 120 by 120 metres and stand 40-50 metres high when partially submerged.
Fully mobile.	While in transit, semisubmersibles are towed by tug boats to a location and then partially lowered by filling the legs with water to provide stability.
Can be agitated by waves, wind and currents which can be a challenge when the vessel is drilling, because the vessel is connected to equipment that can be thousands of metres under the sea.	Often chosen for harsh conditions because of their ability to withstand rough waters.
Both Drillships and Semi-submersibles	
Drilling equipment is passed through the vessel's opening by a flexible riser pipe that extends from the middle of a drillship to the seafloor (called a moonpool).	
Anchors and computer-controlled system used to keep the rigs position.	

Figure 12 Floating Drillship Designed and Configured for Arctic Drilling (Source: Stena Drilling)

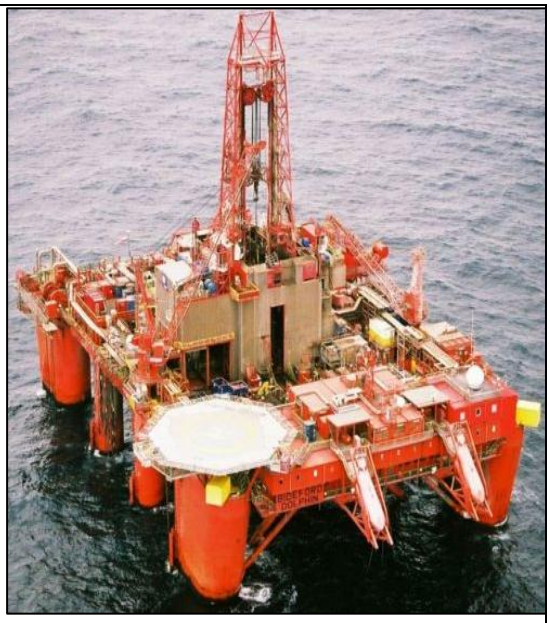


Figure 13 Semi-submersible Drilling Platform (Source: Husky Oil)

Shore-based facilities and services could be provided in Nuuk (Greenland) or St. John's, Newfoundland and Labrador, as there is already established infrastructure that specializes in the offshore oil and gas industry. Facilities could include office space, warehouses, equipment staging sites, storage yards, and storage facilities for emergency equipment. Services could include: communications, land transportation, air transportation, and waste management services for waste materials and used chemicals removed from the drilling platform.

Services and facilities in Iqaluit could be used if available, but it is unlikely that additional infrastructure would be built specifically for offshore oil and gas, unless it was deemed to be more economical or practical than using existing infrastructure in Greenland or Newfoundland. The exception to this would likely be related to storage of emergency equipment at key locations in Nunavut.

Figure 14: Example of support vessel/icebreaker (credit Janine Beckett)

Both drillships and semi-submersibles require certification that the drilling unit is operational and in compliance with regulations. The activities and components associated with exploratory drilling include:

- *Ice management*: Plans and systems for identifying, tracking, mitigating, and responding to hazards such as an iceberg including:
    - towing an iceberg; and
    - rapidly disconnecting the drilling unit from the well and moving to a different location, or both.
- *Drilling Waste Management*: Plans and systems for handling, storing, treating, and disposing of all waste and chemicals produced, including (but not limited to): drilling fluids and other drilling wastes; cooling water from the ocean used to cool the equipment on deck; ballast water; and greywater.
- *Air Emissions Management*: Plans and systems to identify and reduce all possible sources of air contaminants and complying with standard industry best practices, mitigation measures, commitments, and regulatory conditions.

6.2.4. Financial and Human Resources

The cost to complete an exploration drilling program could range from USD $100 million to $150 million. A drillship can cost USD $500 million or more to build. The daily costs of renting a drillship can be USD $250,000–$400,000 per day. The daily costs of renting a semi-submersible are usually less than a drillship, at approximately USD $200,000–$250,000 per day.

Drilling units usually come fully staffed with experienced workers. Offshore exploration programs employ skilled and unskilled workers including engineers, welders, electricians, cooks, support staff, health and safety specialist, environmental specialists, helicopter pilots, technicians, geologists, and healthcare staff. Local employment opportunities might include full-time positions as environmental monitors on board the drilling platform and support vessel to implement and monitor mitigation commitments. With advance training, additional employment opportunities could be available for residents of Nunavut. There could also be indirect employment opportunities associated with supplies and services from local sources.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* –
Section 4: Routine Exploration and Appraisal Activities
Section 9.2: Exploration Drilling

6.2.5. Potential Accidents and Malfunctions

Potential accidents and malfunctions associated with exploration drilling include:

- Fire and explosions
- Loss of life (falling off the vessel)

- Downed aircraft (helicopter)
- Drilling rig loss of integrity
- Vessel collisions
- Major weather and sea ice conditions
- Vessel strike with marine mammals
- Batch spills
- Subsea blowout

6.3. SCENARIO C: FIELD DEVELOPMENT AND PRODUCTION

6.3.1. Purpose of Field Development and Production

The purpose of field development and production is to extract and transport oil and gas to market. Once the presence and extent of oil or gas is determined using three dimensional (3D) marine seismic surveying and exploration drilling, the operator would make a business decision to develop the resource or not. Once all necessary licences are obtained, the operator would create a field development plan and proceed with field development and production drilling. A field development plan would include the:

- Number of development wells to be drilled to most efficiently extract the oil or gas or both;
- Recovery techniques to be used to extract the oil or gas;
- Type and cost of installations, both under the sea and on the surface; and
- Oil and gas separation systems if needed.

6.3.2. Description of Field Development and Production

Although there are several development options, this scenario assumes that the system would be similar to what has recently been used in Norway and would limit or avoid land-based production infrastructure in the Nunavut Settlement Area. Alternatively, it is assumed that Floating Production Storage and Offloading for oil production and Floating Liquid Natural Gas vessels would be used to process, store, and transfer extracted oil and gas to tankers for transport to an export destination.

Similar to Exploration Drilling (Scenario B), the program would require:

- an ice management program;
- a drilling waste management program;
- an air emissions management program;
- mitigation measures to reduce or prevent potential impacts;
- commitments; and
- regulatory conditions.

The process of development drilling would be similar to those described in Section 6.2.2. 'Description of Drilling'. Unlike exploration drilling, the direction of development drilling is not just straight up and down. There are more options to drill the oil and gas resources, such as drilling a horizontal or multi-drain well. Instead of anchoring a ship or platform in multiple points to drill multiple wells, it can stay in one (1) place and send wells horizontally off in different directions, all feeding from a central point and reducing the number of drilling locations needed.

Did you know?
The record at the time of this report for a horizontal well is at ExxonMobil's Sakhalin 1 project with an extended reach of 15,000 metres or 15 kilometres.

Additional activities unique to field development and production are:

- Multiple wells drilled into the resource;
- Equipment under the sea to collect and transfer oil or gas from the wells to the surface; and
- Transportation of the oil or gas from the offshore production facility by tankers to global markets.

All facilities on the seafloor and wells would be taken out and are put into a permanent safe state at the end of the project. Sometimes a field may be preserved and re-opened later to extract any left-over oil and gas.

6.3.3. Equipment and Infrastructure

The major components of an Arctic offshore drilling program in Baffin Bay and Davis Strait would be expected to include:

- Arctic class semi-submersible drilling platform and Floating Production, Storage and Offloading Vessel or Floating Liquid Natural Gas Vessel
- 1–2 icebreaker support vessels
- 2–3 supply vessels
- 1–5 fuel tankers
- 1–2 wareships, a permanently anchored vessel for offshore storage, if no deep-water port is available to: carry fuel, drilling materials and other supplies; store and ship waste products; provide maintenance and repair operations, and support helicopter, well control, and oil spill response operations
- Onshore storage facilities in coastal communities for emergency equipment such as oil spill response equipment and other emergency equipment

The support infrastructure for development and production is similar to that described for Exploration Drilling (Scenario B) and would consist of a permanent fleet of supply and support vessels, icebreakers as required, and aviation support. A supply and helicopter base could be located in Iqaluit. This scenario

assumes that any onshore infrastructure and services required on Baffin Island to support a drilling program would be located in Iqaluit, except for storage facilities for emergency response equipment, which could be located in other communities.

There are two (2)s different type of production and storage vessels that could be used:

A *Floating Production, Storage and Offloading* vessel is designed to lift, process, store, and offload oil and gas. These vessels are essentially tankers with added production and processing equipment and can be used in deeper waters. After processing, the produced oil and gas are stored until they can be offloaded to tankers.

Floating Liquefied Natural Gas vessels are offshore Liquefied Natural Gas facilities designed to enable the development of offshore natural gas resources. Both types of vessels are usually tied down and secured permanently at a specific location, can be used seasonal or year-round, and can be detached from their anchors in case of extreme weather conditions.

Figure 15: Schematic of Terra Nova (Source: Suncor)

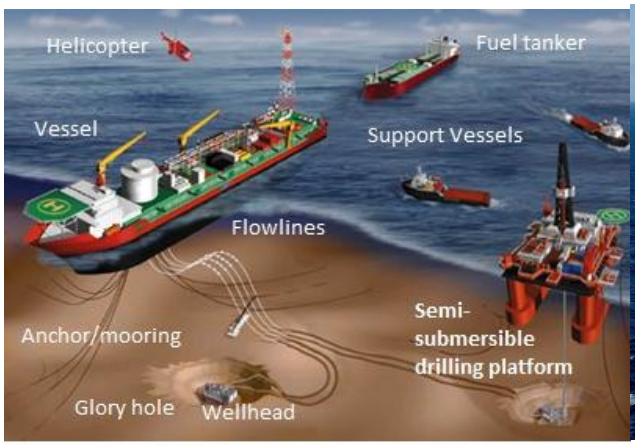


Figure 16: Terra Nova Floating Production, Storage and Offloading (Source: Suncor)

To give an indication of size, the following are details on the equipment and components used for the Terra Nova oil and gas development 350 kilometres southeast of Newfoundland in an area with sea ice and icebergs (Figures 16 and 17):

- Floating Production, Storage and Offloading vessel 300 metres long and 45 metres wide, approximately the size of three (3) football fields laid end to end, and 18 stories high;
- Storage capacity of 960,000 barrels of oil (45 gallons or about 160 litres);
- Accommodations for 120 people;
- Wells pre-drilled by a semi-submersible drilling unit;
- Depressions called glory holes were dug to protect the wellhead equipment from icebergs and pack ice;

- More than 40 kilometres of flexible flowlines were used to bring the oil and gas from the wellhead up to the vessel;
- Gas produced was re-injected into the resource to support oil production and for possible extraction; and
- Large shuttle tankers offloaded and transported produced oil.

There are currently six (6) Floating Liquid Natural Gas vessels in service around the world, with more in design or under construction. There are currently no Floating Liquid Natural Gas facilities in the Arctic, but research and technology are being developed to expand their use into harsh and cold environments. When it reaches the vessel, the gas is processed to separate it from liquids and natural gas that is changed into a liquid form (condensate). The processed gas is then treated and liquefied through freezing down to minus 160 degrees Celsius and stored in the hull of the vessel. Ocean going Liquid Natural Gas carriers off-load the liquid gas for delivery to terminals around the world. Some of the advantages and challenges of Floating Liquid Natural Gas vessels are identified in Table 12.

Table 12: Advantages and Disadvantages of Floating Liquid Natural Gas Vessels

Advantages of Floating Liquid Natural Gas Vessels	Challenges of Floating Liquid Natural Gas Vessels
▪ All processing done at sea with no need to lay long pipelines along the seafloor to connect to a shore base. ▪ Well suited for fields with high production rates and far from land. ▪ Quicker to build than a shore-based processing facility. ▪ Allows flexibility to move the vessel to a new location when the field is depleted. ▪ Can be more economic than other alternatives.	▪ The vessel would be much smaller than a shore-based processing facility but still need the same components. ▪ Wave action on the vessel would need to be reduced to avoid sloshing of the liquefied gas in a partially filled tank. ▪ Need to safely transfer the liquefied gas into a liquid natural gas tanker.

The Shell Prelude, shown in Figure 18, is an example of a new Floating Liquid Natural Gas vessel, which has been designed and built to stay anchored in harsh weather conditions and is over four (4) football fields in length and the largest of such vessels built.

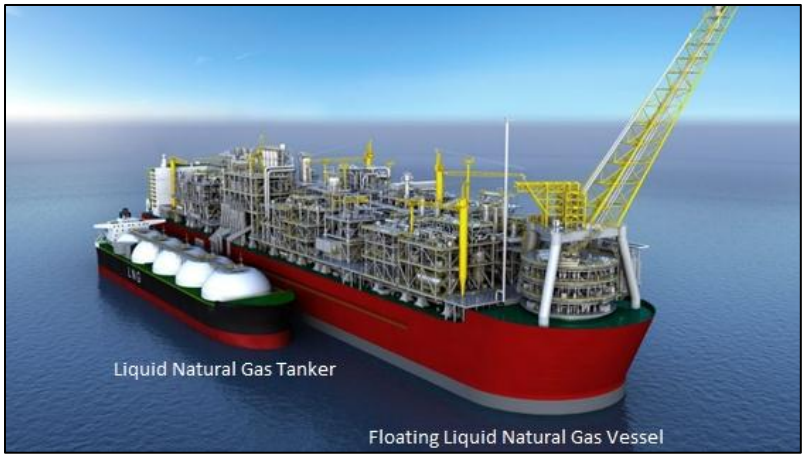


Figure 17: Shell Prelude Floating Liquid Natural Gas vessel and Liquid Natural Gas Tanker

6.3.4. Financial and Human Resources

Nunami Stantec noted that it would cost approximately USD $14 billion to conduct field development and production.

Offshore field development and production could employ skilled and unskilled workers including engineers, welders, electricians, cooks, support staff, health and safety specialists, environmental specialists, helicopter pilots, technicians, geologists, and healthcare staff. Local employment opportunities would likely include full-time positions as environmental monitors on board the drilling rig and support vessels to implement and monitor mitigation commitments. Onshore support (for example, supply base operations) could include, but are not limited to: flight support, providing supplies, medical services, consulting, legal support, human resources and administration staff, logistics and customs brokers, and catering.

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* –
Section 5: Routine Development and Production Activities
Section 9.3: Field Development and Production Drilling

6.3.5. Potential Accidents and malfunctions

The potential accidents and malfunctions associated with field development and production drilling include:

- Fire and explosions
- Loss of life (falling off the vessel)
- Downed aircraft (helicopter)
- Terrorist threats
- Drilling rig loss of integrity
- Vessel collisions (for example, with other vessels or icebergs)
- Major weather and sea ice conditions
- Vessel strike with marine mammals

- Batch spills
- Subsea blowout

6.4. SCENARIO D: NO OFFSHORE OIL AND GAS ACTIVITY

If through planning, consultation, and regulatory decision-making processes, it is decided that the Area of Focus is not an appropriate region for oil and gas activities, then oil and gas resources would remain undeveloped and activities associated with the exploration and development of these resources would not occur.

The following are summaries of additional information provided or requested in written public comments on the *Oil and Gas Hypothetical Scenarios Report:*

Topic	Commenter
Management of sea ice movement	Environment and Climate Change Canada Fisheries and Oceans Canada and the Canadian Coast Guard
Potential effects of climate change on multi-year ice.	Environment and Climate Change Canada Government of Nunavut Fisheries and Oceans Canada
History of oil and gas activities in the Baffin Bay and Davis Strait.	National Energy Board
Alternatives to oil and gas development as well as renewable energy options.	World Wildlife Fund Canada Peter Croal
Potential oil and natural gas discoveries and factors to consider for potential development, including financial feasibility, infrastructure, and challenges.	Canadian Association of Petroleum Producers Greenpeace Canada World Wildlife Fund Canada Government of Nunavut
Additional information and alternative technologies to seismic surveying using air guns.	World Wildlife Fund Canada Government of Nunavut Fisheries and Oceans Canada and the Canadian Coast Guard Natural Resources Canada
Types of oil and gas activities, specifically drilling.	National Energy Board
Sound movement through water and under ice and sound levels from seismic surveys and ships.	World Wildlife Fund Fisheries and Oceans Canada and the Canadian Coast Guard

Consider pipelines connecting a well and the shore and also a processing plant on land.	Government of Nunavut

6.5. ACCIDENTS AND MALFUNCTIONS

Non-routine events, also called accidents and malfunctions, were discussed in the *Oil and Gas Life Cycle Activities and Hypothetical Scenarios* Report and include:

- uncontrolled release of oil and gas
- fire and explosions
- loss of life
- medical evacuations
- downed aircraft
- terrorist threats
- impacts to drilling platforms
- vessel collisions
- major weather and sea
- ice conditions

Proponents would be required to evaluate the potential risks of all proposed activities and have response plans in place for all potential accidents. Effectiveness of response measures for the Area of Focus would depend on multiple factors such as environmental conditions, technology, infrastructure, and capacity. Nunami Stantec recommended that spill response planning consider the variables unique to the region, such as environment, cultural values, local infrastructure, current technology and best practices, and capacity.

A worst case scenario refers to the worst possible type of accident with the most negative effects that could potentially occur associated with a development, used for planning and preparing for required responses and prevention. Nunami Stantec developed a worst case scenario for an oil or gas spill from an offshore well and described general response methods.

6.5.1. Types and Likelihood of Spills

The two (2) types of spills identified were:

- *Batch spill*: A spill of small volume (a few litres) that often happens quickly and does not last for a long time. Batch spills can happen during routine use, storage, and transfer of the rig, production platform, or supply vessels and can include: diesel oil, hydraulic and lubricating fluids, synthetic or water-based drilling fluids, chemicals, and cleaning agents.
- *Blowouts*: A continuous spill of large volumes of crude oil into the ocean and associated gas into the atmosphere that can last for hours, days, or weeks if not controlled. Potential blowouts can

occur above or under the water, including at the wellhead and points along the pipe and drill string.

While medium or large oil spills or blowouts are unlikely to occur given the types of safeguards used in modern oil and gas exploration and development, the effects of oil spills on the environment would be extremely adverse. There have been two (2) blowout events rated as extremely large (greater than 150,000 barrels): Gulf of Mexico in 1979 (3 million barrels) and Deep Water Horizon in 2010 (4 million barrels). The probability of a blowout varies depending on many factors, including: characteristics of the well; well pressure; water depth; operating conditions (for example, weather); and whether the whether it is an exploration, appraisal, or development well.

6.5.2. Worst Case Scenario

A proponent would be required to submit a worst case scenario to the National Energy Board as part of the regulatory process. A worst case scenario would represent an accurate and realistic situation and would be based on numerous considerations, including:

- known characteristics of the type of oil or gas resource;
- environmental information (including currents, waves, sea level, and meteorological information);
- drilling location and information on the characteristics of the drill hole;
- possible locations of a spill; and
- potential paths of uncontrolled flow of oil or gas (including below the water surface, on the water surface, into the atmosphere, and on land).

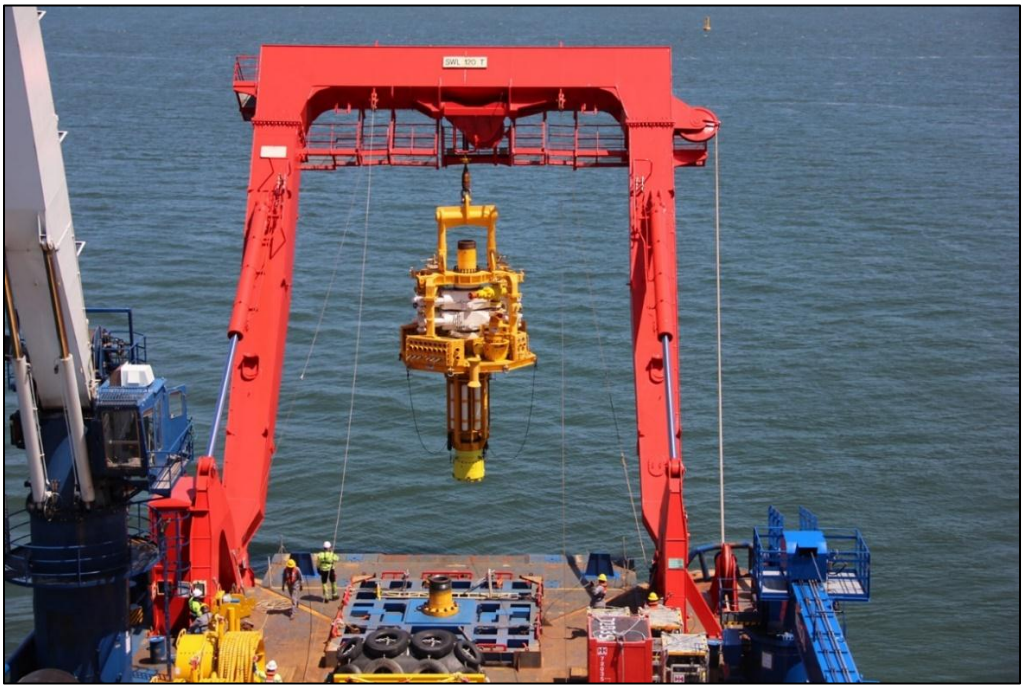
6.5.3. Measures to Regain Well Control

Measures to stop a blowout include:

- Drilling a well, called a relief well, above where the oil or gas is spilling out in the damaged well and adding heavy drilling fluids to stop the flow.
    - The National Energy Board has a Same Season Relief Well policy that requires a company to drill a relief well in the same season of the spill unless they can identify an alternative. This is intended to reduce the risk that a blowout would continue in the winter months.
    - Surface intervention equipment and responses to address the uncontrolled flow of oil or gas above the seafloor, including the use of differently weighted drilling fluids or a secondary blowout prevention barrier, also called a capping stack. If required, a capping stack can be brought to a site and installed within a few weeks (Figure 19). A potential timeline for securing a well could be:

- 1-2 days to assess the damage using a remote operated vehicle;
- Up to 7 days to pump in sea-water to the well and plug with cement (if required);
- 14-21 days move and deploy a capping stack from; and
- Possibly filling the drilled hole (wellbore) with heavy fluid (final well kill) after the oil or gas flow has stopped and the well has been secured.

Figure 18: Deploying a Capping Stack onto the Blowout Preventer on the Seafloor (Credit: Oil Spill Response Limited)



6.5.4. Oil Spill Behaviour

If there is an oil spill from an underground resource through a well, the majority of the oil (and accompanying gas) would rise to the surface. Natural gas would rise into the air, and the oil would be spread onto the water surface. Due to wind and currents, the oil on the surface would naturally disperse over a larger area; over time, some oil droplets would evaporate into the air, and some would eventually mix with water (emulsify). Over the longer term, some components of the surface oil could be combined with oxygen in the air (oxidized) by sunlight, while others could break down (dissolve) in the seawater. Oil on the surface could also be broken down (biodegraded) with the help of microbes in the water. The remainder of the oil that does not make it to the surface could be transported long distances by underwater currents. Over time (potentially decades or longer), some would be broken down by bacteria or other living organisms (biodegrade), and some would dissolve into the water.

Nunami Stantec noted within its report that over the duration of a subsea blowout, 40-50 percent of the oil droplets released would typically evaporate and that over time there would be less oil between the water's surface and the seafloor. The maximum amount of oil on the water surface in the form of a slick would be approximately 15-20 percent of the oil released and a small amount of oil would continually move between the water surface and the upper part of the water column due to winds and waves.

Modeling how oil or gas would react if there was a spill is an important tool when developing an oil spill contingency plan for a specific project. The challenge with running such models for the SEA is that it requires site-specific data and historical data on weather and sea conditions. This data is unavailable given the limited drilling in the region, and there are few examples of wells to use as a basis for predicting the properties of oil and gas from the study region. Nunami Stantec assumed, based on information known, that an oil spill in the region would result in surface and subsurface oil moving south by the Baffin Island and Labrador currents. An oil spill could also potentially get caught in the northward moving West Greenland, North Atlantic, and Hudson Strait currents. The resulting slick would undergo spreading, evaporation and dispersion in the water column.

6.5.5. Offshore Oil Spill Response

The effectiveness of oil spill response measures and ability to reduce damage to the environment would depend on multiple factors, including:

- Exposure
- Seasonal and environmental conditions
- Oceanographic conditions such as currents, water temperature, extent and type of ice cover
- Distance between a spill and the shoreline
- Vulnerability of shorelines to spills and likelihood shoreline would be exposed to oil
- Shoreline types
- Biological communities supported by shorelines
- Use of these areas by traditional harvesters, communities, and others.

Response to oil spills in an Arctic environment introduces additional operational and logistical challenges to be considered, including the remote location, limited available infrastructure, and environmental variables such as limited daylight hours in winter, extreme cold, sea ice, and icebergs. Recent research has focused on methods and technologies for effectively responding to oil spills in the Arctic environment.

Table 13 describes some of the tools available for oil spill response. Used in combination and depending on the environment and the circumstance of the spill, these methods have been demonstrated to be

effective in open water and coastal environments. Where sea ice is present, some techniques may be more effective than others.

Table 13: Table of Common Technologies and Responses to Oil Spills

Response Type	Details
Mechanical Containment and Recovery: Oil is contained by a boom and a device called a skimmer is used to remove the oil.  Figure 19: Boom and Ocean Skimmer (Source: SL Ross)	Limitations to effectively use equipment in areas where waves would be over 1 metre. Performance of containment and recovery is typically low.
Controlled In-Situ Burning: Spilled oil is burned.  Figure 20: Controlled In-Situ Burning (Source: SL Ross)	Effective method of removing oil from the environment based on large Arctic ice trials and actual oil spills from tanker accidents. Generally accepted as an effective way of removing oil from the environment. In practice trials 60–80 percent of spilled oil removed with some trials in Norway achieving 95 percent removal.
Oil Spill Dispersants: Products quickly break up oil slicks on the surface and transfer oil below the surface using the mixing energy of waves.	Dilution of oil reduces the toxicity level. Baffin Bay/Davis Strait likely contain oil-consuming bacteria due to the natural seeps in the area. Could take decades to break down. While potential contact with seabirds and shoreline is lessened, potential contact with fish and marine mammals is increased. Could stay in the water column for decades.

Shoreline response: Details how a spill that reached the shore would be addressed and typically includes the removal and treatment of oil.	Would incorporate traditional knowledge and current resource harvesting practices. Guides to cleanup include The Field Guide to Oil Spill Response on Marine Shorelines by Environment and Climate Change Canada.
Tracking and Surveillance: An oil spill response strategy would include detecting, monitoring, and tracking oil on water and in ice conditions.	Airborne remote sensing technologies, in addition to visual observations collected by trained observers, is considered the most effective way to identify the presence of oil on water and in some situations to detect oil among ice. Additional research is ongoing to evaluate and test next new technologies that could be used. As part of Transport Canada and Fisheries and Oceans Canada response organizations, the federal government's Marine Aerial Reconnaissance Team for the Arctic, based in Ottawa and Iqaluit, owns an airplane equipped with the latest state-of-the-art surveillance equipment.

Oil Spill Response Regime: In the 1980s, the oil and gas industry developed a three-level model to describe an escalating magnitude of spill response capability:

Tier One: Small spills that occur at or near a vessel and the operator is expected to respond using their own onboard resources.

Tier Two: Medium sized spills where responders in addition to the operator could be involved. A response organization could provide equipment, vessels, storage, and locally trained spill response teams.

Tier Three: Large sized spill that could potentially have major environmental or socio-economic effects and would require substantial resources to clean up. Response resources might be provided by many national and international oil spill response organizations, equipment manufacturers and suppliers, and third-party providers (e.g., logistics and aviation companies).

Want more detail?
Look at Report: *Oil and Gas Hypothetical Scenarios* – Section 10: Non-Routine Aspects of Oil and Gas Exploration and Development

The following are summaries of additional information provided or requested in written public comments on the *Oil and Gas Hypothetical Scenarios Report:*

Topic	Commenter
• Responsibilities and regulations for spill prevention and response • Infrastructure	Transport Canada Greenpeace Canada World Wildlife Fund National Energy Board
• Spill predictions • Methods of response to large spills • Effectiveness of response options • Same Season Relief Well • Risk and significance of potential effects (such as spill in ice covered water, impacts to shoreline) • Lessons learned from past spills • Likelihood of spills	Greenpeace Canada World Wildlife Fund Environment and Climate Change Canada Fisheries and Oceans Canada and the Canadian Coast Guard National Energy Board
While large scale events are unlikely, oil and gas activities have frequent small scale unplanned discharges.	World Wildlife Fund Fisheries and Oceans Canada and the Canadian Coast Guard
Clarified considerations for ice breaking by the Canadian Coast Guard.	Fisheries and Oceans Canada and the Canadian Coast Guard

7. ANALYSIS OF POTENTIAL EFFECTS AND OTHER FACTORS

The activities associated with each of the oil and gas scenarios described above have the potential to interact with valued components of the environment. Where an interaction occurs, an impact from an activity could result in an effect on a component of the environment. Potential impacts and effects were assessed from three (3) perspectives:

- *Local* – potential effect would be restricted to the footprint of the activity;
- *Regional* – potential effect would extend outside of the footprint of the activity (for example, within the Area of Focus and/or the Nunavut Settlement Area); and
- *Transboundary* – potential effect would extend beyond Federal waters associated with the Area of Focus to the Nunavut Settlement Area, to other provinces or territories, or to other countries (for example, Greenland).

Based on experience with offshore oil and gas activities elsewhere this section presents information on the potential effects, including: size, area, when and how often an effect could occur, and the length of time an effect could last. This information is primarily from the Nunami Stantec *Environmental Setting and Review of Potential Effects of Oil and Gas Activities* Report. Nunami Stantec reviewed studies done in similar environments and using comparable technologies to make a reasonable judgement of possible effects in Baffin Bay and Davis Strait. Any reference to potential effects based on Inuit Qaujimajatuqangit are founded on the work by QIA Sanammanga Solutions Inc. The QIA will prepare an effects analysis report using the Inuit Qaujimajatuqangit shared, which will be made available to the NIRB later in the fall.

The possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait that were assessed for potential impacts and effects included the following:

- Use of seismic surveys to explore for oil and gas in the seafloor (Scenario A).
- Use of drills to explore for oil and gas in the seafloor (Scenario B).
- Construction and operation of offshore facilities to pump and transfer oil and gas from identified oil fields in the seafloor (Scenario B).

In addition, a fourth scenario, where no oil and gas development activities occur in future in Baffin Bay and Davis Strait (Scenario D), was also assessed. In this case, it was concluded that there would be no effects to the physical, biological, or human environments from oil and gas development; however, impacts to the physical environment in Baffin Bay and Davis Strait may still occur from other activities such as marine shipping and marine-based tourism, and from climate change. The fourth scenario, in effect, becomes the base condition against which the other three (3) scenarios could be compared. Detailed information about the level of potential effects to the physical environment from oil and gas development in Baffin Bay and Davis Strait is presented below. This information is based on existing state of knowledge. Table 14 summarizes the seasonality of activities according to the six (6) Inuit calendar seasons.

Table 14. Activities according to season

Seasons	Offshore Seismic Surveys	Exploration Drilling	Field Development and Production
Ukiuq (winter)		X[9]	X
Upirngasaaq (early spring)		X	X
Upirngaaq (late spring)		X	X
Aujaq (summer)	X	X	X
Ukiassaaq (early fall)	X	X	X
Ukiaq (fall, early winter)		X	X
Table developed by the QIA and the NIRB using information shared in the *Qikiqtaaluk Inuit Qaujimajatuqangit and Inuit Qaujimaningit for the Baffin Bay and Davis Strait Marine Environment* Report, and the *Oil and Gas Life Cycle Activities and Hypothetical Scenarios* Report			

[9] Exploration drilling would likely be conducted in a 1-2 month period from August to October when there is open water (however, drilling could be conducted year-round).

7.1. PHYSICAL ENVIRONMENT

As part of the SEA, potential impacts were assessed to gain a better understanding of the nature of the potential effects to the environment. The selection of components of the physical environment was informed by public engagement and community scoping meetings conducted by the NIRB in potentially interested communities in the Qikiqtani region in 2017 (see Appendix A for a summarized list of community comments; full list is available on the NIRB website in the follow-up reports to each public engagement session).

Additional information on each of the possible scenarios for oil and gas development in Baffin Bay and Davis Strait is provided in Section 6 of this Report.

Impact: Negative or positive influence from an activity on the environment. *For example, seismic surveying produces noise*.

Effect: A change to a valued component of the environment from an activity. *For example, noise from seismic surveying could lead to a change in a whale's behaviour.*

Mitigation: A plan or an action taken to avoid or reduce a negative effect. *For example, the gradual increase in sound for seismic surveys.*

7.1.1. Potential Impacts and Effects

Based on the assessment of the possible scenarios, it was noted that activities associated with scenarios may cause the following impacts:

- Air emissions from marine-based oil and gas exploration, drilling, production and transport activities;
- Noise from seismic surveys, marine shipping, and drilling activities;
- Discharge of liquids (such as wastewater) to the marine environment from routine oil and gas operations;
- Waste and mud from drilling activities; and
- Changes to ice conditions by icebreaking vessels and facilities and equipment used for drilling operations.

A summary of potential impacts on marine water, the seafloor, sea ice, noise levels, and air quality, as identified in the study is presented in Table 15. As noted in Table 15, activities associated with scenarios A, B, and C of oil and gas development, may result in impacts such as air emissions, noise, discharge of liquids (such as wastewater), release of mud from drilling activities, and ice disturbance. Of these, air emissions and changes in ice conditions may extend beyond the Development Scenario Area (Figure 2). These impacts may affect some components of the physical environment including air quality and gases that contribute to the warming of the Earth (greenhouse gases); marine water quality; sea ice and iceberg conditions; noise levels; and marine sediment quality. Based on the study, it is predicted that activities associated with the possible oil and gas development scenarios would not impact climate and meteorology; geology; or coastal landforms. As such, the remainder of the discussion focuses on

components of the physical environment that may be impacted by activities associated with the possible oil and gas development scenarios.

Table 15: Summary of Potential Impacts on the Physical Environment

Components of the Physical Environment	Potential Environmental Impacts				
	Air Emissions	Noise	Routine Discharge	Waste and Mud from Drilling	Ice Disturbance
Climate and Meteorology					
Air Quality and Greenhouse Gases	✓				
Marine Water Quality			✓		
Sea Ice and Iceberg Conditions					✓
Noise Levels		✓			
Geology					
Coastal Landforms					
Marine Sediment Quality				✓	
NOTES: "✓" = Indicates potential effect from oil and gas activities for all development scenarios.					

Air Quality and Greenhouse Gases

Activities associated with scenarios A, B, and C may release gases and particles like dust into the air and result in changes to air quality. In addition, some of the gases released into the air may be greenhouse gases (which are gases that contribute to the warming of the Earth and to climate change – a condition referred to as global warming).

Specifically, activities associated with marine-based oil and gas development, such as the use of diesel fuel and natural gas to operate exploration and production drills; marine vessels for oil and gas exploration, production and transport; air craft (helicopters) to transport site personnel and equipment; flare stacks to burn off waste or excess gas; and the installation and operation of other marine-based oil and gas facilities, including underwater installations (for example, oil wells and oil transport pipelines) and power generators, as described in the possible scenarios for marine-based oil and gas development (see Section 6 of this Report), would result in the release of gases and particles into the air, including the following:

- Gases containing nitrogen, oxygen, sulphur, carbon, and hydrogen which may change the quality of the air;

- Solids similar in size to dust particles which may change the quality of the air; and
- Greenhouse gases, which may contribute to global warming and climate change.

The possible changes to air quality from the release of gases and dust-like particles from marine-based oil and gas development may also impact human health, and components of the marine environment such as ice conditions, fish and marine mammals.

Based on an assessment of the possible oil and gas development scenarios in Baffin Bay and Davis Strait, the air quality after the release of any gases and dust-like particles into the air may approach natural conditions within 5 to 10 kilometres (3 to 6 miles) from sites where the substances are released into the air. It was also predicted that there would be a rapid recovery of air quality to natural conditions once activities associated with any of the oil and gas development scenarios are completed. Overall, the predicted changes to air quality from possible marine-based oil and gas activities in Baffin Bay and Davis Strait were not expected to exceed the Nunavut air quality standards at any locations on land.

Noise Levels

During its Public Engagement Sessions, the NIRB heard questions about noise produced by offshore oil and gas activities, particularly from seismic surveys. Questions were primarily centred around the potential for negative effects to marine wildlife, particularly marine mammals and fish.

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may increase airborne and underwater noise levels in and around the site of such activities. The main sources of noise from marine-based oil and gas development were identified as: seismic exploration; drilling activities; and vessels used to transport products, personnel, and equipment or undertake ice-breaking activities.

Airborne (atmospheric) noise from vessels used for seismic exploration surveys and drilling support and from aerial support (helicopters) used for crew transfer to and from seismic vessels and drilling platforms are expected to be localized and to approach background levels within 1 to 10 kilometres (0.6 to 6 miles) from the source of the noise. Based on an assessment of similar marine-based activities in other parts of the Arctic (Beaufort Sea), airborne noise from possible activities associated with marine-based oil and gas development in Baffin Bay and Davis Strait, such as sea bottom trenching, could reach background noise levels at 1-5 kilometres (0.6 to 3 miles) from the location of the activities generating the noise. Also, underwater noise generated by several activities associated with marine-based oil and gas development in ice or frozen sea ice conditions may approach background noise levels about 7.5 kilometres (4.7 miles) from the source of the noise. However, underwater noise from marine vessels may be detected up to 30 kilometres (18.5 miles) from vessels.

Inuit Qaujimajatuqangit research conducted for QIA identifies numerous examples of changes in marine animal behaviour in response to noise. Specific examples given by Inuit include needing to be quiet on the ice so as not to disturb wildlife. This suggests that sound travels through ice for some distance as well.

Marine Water Quality

During the Public Engagement Sessions, the NIRB heard concerns about the potential for negative effects from ship ballast water on water quality and the potential for invasive species.

Nunami Stantec noted that routine liquid and solid discharges associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait, such as marine-based or offshore drilling, may impact the water quality in the marine environment at the site of the oil and gas activities.

Routine liquid and solid discharges from marine-based oil and gas development activities that may impact marine water quality include the following:

- Sewage, grey water (for example, laundry and kitchen wastewater), cooling water, and deck drainage water from marine vessels and other support facilities;
- Wastewater that collects inside the hull of a ship (bilge water) and water carried in special tanks in a ship to improve stability and balance of the vessel (ballast water); and
- Drill muds, cement, oil, fluids, and other chemicals from drilling equipment.

Routine discharges of sewage, grey water, and other waste liquids from vessels and drilling equipment associated with marine-based oil and gas development activities may increase nutrient levels in marine water near the point of discharge (called organic enrichment). These discharges, particularly those containing oils, may also impact marine water quality by forming a sheen on the water surface near the points of discharge.

Based on an assessment of similar marine-based oil and gas development activities in other marine regions in Canada, including the Grand Banks of Newfoundland, Nunami Stantec predicted that there would be no change in water quality from seismic surveys. It was also predicted that routine liquid discharges from exploration and production drilling as well as project vessels could result in a change in water quality. Any change in marine water quality from routine liquid discharges associated with possible oil and gas development activities in Baffin Bay and Davis Strait would be limited to the immediate area of the discharge. Also, potential effects to marine water quality from routine liquid discharges were expected to be minimal due to dilution of contaminants with water in the surrounding sea, the breakdown of some of the chemicals in water, and evaporation of some of the discharged chemicals. The potential effects to water quality from routine liquid discharges from oil and gas activities, such as exploration drilling, were expected to be low, of medium duration (weeks to months beyond the duration of the activities) and confined to the immediate area of the point of discharge. The effects on water quality from routine discharges associated with production drilling were predicted to be low, of medium duration,

limited to 10 kilometres from the point of discharge, and reversible once activities cease. However, concerns were identified that chemicals associated with routine liquid discharges under ice may accumulate over time because degradation and evaporation processes are slower in ice conditions than in open water conditions.

Marine Sediment Quality

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may change marine sediment quality in and around the site of such activities.

As there would be no contact with the seafloor, exploration with offshore seismic surveys would not result in changes in sediment quality. There could be a change in sediment quality during exploration drilling and development drilling. Specifically, seafloor drilling activities associated with marine-based oil and gas exploration and production generate large amount of drilling waste made up of rocks, muds mixed with water, and muds mixed with drilling fluids, which are usually placed on the seafloor near the drilling equipment during oil and gas development. These drill muds and rocks may impact marine sediment quality by changing the physical nature and the types of chemicals in the marine sediment from natural conditions.

Based on an assessment of similar oil and gas drilling activities in other marine regions in Canada, Nunami Stantec expected that potential effects to marine sediment quality from oil and gas development activities would be low and localized to the immediate area of the drilling activities (within less than 10 kilometres (6 miles) from drilling sites). The duration of the impacts to marine sediment quality was expected to be medium to long term (weeks to months; in some cases, years beyond the duration of the activity). Therefore, the impacts to marine sediment quality were predicted to be reversible, and sediment quality in affected marine areas are expected to approach natural sediment quality conditions in weeks to months, and possibly months to years, after the drilling activities have ceased.

Sea Ice and Iceberg Conditions

During the Public Engagement Sessions, the NIRB heard comments, questions, and concerns from community members about the potential for offshore oil and gas activities to negatively affect sea ice.

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may result in changes to sea ice conditions. Specifically, the use of icebreakers (marine vessels capable of travelling through sea ice) to support oil and gas exploration surveys and to protect marine-based oil and gas development facilities from sea ice may result in changes to the quality (for example, thickness) and the extent or size of sea ice.

However, it was predicted that the area of sea ice that might be impacted or disturbed by icebreakers would be small compared to the total area of sea ice in Baffin Bay and Davis Strait. Also, areas of disturbed ice would be expected to refreeze during the winter months after the icebreaking activities cease. In

addition, it was predicted that the physical disturbances associated with oil and gas development activities may not change the natural course of iceberg development or movement in Baffin Bay and Davis Strait.

Climate Change

Many comments and concerns regarding climate change were raised during the NIRB's Public Engagement Sessions and the importance of considering climate change in the SEA was emphasized. Through public feedback, climate change was added as a separate component to assess within the SEA.

Nunami Stantec predicted that future changes to weather conditions and climate (climate change) could have effects on the physical environment, including:

Water Quality: Any changes to natural ocean conditions from climate change were not expected to change predictions made about potential effects to water quality from routine discharges associated with marine-based oil and gas development in Baffin Bay and Davis Strait.

Marine Sediment Quality: Effects to marine sediment from climate change were not expected to change predictions made about potential effects to water quality from routine discharges associated with marine-based oil and gas development in Baffin Bay and Davis Strait. Climate change may lead to a longer open water season, more marine-based oil and gas activities, and effects happening more often (for example disposal of drilling waste on the seafloor). However, the potential effects to marine sediment were predicted to be low and limited to the immediate area near the activities.

7.1.2. Cumulative Effects

During the Public Engagement Sessions, community members noted concerns and asked questions to the NIRB about the potential for offshore oil and gas activities, particularly the use of vessels, to interact with other activities to have a negative effect on the environment. Concerns about general increases in shipping, particularly if warming trends continue and the length of the open water period increases, were also expressed.

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may interact with past, present, and future projects and activities in the region to cause impacts (also called cumulative impacts) that will result in a physical effect to the physical environment. A summary of potential cumulative effects to the physical environment that may occur in Baffin Bay and Davis Strait from activities associated with marine-based oil and gas development in Baffin Bay and Davis Strait and other past, present, and future activities in the region is presented in Table 16. As noted in Table 14, impacts from activities associated the possible scenarios of oil and gas development may interact with impacts from past, present, and future activities (such as commercial shipping, tourism, and other marine-based activities) to cause cumulative effects to the physical environment in Baffin Bay and Davis Strait. The check marks (✓) in Table 14 indicate interactions between a project or an activity (for example, commercial shipping) and a component of the physical environment (for example, air quality).

Table 16: Summary of Potential Cumulative Effects on the Physical Environment

Other Projects and Physical Activities with Potential for Cumulative Impacts	Potential Cumulative Effects					
	Air Quality	Greenhouse Gas Emissions	Change in Sea Ice Quality and Extent	Change in Noise Levels	Change in Water Quality	Change in Sediment Quality
Past and Present Physical Activities and Resource Use						
Mining—Baffinland Mary River Mine (marine transportation)	✓	✓	✓	✓		
Commercial Shipping	✓	✓	✓	✓		
Commercial Fishing	✓	✓		✓		
Tourism (cruise ships)	✓	✓		✓		
Research (Military, Academic)	✓	✓	✓	✓		
Traditional Use and Practices, Traditional Harvest, Traditional Foods	X	X		✓		
Oil and Gas—Greenland	✓	✓	✓	✓	✓	✓
Oil and Gas—Atlantic Canada	✓	✓	✓	✓	✓	✓
Future Physical Activities						
Mining (marine transportation)	✓	✓	✓	✓		
Deepwater Port (Iqaluit)	✓	✓		✓		
Commercial Shipping	✓	✓	✓	✓		
Commercial Fishing	✓	✓		✓		
Tourism (cruise ships)	✓	✓	✓	✓		
Research (Military, Academic)	✓	✓	✓	✓		
Traditional Use and Practices, Traditional Harvest, Traditional Foods	X	X		✓		
Oil and Gas—Greenland	✓	✓	✓	✓	✓	✓
Oil and Gas—Atlantic Canada	✓	✓	✓	✓	✓	✓
Oil and Gas – Baffin Bay and Davis Strait	✓	✓	✓	✓	✓	✓

Other Projects and Physical Activities with Potential for Cumulative Impacts	Potential Cumulative Effects					
	Air Quality	Greenhouse Gas Emissions	Change in Sea Ice Quality and Extent	Change in Noise Levels	Change in Water Quality	Change in Sediment Quality
NOTE: ✓ = those "projects and physical activities" whose effects are likely to interact cumulatively with effects associated with oil and gas activities in Baffin Bay and Davis Strait. X = 'Air Quality' and 'Greenhouse Gas Emissions' checked off by the NIRB and the QIA for Traditional Use and Practices; Traditional Harvest, and Traditional Foods due to the use of boats with outboard motors for associated activities.						

As discussed in Section 7.1.1 of this Report (Potential Effects), the potential effects to the physical environment from activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait would be expected to be localized around the source of impacts. Also, the potential effects to the physical environment from oil and gas development would be expected to lessen or return to natural or background conditions within a small area from the source of impacts. Therefore, it is generally not expected that the effects to the physical environment from the possible oil and gas activities included in the Oil and Gas Scenarios would interact with other activities to cause cumulative effects. However, there is the potential for greenhouse gas emissions (gases that contribute to the warming of the Earth) and underwater noise from the oil and gas activities to contribute to cumulative impacts.

7.1.3. Transboundary Effects

During its Public Engagement Sessions, the NIRB heard questions about the potential for negative effects from offshore oil and gas activities in Canadian waters to marine areas under Greenlandic jurisdiction, as well as effects to Canadian waters from oil and gas development in Greenland's marine waters.

Activities associated with the possible scenarios may result in long-range transport of pollutants in air emissions from Canadian federal waters to the Nunavut Settlement Area, to other provinces or territories, or to other countries. These types of impacts are called transboundary impacts.

The potential for transboundary effects to the physical environment from oil and gas development in Baffin and Davis Strait was expected to be limited to potential changes to air quality. As the prevailing winds in Baffin Bay and Davis Strait are mostly from the North and Northwest, Nunami Stantec predicted that the likelihood of movement of large quantities of air contaminants from oil and gas activities in the region to outside the Area of Focus to other provinces, territories, or countries is low. However, the

probability of transboundary effects to air quality would increase if oil and gas activities are located close to the border on federal waters.

7.1.4. Accidents and Malfunctions

One of the predominant concerns the NIRB heard from community members in the potentially interested communities was about the potential effects from an oil spill.

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may result in accidents and malfunctions, including the following:

- Fires and explosions;
- Accidents involving aircraft (helicopter);
- Marine vessel collisions; and
- Oil and gas exploration and production equipment failure.

These accidents and malfunctions may result in oil spills or release of other chemicals that may impact the physical environment. Oil spills and accidental release of other chemicals could impact marine water and sediment quality. An oil spill on sea ice may change ice conditions by reducing the ability of sea ice to reflect sunlight, which could increase the rate of melting of sea ice. In addition, a major oil spill may impact coastlines in the region. The level of impacts to the physical environment from the accidental release of oils would largely depend on physical conditions in the marine environment, the duration of the spill, the oil type, and the methods used to contain and treat the oil spill. Also, an accidental release of natural gas (a gas associated with oil) into the marine environment could form ice-like solids which may settle on the seafloor and impact marine sediment quality.

7.1.5. Mitigation Measures and Planning Considerations

Mitigation plans or actions are recommended to avoid or reduce the negative effects to the physical environment from activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait. Many of the mitigation measures are standard to oil and gas development and are part of the usual design of potential projects. The potential effects identified above are what would remain after standard mitigation measures have been applied. Specific measures and commitments by a proponent to decrease potential effects of activities and components would be determined during a project level environmental assessment.

Want more details?
Look at Report: *Environmental Setting and Potential Effects* – Appendix C: Mitigations and Planning Considerations

Specific mitigation measures recommended for potential impacts to air quality and greenhouse gas levels are listed below:

- Use best available technology for fuel combustion and gas emission controls;
- Use high quality fuels (for example, low sulphur fuel) for operation of equipment;
- Reduce marine vessel and aircraft (helicopter) traffic through planning;
- Monitor and reduce the number of gas flaring events;
- Maintenance, inspections, and efficient operation of equipment;
- Follow guidelines and regulations established by Nunavut and Canada for oil and gas activities; and
- Follow applicable international guidelines for oil and gas and marine-based activities (for example, the International Convention for the Prevention of Pollution from Ships).

Specific plans or actions recommended for potential negative effects to marine water and sediment quality include the following:

- Treat discharges and wastewater before released to the environment in accordance with applicable Nunavut, federal, and international regulations and standards;
- Marine vessels used for oil and gas activities should carry out ballast water exchanges before arriving in Canadian waters;
- Appropriate handling, storage, transport, and disposal of solid and hazardous waste at approved facilities;
- Treat all drill muds and fluids to meet applicable standards before discharged to the marine environment or disposal in an approved facility; and
- Dispose of any excess cement from oil well construction in an approved facility.

Want more detail?
Look at Report: *Environmental Setting and Potential Effects* – Section 7.1: Potential Effects Physical Environment

The following are summaries of additional information provided or requested in written comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
Consideration of effects of climate change and sea ice on sound waves	Fisheries and Oceans Canada and the Canadian Coast Guard
Additional consideration of potential cumulative effects of multiple oil and gas activities taking place at the same time as well as other actions (such as research and monitoring).	Peter Croal Crown-Indigenous Relations and Northern Affairs Canada World Wildlife Fund Government of Nunavut Parks Canada

	Environment and Climate Change Canada
Potential cumulative effects on water and sediment quality	Fisheries and Oceans Canada and the Canadian Coast Guard
Potential amounts of greenhouse gas produced by oil and gas activities.	World Wildlife Fund Canada
Multi-year ice	Environment and Climate Change Canada

7.2. BIOLOGICAL ENVIRONMENT

As part of the study, potential impacts to components of the biological environment that are considered important to the region (for example, fish and fish habitat, waterbirds, and marine mammals) were assessed to gain a better understanding of the nature of these potential impacts and effects on the environment. The selection of components of the biological environment was informed by public engagement and community scoping meetings conducted by the NIRB in potentially interested communities in the Qikiqtani region in 2017 (see Appendix A for a summarized list of community comments; full list is available on the NIRB website in the follow-up reports to each public engagement session).

Additional information on each of the possible scenarios for oil and gas development in Baffin Bay and Davis Strait is provided in Section 6 of this Report.

7.2.1. Potential Impacts and Effects

Based on the assessment of the possible scenarios, it was noted that activities associated with the scenarios may cause the following impacts to components of the biological environment that are considered important to the region (such as fish and fish habitat, waterbirds, and marine mammals):

- Noise from seismic surveys, marine shipping, and drilling.
- Air emissions from marine-based oil and gas exploration, drilling, production and transport activities.
- Discharge of liquids (including wastewater) to the marine environment from routine oil and gas operations such as marine transport.
- Waste and mud from drilling activities.

Impact: Negative or positive influence from an activity on the environment. *For example, seismic surveying produces noise*.

Effect: A change to a valued component of the environment from an activity. *For example, noise from seismic surveying could lead to a change in a whale's behaviour.*

Mitigation: A plan or an action taken to avoid or reduce a negative effect. *For example, the gradual increase in sound for seismic surveys.*

- Changes to the habitat for marine wildlife from icebreaking vessel and marine-based facilities for oil and gas production, including equipment used for drilling operations.
- Contact or direct disturbance / interference especially with migratory path.

A summary of potential impacts of activities associated with the possible oil and gas development scenarios in Baffin Bay and Davis Strait to small living organisms in marine water (plankton), sea bottom-dwelling living organisms (benthic flora and fauna), fish and fish habitat, waterbirds, marine mammals, and marine areas of concern or importance as identified in the study is presented in Table 17. As noted in Table 15, activities associated with possible scenarios of oil and gas development may result in impacts related to noise, discharges of liquids (including wastewater), release of drill and mud from drilling activities, and changes to marine wildlife habitat. Nunami Stantec predicted that activities associated with the possible oil and gas development scenarios may not impact the coast and shoreline, but as Baffin Bay and Davis Strait are wintering habitat, such as for marine mammals and fish, the other potential impacts would apply. As such, the remainder of the discussion focuses on components of the biological environment that may be impacted by activities associated with the possible oil and gas development scenarios.

Table 17: Summary of Potential Impacts on the Biological Environment

Valued Ecosystem Component	Potential Impacts			
	Noise	Routine Discharge	Waste and Mud from Drill	Changes to Marine Wildlife Habitat
Species at Risk[1]	✓	✓	✓	✓
Coast and Shoreline				
Plankton	✓			X
Benthic Flora and Fauna	✓	✓	✓	✓
Fish and Fish Habitat	✓	✓	✓	✓
Waterbirds	✓	✓	✓	✓
Marine Mammals	✓	✓	✓	✓
Special and Sensitive Areas				✓
Areas of Concern or Importance				✓

NOTES:
✓ = Indicates potential effect from oil and gas activities.
X = The QIA added 'Changes to Marine Wildlife Habitat' on Plankton as a change to ice could represent a habitat change for marine wildlife.

Plankton

Marine plankton (small living organisms, including early stages of fish and other marine life, in marine water) may be impacted by underwater noise from oil and gas development activities such as seismic surveys (the use of sound generated by devices attached to a marine vessel to assist in locating oil and gas fields in the seafloor). Noise generated from the seismic surveys could result in death of marine plankton up to two (2) metres (6.5 feet) from the location where the noise is generated and injury within five (5) metres (16 feet). However, Nunami Stantec also noted that some previous studies concluded that sound generated during seismic surveys may negatively affect plankton up to 1.2 kilometres (0.75 miles) from the source of sound. The plankton population within an area impacted by noise from a seismic survey are expected to recover rapidly (within months) once the seismic surveys have ceased. Seismic surveys are expected to be seasonal, limited to ice free periods and only to determine if oil and gas sources exist, or to gather details on the formation. Therefore, the level of the effects of these activities to plankton are expected to be low to moderate in the region.

In addition, marine-based oil and gas development activities in Baffin Bay and Davis Strait, such as ice breaking and routine discharges of liquid wastes from marine vessels and muds from drilling activities, may change the habitat for marine plankton within and near the areas of the activities resulting in negative impacts to marine plankton. However, it was noted by Nunami Stantec that these habitat changes may be localized (limited to areas within and near the activities) and were not predicted to impact the health of plankton populations in Baffin Bay and Davis Strait.

The Inuit Qaujimajatuqangit research conducted by Sanammanga Solutions Inc. did capture reference to under ice conditions and ice moving with the currents especially icebergs. While the Nunami Stantec discussed localized changes, these changes due to discharges could be transported elsewhere because of currents.

Benthic Flora and Fauna

During its Public Engagement Sessions, the NIRB heard concerns about the potential for negative effects from ship ballast water on water quality and the potential for invasive species.

Sea bottom-dwelling organisms (benthic flora and fauna) may be affected by underwater noise from seismic surveys associated with oil and gas development. Based on past research, noise from seismic surveys may change the behaviour of benthic organisms, such as shellfish (for example, mussels and crabs), cause injury or death, and reduce the population of these organisms. However, based on studies conducted in other marine regions regarding effects of noise from seismic surveys, benthic organisms, such as shellfish, appear to be less impacted by seismic surveys when compared to marine plankton (small living organisms, including early stages of fish and other marine life, in marine water). It was noted that more research needs to be done to understand the potential effects of marine seismic surveys on sea bottom-dwelling organisms. No effects are expected from noise associated with Scenarios B and C as

noise levels from activities (including drilling) are not expected to be intense enough to harm plankton. Nunami Stantec predicted that impacts to benthic organisms from noise associated with seismic surveys would be low, limited to the area of the seismic activity, and of medium duration (months to a year or more). Benthic flora and fauna could be affected by noise during seismic exploration, but no effects are expected from noise associated with Scenarios B and C as noise levels are not expected to be intense enough.

It was noted that discharges of liquids (such as wastewater) and waste muds to the marine environment from routine oil and gas operations such as the use of marine vessels and drilling activities may change marine water and sediment quality and result in negative effects to marine animals and plants found on or in the seafloor. Liquids containing high concentrations of metals, chemicals, and suspended solids may be ingested by the organisms over time and reach high levels in their tissues or bodies and may also cause changes to the habitat of these organisms. However, based on studies of marine-based oil and gas activities in other marine regions, routine discharges from oil and gas activities in Baffin Bay and Davis Strait were not expected to contain high levels of chemicals and metals that may contaminate marine animals and plants found on or in the seafloor.

Waste mud from drilling, which may be up to two (2) metres (6.5 feet) deep in the immediate area around drilling operations, could result in injury and death of marine life that live within the area of the seafloor where the waste mud is deposited. Also, discharges of ballast water from the marine vessels may introduce invasive species (living organisms that do not naturally occur in an area) to the marine environment in Baffin Bay and Davis Strait. However, strict guidelines exist in Canada for limiting the release of contaminants into the marine environment and for monitoring of impacts of routine discharges from marine-based oil and gas activities, including from marine vessels. Although there may be effects to the organisms near the source of discharge, there seems to be little evidence that there would be severe or long-term effects on marine animals and plants found on or in the seafloor in Baffin Bay and Davis Strait. Overall, drill mud wastes were expected to result in low to moderate level of effects to existing marine conditions for benthic marine organism in Baffin Bay and Davis Strait.

Fish and Fish Habitat

During its Public Engagement Sessions, the NIRB continually heard many comments, questions, and concerns about potential noise-related effects to fish from offshore oil and gas activities, specifically seismic surveys. Community members who worked with Panarctic Oils Ltd. shared observations of negative effects from noise on fish. Concerns about the potential negative effects from a possible oil spill on fish were also raised.

Marine fish may be impacted by underwater noise from seismic surveys, drilling activities, and vessel traffic associated with possible marine-based oil and gas development in Baffin Bay and Davis Strait. During the QIA's Inuit Qaujimajatuqangit meetings, community members commented on their experience with seismic surveys and the impact to fish. Most of the comments related to the effect of percussion

causing disorientation and/or death when explosives were used. The loss of the fishery was of immediate concern to community members. They also noted the changes in marine mammal behaviour when the fish disappeared.

The effects of noise may include changes in behaviour (for example, avoidance of the area where the noise is generated), injury, or death of fish. The *Inuit Qaujimajatuqangit Report* noted these concerns during their community meetings. However, based on studies of impacts to fish from airgun noise associated with oil and gas development in other marine regions, Nunami Stantec expected the effects of noise to fish from possible oil and gas development in Baffin Bay and Davis Strait to range from low to high, depending on the type of noise, the type of fish, and the development stage of the fish. Effects to fish from noise were predicted to be limited to the immediate area of the noise-generating activities and would stop when the oil and gas activities generating the noise stopped. Therefore, according to Nunami Stantec, the effects to fish from noise associated with oil and gas development were predicted to be reversible. The community members interviewed during QIA's Inuit Qaujimajatuqangit consultations did speak to changes in behaviour, but that with time, the effects disappeared, and the fish returned.

Marine fish and fish habitat may also be affected by discharges of liquids (such as wastewater) and drill mud waste to the marine environment from routine oil and gas operations. Specifically, marine fish may be affected by chemicals, metals, and suspended solids in the discharges. Ground fish (fish that inhabit the seafloor such Greenland halibut) are most likely to be affected by other changes to their habitat, such as changes to sediment quality, from the discharges. These discharges may also indirectly affect marine fish by reducing access to food sources in the marine environment. However, based on the strict guidelines in Canada for limiting the release of contaminants and for monitoring of impacts of routine discharges from marine-based oil and gas activities, effects of routine discharges to fish and fish habitat in Baffin Bay and Davis Strait were expected to be small and limited to the area of discharge. Contaminants were a specific concern to the Inuit Qaujimajatuqangit advisory committee of the QIA.

Waterbirds

The NIRB heard questions on the potential effects of seismic surveys on waterbirds during its Public Engagement Sessions.

Waterbirds in the marine environment may be affected by in-air and underwater noise from seismic surveys, drilling activities, and vessel traffic associated with the possible marine-based oil and gas development in Baffin Bay and Davis Strait. Effects of noise may include changes in behaviour (for example, avoidance of the area where the noise is generated), injury, or death of waterbirds. Noise from activities associated with oil and gas production may make it difficult for waterbirds, especially those that gather in large groups, to access food for migration, fledging (sufficiently developing the muscles and feathers for flight), or nesting in areas where the noise occurs. This could have consequences for the health and survival of waterbirds. Changes in behaviour and the risk of death for waterbirds from noise associated with marine-based oil and gas activities in Baffin Bay and Davis Strait were anticipated be short

to medium in duration (occurring over one or several breeding seasons) and restricted to the immediate area of those activities. Nunami Stantec predicted that the overall effects to waterbirds from noise associated with oil and gas activities are likely to be moderate since these impacts were not expected to negatively affect the health of waterbird populations in the region.

Waterbirds may also be affected by discharges of liquids such as wastewater and drill waste (muds) to the marine environment from routine oil and gas operations. Specifically, waterbirds may be impacted by changes to their habitat from chemicals, metals, and solids in the discharges. Discharges containing oil can form a sheen on the surface of marine water and may result in death to waterbirds by affecting their feathers and internal organs. However, based on the strict guidelines in Canada for limiting the release of contaminants and for monitoring of impacts of routine discharges from marine-based oil and gas activities, potential impacts of routine discharges to waterbirds in Baffin Bay and Davis Strait were expected to be small and limited to the area of discharge. Overall, routine discharges from oil and gas activities in Baffin Bay and Davis Strait on waterbirds were expected to result in small effects and were not predicted to negatively affect the long-term health of waterbird populations in the region.

Marine Mammals

During its Public Engagement Sessions, the NIRB continually heard many comments, questions, and significant concerns from community members in each of the potentially interested communities about potential noise-related effects to marine wildlife from offshore oil and gas activities, specifically seismic surveys. There was specific concern about the potential for hearing loss and changes in behaviour. Community members who worked with Panarctic Oils Ltd. shared observations of negative effects from noise on marine mammals. Concerns about potential effects from marine shipping activities on marine mammals. Discussions also included rules, regulations, and best management practices to reduce impacts to marine mammals from oil and gas and associated activities.

Marine mammals (for example, seals, whales, and Polar Bears) may be affected by in-air and underwater noise from seismic surveys, drilling activities, and vessel traffic associated with possible marine-based oil and gas development in Baffin Bay and Davis Strait. These marine-based oil and gas activities may affect the behaviour of marine mammals by making them avoid the areas of the noise source. Changes in behaviour and avoidance of areas was identified and discussed by the QIA Inuit Qaujimajatuqangit advisory committee. They commented on the extreme sensitivity to noise of whales and how traditional hunting rules included advice on how to move on ice because of the sensitivity and the need to be quiet otherwise whale and walruses would go elsewhere. Western science indicates that noise may also affect communication among groups of marine mammals of the same species (a condition called masking). Based on studies conducted in Baffin Bay and Davis Strait and in other similar marine regions, effects to marine mammals from noise associated with oil and gas activities, such as seismic surveys and drilling, are anticipated to be temporary and restricted to the area where the noise may be noticed by marine mammals. Activity related noise during production would be continuous over the length of a project. Overall, the level of the impacts from noise associated with oil and gas activities was predicted by Nunami

Stantec to be moderate since underwater noise levels were not expected to affect the long-term health of marine mammal populations in Baffin Bay and Davis Strait.

Marine mammals may also be affected by discharges of liquids (such as wastewater) and drill muds to the marine environment from routine oil and gas operations. Specifically, marine mammals may be affected by changes to their habitat, including a reduction in food sources within the area of the discharge or by feeding on other marine organisms that may be contaminated with chemicals and metals from routine discharges associated with oil and gas development. Discharge of drill muds into the marine environment may also make the water cloudy (turbid) and reduce visibility for marine mammals that feed by sight. However, based on the strict guidelines in Canada for limiting the release of contaminants and for monitoring the effects of routine discharges from marine-based oil and gas activities, direct negative impacts, such as death to marine mammals, from routine discharges in Baffin Bay and Davis Strait was considered unlikely. In addition, indirect impacts to marine mammals from feeding on food sources contaminated with chemical and metals from oil and gas activities was expected to be small. Further, routine discharges were not expected to affect the long-term health of marine mammal populations in Baffin Bay and Davis Strait.

Special and Sensitive Areas and Areas of Concern or Importance

During its Public Scoping Sessions, the NIRB was asked to consider areas including Marine Protected Areas, Bird Sanctuaries, National Wildlife Areas, coral reefs, the Pikialasorsuaq (North Water Polynya), and narwhal wintering areas.

Special and sensitive areas and areas of concern or importance (such as marine areas known to be habitat for large groups of waterbirds or marine mammals) may be affected by marine-based oil and gas development activities in Baffin Bay and Davis Strait, such as ice breaking and routine discharges of liquid wastes from marine vessels and muds from drilling activities. These marine-based activities may result in changes to marine habitat that are particularly sensitive to disturbance. However, changes to habitat from possible oil and gas development in Baffin Bay and Davis Strait were expected to be short term (lasting the duration of the activity) and reversible (returning to natural conditions) once activities end.

Also, special and sensitive areas and areas of concern or importance in marine regions in Canada are protected by regulations including the *Migratory Birds Convention Act* and through the creation of protected areas such as Migratory Bird Sanctuaries, National Wildlife Areas, or National Parks. The types of activities allowed in these protected areas are strictly regulated to reduce the likelihood of impacts to special and sensitive areas and areas of concern or importance.

QIA's *Inuit Qaujimajatuqangit Report* outlines that Inuit did not so much discuss protected areas, but specific habitat conditions. The floe edge and immediate under ice conditions were considered areas of importance because of their high biodiversity. The floe edge is where Inuit travel to find seals and whales therefore changes in floe edge conditions are of concern to harvesters.

Climate Change

Nunami Stantec predicted that possible increases in ice-free conditions during the open water season from future changes to weather conditions and climate from human activities (climate change), may increase the area covered by, and duration of, marine-based oil and gas activities in Baffin Bay and Davis Strait. Potential effects include:

Plankton: These conditions could increase effects of oil and gas activities on plankton. However, potential effects from climate change were not expected to change the predicted size of these impacts without climate change.

Benthic Flora and Fauna: While this could increase effects of these activities on sea-bottom dwelling organisms, potential effects from climate change are not expected to change the predicted size of these impacts without climate change.

Fish and Fish Habitat: These conditions could increase effects of these activities on fish and fish habitat. However, these potential effects from climate change were not expected to alter the predicted size of these impacts without climate change.

Waterbirds: Potential effects to waterbirds from climate change were not expected to alter the predicted size of these impacts without climate change.

Marine Mammals: Due to the limited amount and area of any routine discharge to the marine environment from marine-based oil and gas development activities, such as offshore drilling, changes to natural marine environment conditions from climate change may not change current predictions about potential effects on marine mammals from routine discharges associated with marine based oil and gas development in Baffin Bay and Davis Strait.

Special and Sensitive Areas: Nunami Stantec predicted that future changes to natural marine environment conditions from climate change may increase the size of the effects to special and sensitive areas and areas of concern of importance from marine-based oil and gas activities in Baffin Bay and Davis Strait.

7.2.2. Cumulative Effects

During the NIRB's Public Engagement Sessions, community members noted concerns and asked questions about the potential for offshore oil and gas activities, particularly vessels, to interact with other activities to have a negative effect on the environment. Community members discussed effects, particularly on marine mammals, already being observed and concerns about any increases to those.

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may interact with past, present, and future projects and activities in the Baffin Bay and Davis Strait to cause effects (also called cumulative effects) to the biological environment (which includes fish

and fish habitat, waterbirds, and marine mammals). A summary of potential cumulative effects to the biological environment from activities associated with marine-based oil and gas development in Baffin Bay and Davis Strait and other past, present, and future activities in the region is presented in Table 18. As noted in Table 16, effects from activities associated possible scenarios of oil and gas development may interact with effects from past, present, and future activities (such as commercial shipping, tourism, deep water ports, and other marine-based activities) to cause cumulative effects to the biological environment in Baffin Bay and Davis Strait. The check marks (✓) in Table 8.0 indicate interactions between a project or an activity (for example, commercial fishing) and a component of the biological environment (for example, marine mammals).

Table 18: Summary of Potential Cumulative Effects on the Biological Environment

Other Projects and Physical Activities with Potential for Cumulative Effects	Potential Cumulative Effects			
	Change in Habitat of Marine Wildlife	Change in Behaviour of Marine Wildlife	Change in Physical Health of Marine Wildlife	Change in Mortality Risk of Marine Wildlife
Past and Present Physical Activities and Resource Use				
Mining – Baffinland Mary River Mine (Marine Transportation)	✓	✓		
Commercial Shipping	✓	✓		
Commercial Fishing	✓	✓		✓
Tourism (cruise ships)	✓	✓		
Research (Military, Academic)	✓	✓		✓
Traditional Use and Practices, Traditional Harvest, Traditional Foods		✓		✓
Oil and Gas – Greenland	✓	✓	✓	✓
Oil and Gas – Atlantic Canada	✓	✓	✓	✓
Future Physical Activities				
Mining (marine transportation, air traffic)	✓	✓		
Deepwater Port (Iqaluit)	✓	✓		
Commercial Shipping	✓	✓		
Commercial Fishing	✓	✓		✓
Tourism (cruise ships)	✓	✓		
Research (Military, Academic)	✓	✓		✓
Traditional Use and Practices, Traditional Harvest, Traditional Foods		✓		✓
Oil and Gas – Greenland	✓	✓	✓	✓
Oil and Gas – Atlantic Canada	✓	✓	✓	✓

Other Projects and Physical Activities with Potential for Cumulative Effects	Potential Cumulative Effects			
	Change in Habitat of Marine Wildlife	Change in Behaviour of Marine Wildlife	Change in Physical Health of Marine Wildlife	Change in Mortality Risk of Marine Wildlife
Oil and Gas – Baffin Bay and Davis Strait	✓	✓	✓	✓
NOTE: ✓ = those "projects and physical activities" whose effects are likely to interact cumulatively with effects associated with oil and gas activities in Baffin Bay and Davis Strait.				

As discussed in Section 7.2.1 (Potential Effects), the potential effects to the biological environment from activities associated with the possible scenarios would generally be localized around the source. Also, the effects to the biological environment from oil and gas development are expected to lessen to natural or background conditions within a small area from the source. However, there is potential for cumulative effects to components of the biological environment in Baffin Bay and Davis Strait as follows:

- Cumulative effects to plankton (small living organisms, including early stages of fish and other marine life, in marine water) may occur from marine vessel traffic in combination with marine-based oil and gas development. These cumulative effects were expected to be small and short-term.
- Cumulative effects to benthic flora and fauna (marine animals and plants found on or in the seafloor) may occur from marine port construction (for example, Iqaluit and Pond Inlet port infrastructure) and commercial and traditional fishing in combination with marine-based oil and gas development. These cumulative effects were expected to be moderate and medium- to long-term and were not predicted to affect the long-term health of benthic organisms in Baffin Bay and Davis Strait.
- Cumulative effects to fish and fish habitat may occur from commercial fishing in combination with marine-based oil and gas development. These cumulative effects were expected to be small and medium- to long-term and were not predicted to impact the health of fish populations in Baffin Bay and Davis Strait.
- Cumulative effects to waterbirds and marine mammals may occur from increased exposure to in-air and underwater noise from marine infrastructure or activities, vessel traffic, and air traffic in combination with oil and gas development. Depending on how often, loud, the length of time the noise lasts for, and the sensitivity of individual species, these activities could lead to changes in behaviour or death. These cumulative effects were expected to be moderate and were not predicted to affect the health of populations of waterbirds and marine mammals in Baffin Bay and Davis Strait.

- Cumulative effects to special and sensitive areas and areas of concern or importance (such as marine areas known to be habitat for large groups of waterbirds and marine mammals) may occur from marine vessel traffic in combination with marine-based oil and gas development. These cumulative effects were not predicted to affect the long-term health of populations of marine wildlife within the special and sensitive areas and areas of concern or importance in Baffin Bay and Davis Strait.

7.2.3. Transboundary Effects

Activities associated with the various possible stages of development may result in effects including changes to plankton (small living organisms, such as early stages of fish and other marine life, in marine waters) and benthic flora and fauna (sea bottom-dwelling living organisms) from Canadian federal waters to the Nunavut Settlement Area, to other provinces or territories, or to other countries. However, due to the expectation that effects to plankton and benthic flora and fauna from oil and gas activities would be limited to the area where the activities occur, transboundary effects are not predicted. Fish, waterbirds and marine mammal populations cover large areas that overlap territories, provinces, and countries; therefore, if oil and gas development results in effects to local populations of fish, waterbirds and marine mammals, transboundary effects may also occur.

7.2.4. Accidents and Malfunctions

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may result in accidents and malfunctions such as collisions of marine vessels with marine mammals, including whales. However, such vessel strikes with marine mammals are not expected to be a common occurrence.

Accidents and malfunctions from oil and gas development, such as marine vessel accidents and oil pipeline or well damage, may also cause oil spills or release of other chemicals that may affect the biological environment. Such accidents could impact marine water and sediment quality, and sea ice conditions and cause effects to components of the biological environment. In addition, a major oil spill may impact coastlines in the region and cause direct effects, such as death, to marine wildlife including fish, waterbirds, and marine mammals. Nunami Stantec noted that impacts to the biological environment from oils spills would depend on physical conditions in the marine environment, the distance of the spill from marine wildlife habitat, the length of time the spill lasts, the oil type, and the methods used to contain and treat the oil spill.

Overall, impacts of oil spills to components of the biological environment could be regional (limited to Baffin Bay and Davis Strait) or transboundary and have long-term effects. There is potential for a large oil spill to have wide-spread negative impacts to marine species in Baffin Bay and Davis Strait. However, since such oil spills occur through an accident or malfunction, they are predicted to be irregular in occurrence with appropriate safeguards in place.

7.2.5. Mitigation Measures and Planning Considerations

Mitigation plans or actions are recommended to avoid or reduce impacts to the biological environment, such as fish, waterbirds, and marine mammals, from activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait. The potential effects identified above are what would remain standard mitigation measures have been applied. Specific plans or actions and commitments by a proponent to decrease potential effects of activities would be determined during a project level environmental assessment. Many of the plans or actions are standard to oil and gas development and are part of the usual design of the development of oil gas fields and are listed below:

- Establishment of safe distances from marine wildlife (also termed habitat setbacks);
- Avoid sensitive periods for wildlife such as breeding, rearing, and nesting;
- Apply mitigation plans or actions for seismic surveys as specified in the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*;
- Marine vessels should use existing and common travels routes where possible and practical;
- Marine vessels should maintain a steady course and safe vessel speed whenever possible;
- Implement a Marine Mammal Management Plan that includes marine mammal monitoring for vessel-related activities; and
- Establish safe vessel operation practices to avoid marine mammals and sensitive marine mammal habitat.

Want more detail?
Look at Report:
- *Environmental Setting and Potential Effects* – Section 7.2: Potential Effects Biological Environment
- *Inuit Qaujimajatuqangit Report* – Section 4

The following are summaries of additional information provided or requested in written public comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
• Potential effects of underwater noise on waterbirds, marine mammals, fish, and marine organisms. including: temporary or permanent hearing damage, death, changes to behaviour. • Mitigation measures • Associated rules and regulations in the Development Scenario Area.	Environment and Climate Change Canada World Wildlife Fund Canada Peter Croal Fisheries and Oceans Canada and the Canadian Coast Guard Greenpeace Canada
Updated information on Polar bears.	Government of Nunavut
Potential effects of oil and gas activities on sensitive areas, Species at Risk, and waterbirds and associated mitigation measures.	Environment and Climate Change Canada Fisheries and Oceans Canada and the Canadian Coast Guard

Potential cumulative and transboundary effects on marine mammals, waterbirds, and fish.	Fisheries and Oceans Canada and the Canadian Coast Guard
Arctic research by federal departments, including on: sea mammals and birds, marine species, and water quality.	Crown-Indigenous Relations and Northern Affairs Canada

7.3. HUMAN ENVIRONMENT

Potential impacts of possible oil and gas stages, or scenarios, to the components of the human environment considered important to the region were assessed to gain a better understanding of the nature of the potential effects. The selection of components of the human environment was informed by public engagement and community scoping meetings conducted by the NIRB in potentially impacted communities in the Qikiqtaaluk Region in 2017 (see Appendix A for a summarized list of community comments; full list is available on the NIRB website in the follow-up reports to each public engagement session).

The valued components of the Human Environment identified through the NIRB's scoping process have been grouped together for the description of potential effects as identified in Table 19.

Table 19: Valued Components Groupings for the Human Environment

Valued Components Grouping	*Valued Components in the SEA Final Scope*
Economy, Employment and Business	• Economic Development and Opportunities, • Employment • Contracting and Business Development
Community, Infrastructure and Services	• Education and Training • Community Infrastructure and Services
Community Health and Wellbeing	• Health and Wellbeing
Commercial Harvesting	• Commercial Harvest
Land and Marine Use	• Traditional Use and Practices • Traditional Harvest • Traditional Foods • Non-Traditional Use • Marine Transportation
Heritage Resources	• Heritage Resources

7.3.1. Potential Impacts and Effects

Based on the assessment by Nunami Stantec, the following possible impacts to components of the human environment considered to be of importance to the region were identified:

- *Ice disturbance*, specifically from icebreaking activities;
- *Employment and expenditures* associated with use of local or regional services and infrastructure to support oil and gas activities;

- *Exclusion zones* (safety areas around oil and gas activities restricted to other uses);
- *Direct interference* of seismic, exploration drilling, or production drilling operations with commercial fishing gear and equipment, causing damage, lost-time, and profit from delays;
- *Direct interference* of seismic or drilling (for both exploration and production) operations with land and marine use (not including commercial fishing) and changes to harvesting, cultural, and spiritual practices, as well as recreational activities;
- *Indirect interference* with land and marine use mainly related to potential effects on the biological environment that could affect commercial fishing; and
- *Indirect interference* with land and marine use resulting in changes to harvesting, cultural, and spiritual practices, as well as recreational activities.

A summary of potential impacts on the valued components of the human environment listed above is presented in Table 20.

Table 20: Summary of Potential Impacts on the Human Environment

Valued Components of the Human Environment	Potential Environmental Impacts				
	Ice Disturbance	Employment and Expenditures	Exclusion Zones	Direct Interference	Indirect Interference
Economy, Employment and Business		✓			
Community, Infrastructure and Services		✓			
Perceived Community Health and Wellbeing		✓			
Commercial Harvesting			✓	✓	✓
Land and Marine Use	✓		✓	✓	✓
Heritage Resources				✓	
NOTES: "✓" = Indicates potential effect from oil and gas activity					

Economy, Employment, and Business

During the Public Engagement Sessions, the NIRB heard many comments and questions from community members on potential employment and training opportunities and potential financial benefits to Nunavut and the Qikiqtaaluk communities from possible offshore oil and gas activities. Multiple community members noted that the potential negative effects from offshore oil and gas development would need to be compared to the potential benefits. The reason most often given by individuals in support of possible offshore oil and gas activity was the potential for jobs.

Nunami Stantec predicted that the potential effects on the local economy, businesses, and employment from oil and gas activities would be: limited; generally short (months) for seismic and exploration activities and potentially years long for production activities; occur within local communities and regional governments, and happen throughout the length of the activity. It was clarified that potential positive effects would depend in part on the plans and actions taken by a proponent, such as those related to processes for companies to get contracts with oil and gas companies. It was noted that potential positive effects could be direct (for example a job as a Marine Wildlife Observer on a seismic vessel) or indirect (such as more income in the communities from oil and gas development in the region). Potential negative effects include: short term Inuit employment opportunities, few employment opportunities, and increased local jobs leading to fewer hunters in the communities harvesting country foods. The QIA Inuit Qaujimajatuqangit advisory committee discussed the limited nature of benefits. The participants felt that oil and gas development would need to compensate for impacts to the human environment especially as it relates to changes in harvesting and traditional use.

Nunami Stantec noted that the number of local employment and business opportunities provided by oil and gas activity would depend on the number of trained people and prepared businesses when work starts. Seismic survey and exploration drilling activities are generally short, would happen offshore, have limited interaction with communities, and the ships usually come from another part of the world with all the employees it would need. Potential employment and business opportunities may be unlikely.

As the entire oil and gas field development and drilling process could be 30-60 years long, with production lasting up to 40 years, there would be more time for local residents and businesses to prepare for opportunities and compete for oil and gas-related contracts. However, vessels (such as Production, Storage and Offloading Vessels or wareships[10]) would be able to provide most, or all, of the required goods and services to support oil and gas activities. This would limit the need for onshore services and infrastructure and may mean fewer economic opportunities for Nunavummiut. A summary of some of the potential local employment and business opportunities from oil and gas activities is provided in Table 21.

[10] a vessel anchored for offshore storage and to provide services

Table 21: Potential Local Employment and Business Opportunities from Oil and Gas Scenarios in Baffin Bay and Davis Strait (Created by the NIRB using Nunami Stantec information)

Seismic Surveying	Exploration Drilling	Field Development and Production
Ship comes fully staffed Little onshore support needed	Ship comes fully staffed Little onshore support needed	More opportunities for employment and business opportunities
Marine Wildlife Observers on board vessel	Marine Wildlife Observers on board vessel Qualified: engineers, welders, electricians, cooks, support staff, health and safety specialist, environmental specialists, helicopter pilots, technicians, geologists, and healthcare staff	Marine Wildlife Observers on board vessel Qualified: engineers, welders, electricians, cooks, support staff, health and safety specialist, environmental specialists, helicopter pilots, technicians, geologists, and healthcare staff
Onshore support: Air based crew transfer from Iqaluit airport or other community if closer to seismic location	Onshore support: Air based crew transfer from Iqaluit airport or other community if closer to seismic location	Onshore support: flight support, supplies, medical services, consulting, legal support, human resources and administration staff, logistics and customs brokers, and catering
There may be indirect opportunities with environmental engineering firms hired to conduct environmental studies associated with exploration and production drilling.		

Community, Infrastructure and Services

During the Public Engagement Sessions, the NIRB heard that there was a need for improved local infrastructure to support offshore oil and gas activities. Nunami Stantec noted that potential effects of oil and gas activities on community infrastructure (including ports, airports, health centres, and housing) and services (including healthcare, emergency services, water, and wastewater) would depend on their ability to support the industry and more workers in the communities. Nunami Stantec predicted that overall effects on local infrastructure and services from oil and gas activities would: have a low level of impact; be limited to a local (community) or regional area (Qikiqtaaluk Region) depending on the communities affected; short-term for seismic and exploration activities; long-term for production activities; happen often throughout the activity; and would stop once oil and gas activities ended.

Seismic surveys would be unlikely to make a noticeable change to local infrastructure or services as vessels would generally remain offshore and only operate in open water.

There is potential for increased traffic in marine ports for services such as maintenance during exploration drilling programs and for Field Development and Production. However, the use of vessels for offshore storage and to provide services (wareships) would mean that there would be limited need to use services and infrastructure in the communities. Potential negative effects could happen if marine infrastructure

in Nunavut would not be able to support the increased level of marine activity. For example, workers missing their flights home and needing temporary accommodations in a community may put pressure on community infrastructure and services. As production activities could last up to 40 years, Nunami Stantec noted the potential for non-local workers to move to the region. While this could increase pressure on community infrastructure and services, the long time leading up to production could potentially be used to invest in local infrastructure and services.

Perceived Community Health and Wellbeing

Nunami Stantec noted that potential effects on the health and wellbeing of communities from possible offshore oil and gas activity was hard to measure. Health and wellbeing are linked to many parts of everyday life, including: access to healthcare, food security, financial security and comfort, and access to land use for both traditional and non-traditional purposes. As possible oil and gas activity would happen in the offshore environment and outside the range of local communities, there would not be a direct link to the physical human health of local communities in the Qikiqtaaluk Region. It was predicted that overall effects on health and wellbeing from oil and gas activities would: have a low level of impact; occur only in the communities that would interact with oil and gas activities; and occur throughout the length of the activity. Without mitigation plans or actions to avoid or reduce potential effects, the extent of effects on community health and wellbeing would depend on the type of oil and gas activity and how long it would last.

There is potential for positive effects on community health and wellbeing from new economic activity and increased income to individuals to purchase goods and services (such as a house or snow machine). Other positive effects could come from taxes, royalties, and benefits agreements to governments. Potential negative effects on community health and wellbeing could occur if, for example: community life is changed; higher incomes lead to drug or alcohol abuse; housing costs go up; or residents have less time to harvest country food. Less time participating in traditional hunting activities could mean less consumption of country food and fewer opportunities to pass on Inuit Qaujimajatuqangit, which could have a negative effect on personal health and wellbeing. The QIA heard this concern repeatedly from the Inuit Qaujimajatuqangit advisory group participants. They spoke to Inuit youth not being grounded in Inuit culture.

Commercial Harvesting

During the Public Engagement Scoping Sessions, the NIRB heard concerns that commercial fisheries could be negatively affected by offshore oil and gas activities and as a result, the livelihood of community members who work for the fisheries could be negatively affected. Concerns were also raised that fish sales may go down if consumers thought the quality of Nunavut fish had decreased because of oil and gas activities, even if the quality did not change.

Direct Interference: Seismic vessels, as well as supply vessels could contact and damage fishing equipment and other vessels. As a result, commercial fishers could lose time fishing. Nunami Stantec expected that seismic operations would have an established compensation policy to deal with such incidents. The use of a wareship for exploration drilling and field development and production would reduce the distance supply vessels would need to travel and therefore the potential for an interaction.

Indirect Interference: As mentioned in Section 7.2 (potential effects on the biological environment), without mitigation measures to avoid or reduce potential impacts, oil and gas activities could have negative effects on fish species that could decrease the quantity or quality of fish harvested, which could negatively affect fish sales. Potential impacts include fish avoiding a usually productive fishing area, which could result in commercial fishers losing time fishing. Also, fish could absorb oil and store it in their fat (called fish taint) which could affect the ability of fish being sold on the market. However, oil discharge during routine operations is not permitted.

Safety zones: During exploration drilling and production activities, safety zones (exclusion zones) would be set around seismic vessels, drilling rigs, and production platforms when activity is occurring to reduce potential accidents such as a collision or spill. Within these safety zones, ships or other activities, such as commercial fishing, would not be allowed. Nunami Stantec predicted that overall effects on commercial fishing from oil and gas activities would be: limited to the area around the drill rig or production platform; short to long term as production activities last a long time; would happen the entire time the drill rig or production platform was active; and that fishers could start fishing as soon as the safety zone was lifted.

The potential effects of being restricted from certain fishing areas would likely be during the summer months, when there are lower ice levels and fishing activity is at its highest. Mitigation plans or actions to avoid or reduce potential negative effects include industry best practices of ongoing communication with the fishing industry, and the use of a Fisheries Liaison Officer onboard drilling and production facilities.

Land and Marine Use

During the Public Engagement Sessions, the NIRB heard many concerns that offshore oil and gas activities would have extremely negative effects on traditional use and harvesting of marine wildlife and fish in Baffin Bay and Davis Strait. Specific concerns included the potential for compensation if marine use was negatively affected and if food security was worsened. Other comments included the potential for negative effects to marine based tourism if offshore oil and gas development occurred in Baffin Bay and Davis Strait. Similar concerns were expressed in the communities during QIA's Inuit Qaujimajatuqangit collection meetings.

> *When a seal is brought to the huts everybody is entitled to a share of the meat and blubber, which is distributed by the hunter himself or carried to the individual huts by his wife. This custom is only practiced when food is scarce. In times of plenty only the housemates receive a share of the animal.*
>
> Source: (Boas. 1888; p.582)

Ice Disturbance: The use of icebreakers (marine vessels capable of travelling through sea ice) to support oil and gas exploration surveys and to protect marine-based oil and gas development facilities from sea ice may result in changes to the quality (for example, thickness) and the extent or size of sea ice, which might have an impact on marine mammals such as walruses. Overall, Nunami Stantec predicted that potential effects from oil and gas activities on land and marine use would have a low level of impact, be short-term, and happen only along the vessel's routes.

Activities associated with the scenarios are predominantly located offshore with limited shore and nearshore interaction. Seismic surveys and exploration drilling activities are anticipated to occur in open water, and it was considered unlikely that ice would need to be broken up to support activities. However, icebreakers would be available to assist vessels if needed.

Ice breaking could be used during production activities to protect marine-based oil and gas development facilities from sea ice and to support any ships travelling to shore. During Inuit Qaujimajatuqangit consultations, communities expressed concerns about the impacts of ice breaking. This may affect marine mammals wintering in the area, and indirectly affect Inuit harvesting attempts. There was also discussion of the use of ice as haul outs and dens for seals and walrus. The Inuit Qaujimajatuqangit research conducted by Sanammanga Solutions Inc. for the QIA and Nunami Stantec noted that icebreaking in areas used by Inuit and Nunavummiut could also impact over-ice travel for traditional harvesting and other activities. Potential negative effects could include: more travel time, fuel used, and wear and tear on equipment as well as reduced access to preferred hunting areas. Any resulting changes to traditional use and practices, changes in access to harvesting sites, changes in harvesting site locations, and changes in quality of harvest could also lead to changes to perceived community health and well-being. If there was a project, discussions would occur between operators and harvesters, hunting and trapping organizations, and the QIA about potential effects and recommended mitigation plans or actions to assist in planning to avoid or reduce potential negative effects.

Direct Interference: Nunami Stantec predicted that direct effects on land and marine use from offshore oil and gas activities would: have low to moderate level of impact; be short to long term; and occur frequently and where the interaction occurred. A communication procedure between operators and community organizations would need to be established to reduce potential direct interactions.

Indirect Interference: Nunami Stantec and *QIA's Inuit Qaujimajatuqangit* research identified that contamination of species (real or thought to occur) or changes to species distribution, could result in less harvesting or consumption of country foods and could affect other activities such as wildlife focused marine tourism. As mentioned above based on the study by Impact Economics, 90% of Inuit still consume country food and the value of the country food in the nearest communities is worth $3.3 million annually. These potential effects could also impact the economy, food security, and perceived well-being. Indirect effects on land and marine use from oil and gas activities were predicted to be low to moderate in size, short to long term, and happen infrequently and be limited to where the interaction happened.

Safety Zones: Nunami Stantec predicted that there would be limited or no effects from safety zones on traditional harvesters and other coastal marine users as the scenarios would be located in the offshore. Safety zones would also apply to other offshore marine users such as freighters, tankers, military vessels, coast guard, and research vessels. Potential effects include vessels changing their routes and were predicted to: have low to moderate size of effect; be short to long-term; be limited to the area surrounding the drill rig or production platform; occur the entire time the rig or platform was active; and would recover quickly once the safety zone was removed. Mitigation plans or actions to avoid or reduce impacts include vessels communicating with the oil and gas operators.

Heritage Resources

Nunami Stantec noted that current and past Inuit land and marine use is greatest within the land-fast ice zone and next to onshore areas. Although any potential destruction of a heritage resource would be long-term and permanent, as the activities for possible scenarios would primarily take place far offshore, the potential for an interaction was predicted to be low. Direct effects on heritage resources from oil and gas activities were predicted to occur occasionally, only where there was disturbance from oil or gas activities, and be short to long term. Heritage Resources are protected under the *Nunavut Act* and any onshore development would be subject to the environmental assessment process.

Climate Change

Climate change could have multiple effects on the human environment, including:

Land and Marine Use: Changes to the physical extent, thickness, quality, and predictability of sea ice could affect the ability of local residents to travel over sea ice and access fishing or hunting grounds, as well as conduct other types of traditional use and practices. However, the potential reduced extent of sea ice could also reduce the need for ice-breaking activities. Changes in sea ice was discussed extensively in the sessions run by Sanammanga Solutions Inc. and during the NIRB's Public Scoping Sessions.

Economy, Employment, and Business: While climate change was not expected to affect local economy, employment, and business, it is predicted to affect the ability of traditional harvesters to participate in the local economy. Changes to infrastructure conditions from changes to permafrost and wind could result in changes to infrastructure and affect the local economy.

Community Infrastructure and Services: If warming trends continue and there is more open water and access to areas of Nunavut, there could be more vessel traffic in and out of available ports. Oil and gas activity has the potential to further increase the number of vessel activity out of these ports, which may negatively affect the quality of marine infrastructure and ability to service all vessels.

7.3.2. Cumulative Effects

Activities associated with the possible oil and gas scenarios in Baffin Bay and Davis Strait may interact with past, present, and future projects and activities in the region to cause effects (also called cumulative effects) to the human environment. A summary of potential cumulative impacts to the human environment in Baffin Bay and Davis Strait from activities associated with marine-based oil and gas development in Baffin Bay and Davis Strait and other past, present, and future activities in the region is presented in Table 22.

Table 22: Potential Cumulative Effects - Human Environment

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects-Routine Activities					
	Change in Economy, Employment, and Business,	Change in Capacity of Infrastructure and Services	Change in Access to Resources	Change in Quality of Harvest	Change in Heritage Resources	Change in Perceived Community Health and Well-being
Past and Present Physical Activities and Resource Use						
Mining—Baffinland Mary River Mine (marine transportation)	✓	✓	✓			✓
Commercial Shipping	✓		✓	✓		
Commercial Fishing	✓	✓	✓			✓
Tourism (cruise ships)		✓	✓			✓
Research (Military, Academic)		✓	✓			
Traditional Use and Practices, Traditional Harvest, Traditional Foods	✓		✓	✓		✓
Oil and Gas—Greenland			✓			
Oil and Gas—Atlantic Canada						
Future Physical Activities						
Mining (marine transportation)	✓	✓	✓			✓
Deepwater Port (Iqaluit)	✓	✓	✓			✓
Commercial Shipping	✓			✓	✓	
Commercial Fishing	✓		✓	✓		✓
Tourism (cruise ships)	✓	✓	✓	✓		✓
Research (Military, Academic)	✓	✓		✓		
Traditional Use and Practices, Traditional Harvest, Traditional Foods	✓		✓	✓		✓
Oil and Gas—Greenland				✓		

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Potential Cumulative Environmental Effects-Routine Activities					
	Change in Economy, Employment, and Business,	Change in Capacity of Infrastructure and Services	Change in Access to Resources	Change in Quality of Harvest	Change in Heritage Resources	Change in Perceived Community Health and Well-being
Oil and Gas—Atlantic Canada						
Oil and Gas – Baffin Bay and Davis Strait (Scenario A, B, and C)	✓	✓	✓	✓		✓

NOTES:
✓ = those "other projects and physical activities" whose residual effects are likely to interact cumulatively with residual environmental effects associated with oil and gas activities in the Area of Focus.

As discussed in Section 7.3.1 (potential effects on the human environment), the potential impacts to the human environment from activities associated with the possible oil and gas scenarios in Baffin Bay and Davis Strait would generally be localized to the communities interacting with the activities. However, there is potential for cumulative impacts to components of the human environment in Baffin Bay and Davis Strait as follows:

- *Cumulative impacts to the economy, employment, and business opportunities* could occur if the demand for oil and gas companies as well as companies in other industries lead to a shortage of local workers, businesses having difficulties serving multiple projects, or individuals no longer being able to participate in traditional hunting activities (this could lead to a loss of passing on Inuit Qaujimajatuqangit or consuming country food). The Government of Nunavut could benefit if it receives royalties or taxes from multiple projects.
- *Cumulative impacts to the capacity of infrastructure and services* to support multiple industries may occur from oil and gas activities in combination to other future projects, including increases to shipping and tourism from declining sea ice and new mining activities. However, it was considered likely that increases in the use of marine infrastructure in most potentially interested communities would be limited due to lack of current harbour infrastructure to support such increases and that future mining developments are likely to be in remote locations away from communities.
- *Cumulative impacts to access to resources* by commercial and traditional fish harvesters as well as to traditional uses and practices may occur from vessels, equipment, and safety zones associated with new oil and gas development activities in combination with multiple projects or activities taking place offshore. Any increase in marine traffic in the nearshore and land-fast ice zone could potentially increase the cumulative effect on traditional travel routes and access to harvesting locations, which could result in difficulties hunting and consuming country foods; and therefore, food security.

- *Cumulative effects to quality of resources* may occur from emissions from multiple offshore projects or activities in combination with any oil and gas development and could have negative effects on both traditional and non-traditional harvests.
- *Perceived community health and well-being* could be affected both positively and negatively from oil and activities in combination with other activities. Changes in economy, employment, and business opportunities; capacity of infrastructure and services; access to resources; and quality of harvest can negatively affect traditional use and practices, traditional harvest, and the consumption of traditional foods. Positive effects could also occur.

7.3.3. Transboundary Effects

Nunami Stantec did not anticipate there would be transboundary effects from routine oil and gas activities on the valued components of the human environment, other than workers moving between provinces or territories or individuals buying goods and services outside of Nunavut.

7.3.4. Accidents and Malfunctions

Activities associated with the possible stages, or scenarios, of oil and gas development in Baffin Bay and Davis Strait may result in accidents and malfunctions such as: fire and explosions; death from falling off a vessel; helicopter crash; vessel collisions; major weather and sea ice conditions; vessel strike with marine mammals; and oil and gas spills. Most of these could negatively affect the capacity of infrastructure and services for days or months and may even provide short-term employment opportunities. Oil and other chemical spills have the greatest potential to negatively affect the human environment, including small accidental spills from ships or platforms or large spills (a blowout).

Commercial fishers could experience lost time and income due to a spill of oil or other contaminants for multiple reasons, including: stopping fishing activity; damaged fishing gear and equipment; reduced or contaminated fish; or consumers believing the quality of fish has been affected. The significance of potential effects would depend on various factors, including the size of an area closed, time of year, and length of closure.

A spill of oil or other contaminants into the marine environment could negatively affect community physical and mental health and well-being if it prevents local residents from undertaking traditional or recreational activities such as fishing, hunting, and consuming sea-ice or icebergs. A spill could also directly interfere with marine based tourism, traditional use and practices, traditional harvest and the consumption of traditional foods, and therefore, food security.

7.3.5. Mitigation Measures and Planning Considerations

Mitigation plans or actions are recommended to avoid or reduce potential negative effects or increase potential positive effects from oil and gas activities to the human environment, including the following:

- Early discussions with all interested groups and individuals to notify and discuss potential employment and business opportunities;
- Partnerships with educational institutions to train and develop local capacity for potential employment opportunities;
- Assist local businesses to prepare for potential contract opportunities;
- Develop a Benefits Plan outlining initiatives and programs to enhance benefits to local residents, communities, and businesses;
- Use a Fisheries Liaison Officer and/or fisheries guide vessels during certain activities (such as on seismic vessels, and during movement of a drilling rig);
- Notify Shippers of planned oil and gas activity through the Canadian Coast Guard; and
- Develop a compensation program for loss or damages to commercial fishers from an accidental release of oil or other contaminants, or debris, or expenses incurred in taking remedial action.
- Develop a compensation plan for loss or damages to traditional harvesters that identifies the contribution of country food to food security and cultural connection to the land.

Want more detail?

Look at Report:

- *Environmental Setting and Potential Effects* – Section 7.3: Potential Effects Human Environment
- *Inuit Qaujimajatuqangit Report* – Section 4

The following are summaries of additional information provided or requested in written public comments on the *Environmental Setting and Potential Effects Report*:

Topic	Commenter
Taxes, royalties, and Inuit rights to benefits and compensation	Government of Nunavut Greenpeace Canada
Additional information related to potential employment opportunities and education and training requirements	Government of Nunavut Greenpeace Canada World Wildlife Fund Canada
Recommended a further quantitative breakdown on country foods for each community as well as economic sectors at a community level if available.	Fisheries and Oceans Canada and the Canadian Coast Guard
Local capacity to participate in potential oil and gas development projects	Greenpeace Canada

8. EFFECTS OF THE ENVIRONMENT ON OIL AND GAS ACTIVITIES

There are long timelines for all the steps needed to undertake the oil and gas scenarios. If new oil and gas activities were allowed and went ahead, some of the activities, like production drilling, would likely not happen for decades. Changes to climate are happening very fast in the Arctic. As part of the study of possible future oil and gas development (or scenarios) in Baffin Bay and Davis Strait, potential impacts of the natural environment on marine-based oil and gas activities in the region were assessed. Components of the natural environment that may cause impacts to marine-based oil and gas activities in Baffin Bay and Davis Strait include:

- Current climate and climate change;
- Seismic activity (for example, earthquakes and resulting tsunamis); and
- Bathymetry (water depth or distance of the seafloor from the water surface).

8.1. EFFECTS OF CLIMATE AND CLIMATE CHANGE

During the Public Engagement Sessions, community members noted concerns and asked questions to the NIRB about the potential for offshore oil and gas activities, particularly the use of vessels, to interact with other activities to have a negative effect on the environment. Observations of climate change and resulting effects were shared throughout the engagement sessions.

Current climate and future climate change may result in extreme temperatures, fog, high winds, icing and floating ice, and other extreme weather events (for example, storms and waves) that may cause negative effects on marine-based oil and gas activities in Baffin Bay and Davis Strait, including:

- Less visibility for operation of equipment such as marine vessels;
- Delays in oil and gas development activities;
- Workers not being able to get to work sites;
- Damage to oil and gas facilities and equipment; and
- Build-up of ice on marine-based facilities.

Negative effects of current climate and climate change on possible oil and gas development in Baffin Bay and Davis Strait can be avoided or reduced (mitigated) by carrying out the following measures:

- Design of all activities and components, including materials selection, planning, facility construction and operation, equipment (including marine vessels), and maintenance, should consider normal and extreme environmental conditions in the region;
- Work should be scheduled to avoid predicted times of extreme weather for the safety of site personnel and facilities; and
- Use ice management systems to reduce ice build-up on marine-based facilities.

8.2. EFFECTS OF SEISMIC ACTIVITY

Baffin Bay and Davis Strait is considered as a marine region prone to seismic activity (for example, earthquakes and resulting tsunamis). Large earthquakes could result in damage to marine-based facilities and disruption of activities associated with oil and gas development in the region.

To reduce or prevent negative effects of seismic activities, such as earthquakes and tsunamis, facilities and equipment related to the various possible stages (or scenarios) of oil and gas development in Baffin Bay and Davis Strait would need to be designed according to the Canadian Standards Association and other applicable standards and guidelines to reduce the potential effects to marine-based oil and gas facilities from earthquakes in the region.

8.3. EFFECTS OF BATHYMETRY

Due to varying bathymetry (water depth or distance of the seafloor from the water surface) in Baffin Bay and Davis Strait, oil and gas equipment and facilities, such as exploration and production drilling equipment and marine vessels, could accidentally contact the seafloor during transport and result in damage to these human-made structures.

To reduce or prevent negative effects to oil and gas equipment and facilities from differences in water depth or distance from the water surface to the seafloor, additional studies of the bathymetry of the region, proper design of facilities and some dredging of the ocean floor may be required to reduce the likelihood of damage to oil and gas facilities and equipment during transport to project sites.

8.4. ACCIDENTS AND MALFUNCTIONS

Accidents or malfunctions that may result from effects of the environment on oil and gas activities would need to be managed through environmental management plans developed by each proponent and approved by applicable regulators. Environmental management plans would include emergency response measures and project personnel training requirements.

8.5. INFORMATION GAPS

Confidence in the conclusions for potential effects of the environment on oil and gas activities are based on future climate predictions and the existing climate information collected for Baffin Bay and Davis Strait. The accuracy of these climate change predictions for many of the environmental components (such as sea ice conditions) is medium to high. However, confidence in predictions on the strength and number of storms and the type of waves that could occur in the region in future is low. These uncertainties may need to be addressed to ensure that possible oil and gas equipment and facilities that may be used in Baffin Bay and Davis are designed to withstand potential impacts of the environment.

8.6. SUMMARY

The potential effects of the environment on possible future oil and gas development (or scenarios) in Baffin Bay and Davis Strait would need to be considered in the design, construction, and operation and maintenance of equipment and facilities that may be used for offshore oil and gas development.

Want more detail?
Look at Report: *Environmental Setting and Potential Effects* – Section 7.4: Effects of the Environment on Oil and Gas Activities

Any proponent proposing marine-based oil and gas development projects in Baffin Bay and Davis Strait would need to establish appropriate monitoring programs and use the adaptive management approach throughout exploration and production activities to manage potential impacts of climate change

and other components of the environment on oil and gas development projects in the region. The proponent would also need to confirm that compensation that adequately offsets the impacts to Inuit and Inuit traditional lifestyles would be available.

9. NEXT STEPS

The Preliminary Findings Report was developed as an opportunity to bring together the information received to date for the SEA. Both the NIRB and the QIA hope that this report is informative and provides information for participants to form their own opinion. This Report will be the focus of discussions during the final round of public community meetings planned for the Fall, 2018 in the communities of: Resolute, Grise Fiord, Clyde River, Pond Inlet, Arctic Bay, Pangnirtung, Qikiqtarjuaq, Cape Dorset, Kimmirut, and Iqaluit. This will be the final time the NIRB will visit the communities to collect feedback prior to the conclusion of the SEA. The NIRB will be accompanied by Crown-Indigenous Relations and Northern Affairs Canada, Nunavut Tunngavik Incorporated, the QIA, and the Government of Nunavut. The QIA will be bringing together the Inuit Qaujimajatuqangit advisors committee a second time to confirm the Inuit Qaujimajatuqangit that has been collected and used in the preliminary findings report, they will also provide input into an effects assessment based on the QIA's *Inuit Qaujimajatuqangit Report* that will submitted to the NIRB SEA process. There will be one (1) more opportunity for written comments and then the NIRB will hold a final Public Meeting in Iqaluit. Community representatives will be invited from each of the 10 communities to participate in the Public Meeting and the associated Community Roundtable. The Board members will consider all the information provided at the time of the final Public Meeting to prepare the recommendations for the Minister.

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APPENDIX A

Tracking Table of Topics from Public Feedback on SEA in Baffin Bay and Davis Strait

Community	Topic/Concern	Final Scope Section	Reason Not in the SEA (if applicable)	Preliminary Findings Section
Physical Environment				
Climate and Meteorology (weather and storm conditions)				
Resolute, Cape Dorset, Iqaluit	Consider tornadoes, earthqaukes, and tsunamis.	Components to be Considered - Physical Environment Assessment of Effects of the Environment on Oil and Gas Activities		Description of the Environment - Physical; Effects of the Environment on Oil and Gas Activities - Effects of Seismic Activity
Oceanography (including wind, waves, tides, currents, sea level, storm surge, and upwelling)				
Clyde River, Pangnirtung	Potential impacts to water from oil and gas activities, including accidents or malfunctions (e.g., spill).	Assessment of Effects of Offshore Oil and Gas Activities Other Considerations - Accidents and Malfunctions		Analysis of Potential Effects - Physical Environment; Accidents and Malfunctions
Grise Fiord, Qikiqtarjuaq	Currents are strong and need to be better understood. Community knowledge shared regarding currents.	Components to be Considered - Physical Environment		Description of the Environment - Physical
Sea Ice and Iceberg Conditions				
Arctic Bay, Grise Fiord, Resolute, Qikiqtarjuaq, Cape Dorset, Iqaluit	Ice and icebergs would need to be considered. Community knowledge shared on ice conditions.	Components to be considered - Physical Environment Assessment of Effects of Offshore Oil and Gas Activities Other Considerations - Accidents and Malfunctions Assessment of Effects of the Environment on Oil and Gas Activities		Description of the Environment - Physical Analysis of Potential Effects - Physical Environment
Iqaluit	Effects of oil rigs on sea ice.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Physical Environment
Geology (Coastal and Submarine)				
Clyde River, Pond Inlet, Pangnirtung, Qikiqtarjuaq, Iqaluit, Cape Dorset	The potential for extraction activities to result in earthquakes, landslides, or mudslides.	Components to be Considered - Physical Environment		Effects of the Environment on Oil and Gas Activities

Biological Environment				
Coast and Shoreline Environment				
Clyde River	Impacts to coastal organisms.	Assessment of Effects of Offshore Oil and Gas Activities Other Considerations - Accidents and Malfunctions		Analysis of Potential Effects - Biological Environment
Benthic flora and fauna (including soft corals and seaweed)				
Clyde River, Pond Inlet, Pangnirtung, Qikiqtarjuaq, Iqaluit	Include information on sea-bottom dwelling organisms and plants (for example, clams, shrimp, capelin, coral reefs, and phytoplankton) and effects from oil and gas activities.	Components to be considered - Biological Environment Assessment of Effects of Offshore Oil and Gas Activities		Description of the Environment - Biological; Analysis of Potential Effects - Biological Environment
Arctic Bay, Grise Fiord	Potential negative impacts from ship ballast water on water quality, including invasive species.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Physical Environment; Biological Environment
Fish and Fish Habitat (including water quality)				
Clyde River, Pangnirtung, Qikiqtarjuaq, Cape Dorset	Potential impacts to fish from seismic activity (e.g., cod and Arctic Char). Community knowledge shared on impacts of seismic activity on fish.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Biological Environment
Cape Dorset	Potential impacts to fish from an oil spill.	Other Considerations - Accidents and Malfunctions		Analysis of Potential Effects - Biological Environment
Waterbirds				
Pond Inlet	Potential for seabirds to be affected by seismic surveys.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Biological Environment
Marine Mammals				
Clyde River, Arctic Bay, Resolute, Pond Inlet, Qikiqtarjuaq, Cape Dorset, Iqaluit, Pangnirtung	Potential negative effects to marine wildlife from seismic surveying and drilling activities. Community knowledge shared on past effects of seismic surveying on marine mammals. Need for more Inuit Qaujimajatuqangit studies to be done on potential impacts of noise on marine mammals.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Biological Environment

Arctic Bay, Pond Inlet, Pangnirtung	Rules, regulations, and best management practices to reduce impacts to marine mammals from oil and gas and associated activities.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Biological Environment
Clyde River, Arctic Bay, Pond Inlet, Cape Dorset, Kimmirut, Pangnirtung, Iqaluit	Type of compensation to communities if wildlife were impacted by oil and gas activities, such as seismic activities.	Objectives - Describe possible oil and gas development	The SEA will include a general description of what would be expected in an Inuit Impact and Benefit Agreement. It is outside the Board's jurisdiction to discuss more specific compensation.	Analysis of Potential Effects - Human Environment
Clyde River, Pond Inlet, Resolute, Pangnirtung, Qikiqtarjuaq, Iqaluit	Community knowledge shared on wildlife behaviour.	Components to be considered - Biological and Human Environment		Description of the Environment - Biological
Clyde River, Resolute, Grise Fiord, Pond Inlet, Pangnirtung, Qikiqtarjuaq, Cape Dorset, Iqaluit	Use scientific information and Inuit Qaujimajatuqangit to conduct research on the food chain, including information on habitat, migration patterns, diet, distribution.	Components to be considered - Biological Environment	The SEA will consider existing available scientific information and Inuit Qaujimajatuqangit and knowledge shared by community members. Board recommendations could refer to additional studies that should be undertaken.	Description of the Environment - Biological Analysis of Potential Effects - Biological Environment
Pond Inlet, Pangnirtung	Potential effects on marine wildlife from shipping. Community knowledge shared on effects of shipping on marine mammals.	Assessment of Effects of Offshore Oil and Gas Activitities Assessment of Cumulative Effects		Analysis of Potential Effects - Biological Environment
Special and Sensitive Areas and Areas of Concern and Importance				
Pangnirtung, Cape Dorset, Pond Inlet, Qikiqtarjuaq	Consider, Marine Protected Areas, Bird Sanctuaries, National Wildlife Areas, coral reefs.	Components to be considered - Biological Environment		Description of the Environment - Biological Analysis of Potential Effects - Biological Environment
Iqaluit	Consider the North Water Polynya.	Components to be considered - Biological Environment		Description of the Environment - Biological Analysis of Potential Effects - Biological Environment

Qiqiktarjuaq	Include narwhal wintering areas.	Components to be considered - Biological Environment		Description of the Environment - Biological Analysis of Potential Effects - Biological Environment
Human Environment				
Economic Development and Opportunities				
Clyde River, Arctic Bay, Pond Inlet, Pangnirtung, Iqaluit, Qikiqtarjuaq	Potential tax savings and financial benefits, including royalties, partnerships in ownership, etc. for Nunavut and the Qikiqtani communities.	Assessment of Effects of Offshore Oil and Gas Activities	The SEA will include how benefits will flow and potential types of benefits. Specific numbers and commitments would be considered at a project level assessment.	Will be further considered.
Employment				
Pond Inlet, Pangnirtung, Qikiqtarjuaq, Cape Dorset, Iqaluit, Resolute	Numbers of potential jobs, type of qualifications required, and wages for Nunavummiut, as well as distribution among communities.		Would be considered at a project level assessment.	
Pond Inlet, Pangnirtung, Qikiqtarjuaq, Cape Dorset, Iqaluit, Resolute	Types of jobs associated with the oil and gas development scenarios.	Components to be considered - Assessment of Effects of Offshore Oil and Gas Activities		Will be further considered.
Education and Training				
Pond Inlet, Qikitarjuaq, Cape Dorset, Iqaluit, Clyde River	Need for training opportunities associated with the possible development scenarios.	Components to be considered - Human Environment	Specific courses or programs would be considered at a project level assessment.	Will be further considered.
Community Infrastructure and Services				
Pond Inlet, Qikiqtarjuaq, Iqaluit	Need for improved infrastructure to support offshore oil and gas activities.	Components to be considered - Human Environment Other Considerations - Accidents and Malfunctions		Analysis of Potential Effects - Human Environment
Iqaluit	Impact of the future deep sea port on oil and gas activities.	Components to be considered - Human Environment Oil and Gas Life Cycle Activities and Hypothetical Scenarios Report	Infrastructure is discussed at a general level.	Analysis of Potential Effects - Human Environment
Wellbeing and Health of Coastal Communities				

Pangnirtung	Impacts of flaring of natural gas on respiratory illness.	Would be dependent on the Possible Oil and Gas Development Scenarios and incorporated under Assessment of Effects of Offshore Oil and Gas Activities if applicable		
Traditional Activity and Knowledge and Community Knowledge (including Land Use, Food Security, and Cultural Activities)				
Clyde River, Arctic Bay, Grise Fiord, Resolute, Pond Inlet, Kimmirut, Pangnirtung, Cape Dorset	Importance of harvesting country food to Inuit culture and for nutrition. Food security is a significant concern. Community knowledge shared of observed changes to country food. Concern about the potential for oil and gas activities to further impact food security.	Components to be considered - Human Environment Assessment of Effects of Offshore Oil and Gas Activities		Description of the Environment - Human Analysis of Potential Effects - Human Environment
Clyde River, Pond Inlet, Resolute, Pangnirtung	Community knowledge shared regarding harvesting.	Components to be considered - Human Environment		Description of the Environment - Human
Clyde River, Resolute, Pond Inlet	The pristine environment is valued and tied to enjoyment of the environment, both for traditional (for example camping) and non-traditional reasons (such as tourism). Potential for offshore oil and gas activities to result in pollution and negatively impact enjoyment and use of the environment.	Components to be considered - Human Environment Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Human Environment
Cultural and Commercial Harvesting (including fisheries)				
Clyde River, Arctic Bay, Pond Inlet, Grise Fiord, Qikiqtarjuaq, Kimmirut	Potential negative effects from seismic surveying and other oil and gas activities on fisheries and compensation.	Assessment of Effects of Offshore Oil and Gas Activities	It is outside the Board's jurisdiction to discuss specific compensation.	Analysis of Potential Effects - Human Environment
Heritage Resources				
Clyde River	Many heritage and cultural sites in Baffin Bay and Davis Strait could be negatively affected	Components to be considered - Human Environment Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Human Environment
Other Reasonably Foreseeable Activities				

Grise Fiord	Increased ship traffic through the Northwest Passage.	Assessment of Effects of Offshore Oil and Gas Activities Assessment of Cumulative Effects		Analysis of Potential Effects - Physical, Biological, Human Environment
Other Considerations				
Climate Change				
Resolute, Cape Dorset, Pangnirtung	Climate change is an important consideration. Community knowledge shared on climate change.	Other Considerations - Climate Change		Description of the Environment - Climate Change Effects of the Environment on Oil and Gas Activities
Cape Dorset	Impact of climate change on icebergs and potential for increased icebergs to negatively impact oil rigs and platforms.	Other Considerations - Climate Change Assessment of Effects of Offshore Oil and Gas Activities		Effects of the Environment on Oil and Gas Activities
Iqaluit	Will the potential for the release of methane clathrates from meting sea ice be included.	Components to be Considered - Physical Environment Assessment of Effects of Offshore Oil and Gas Activities		Information Gaps
Iqaluit	How does the SEA fit in with Canada's targets on climate change and carbon cycle matters? Would Canada be able to meet its climate change targets?		The Federal Government determines how Canada's international commitments will be met. It is outside the Board's mandate to discuss the Government of Canada's compliance with international commitments.	
Accidents and Malfunctions				
Clyde River, Resolute, Pond Inlet, Cape Dorset, Iqaluit, Pangnirtung	Risk of disaster from earthquakes, high winds, storms, and icebergs.	Assessment of Effects of the Environment on Oil and Gas Activities		Accidents and Malfunctions; Effects of the Environment on Oil and Gas Activities
Clyde River, Arctic Bay, Resolute, Pond Inlet, Pangnirtung, Qikiqtarjuaq, Grise Fiord	Potential for ship based oil spills and oil spills from oil and gas activities and resulting effects on marine life and people.	Assessment of Effects of Offshore Oil and Gas Activities		Analysis of Potential Effects - Biological Evironment; Human Environment
Iqaluit	How will the probability of an oil spill be determined in the SEA?		The Board will consider modelling information shared but will not be undertaking independent spill modeling.	

Clyde River, Arctic Bay, Grise Fiord, Kimmirut, Pangnirtung, Qikiqtarjuaq, Cape Dorset, Iqaluit, Pond Inlet, Resolute	More information needed on the spill response regime (including notification to communities), spill prevention, spill response capacity, and related infrastructure, equipment and technology (including same season relief wells).	Other Considerations - Accidents and Malfunctions		Accidents and Malfunctions
Clyde River, Grise Fiord, Pond Inlet, Kimmirut, Pangnirtung, Iqaluit	Requirements for financial compensation in case of an accident.	Objectives of the SEA	The SEA will include a general description of what would be expected in an Inuit Impacts and Benefits Agreement. It is outside the Board's jurisdiction to discuss more specific compensation.	Analysis of Potential Effects - Human Environment
Qikiqtarjuaq	Behaviour of spilled oil. Consider currents, as they would carry spills south.	Other Considerations - Accidents and Malfunctions	The Board will consider modelling information shared but will not be undertaking independent spill modeling.	Accidents and Malfunctions
Iqaluit	Would there be medical staff on board to deal with potential medical emergencies?		This level of information could be considered in potential future project level environmental assessments.	
Jurisdiction and Responsible Authorities				
Arctic Bay, Iqaluit	Regulatory responsibilities and oil and gas regulations.	Other considerations - Jurisdiction and Responsible Authorities		Regulatory Roles in the Offshore Oil and Gas Industry
Pangnirtung, Iqaluit	What will the role of Inuit be in making decisions related to oil and gas?		The Board is working with the communities and the Qikqitani Inuit Association to ensure that Inuit Qaujimajatuqangit and Inuit Qaujimaningit are informing the SEA. The Federal Government is responsible for making decisions regarding oil and gas in the Canadian offshore waters. Inuit would be involved at a project level assessment.	

Subject of Note				
Natually Occuring Oil Seeps				
Pond Inlet, Pangnirtung, Kimmirut, Cape Dorset, Clyde River	Details on the seeps and associated seeps studies, including: data collected, amount of oil, management, and effects.	Subject of note - Naturally Occuring Oil Seeps		Description of the Environment - Physical
Pond Inlet, Pangnirtung, Cape Dorset	Use of the oils from naturally occuring seeps by government and companies.		This is outside of the scope of the SEA.	
Oil and Gas Activities				
Grise Fiord, Pond Inlet, Cape Dorset, Pangnirtung	Historic and current oil and gas activities and current resources in Nunavut.	Objectives - Describe possible oil and gas development		Past Oil and Gas Activities
Clyde River, Pangnirtung, Qikiqtarjuaq, Arctic Bay, Pond Inlet, Cape Dorset	Oil and gas activities and components that will be included in the scenarios, including seismic surveying, drilling, use of blowout preventers, possibility of and location of onshore facilities, pipelines, real or artifical islands.	Objectives - Describe possible oil and gas development		Possible Development Scenarios in Baffin Bay and Davis Strait
Qikiqtarjuaq, Cape Dorset	Specific information, such as size of survey area, and drilling depths.		This level of information could be considered in potential future project level environmental assessments.	
Arctic Bay, Resolute, Cape Dorset	Alternative technologies to seismic surveying and drilling.	Objectives - Describe possible oil and gas development		Scenario A - Exploration with Offshore Seismic Surveys
Iqaluit	No development scenario.	Objectives - Describe possible oil and gas development		Scenario D - No Offshore Oil and Gas Activity
Clyde River, Cape Dorset, Pangnirtung, Kimmirut	End use of any extracted oil and gas.		This level of information could be considered in potential future project level environmental assessments.	
Arctic Bay, Pond Inlet, Iqaluit, Resolute	Community experience shared regarding offshore oil and gas activities (Panarctic Oils Ltd.)	Objectives - Assess the potential impacts and benefits		Analysis of Potential Effects and Other Factors
Grise Fiord, Pond Inlet, Pangnirtung, Qikiqtarjuaq	What will happen after the moratorium? Will there be oil and gas activities?		The Federal Government is responsible for making decisions regarding oil and gas in the Canadian offshore waters.	

Iqaluit	Will the SEA consider the viability of offshore oil and gas in Baffin Bay and Davis Strait and what the break-even price of a barrel is?	General potential economic considerations and challenges included in Objectives - Describe potential challenges and Describe Oil and Gas Scenarios		Additional Factors to Consider to Possible Oil and Gas Development
Arctic Bay, Pond Inlet, Kimmirut	Consultation, knowledge of Inuit Qaujimajatuqangit and the Nunavut Agreement, plans, and other requirements for oil and gas companies.		Specific requirements for a project proponent would be considered in potential future project level environmental assessments.	
Resolute, Pond Inlet, Pangnirtung, Iqaluit, Cape Dorset	The government should be looking into alternative sources of energy to oil and gas, like wind energy.		Outside of the scope of the SEA.	
Impacts of the Environment on Offshore oil and gas				
Clyde River, Arctic Bay, Grise Fiord, Resolute, Pond Inlet, Cape Dorset, Iqaluit, Qikiqtarjuaq	Potential for icebergs and multi-year ice to impact oil and gas equipment (e.g., drills) and response measures, including how equipment would be repaired if damaged.	Assessment of Effects of the Environment on Oil and Gas Activities		Effects of the Environment on Oil and Gas Activities
Cumulative Effects				
Clyde River, Pond Inlet, Arctic Bay	Potential for cumulative effects to marine wildlife from increased shipping activities (including cruise ships), other industries such as fishing; and oil and gas activities and management practices.	Assessment of Cumulative Effects		Analysis of Potential Effects - Biological Environment; Human Environment
Qikiqtarjuaq	Community knowledge shared on effects to wildlife from other marine development.	Assessment of Cumulative Effects		Description of the Environment - Biological; Analysis of Potential Effects - Biological Environment

Transboundary Effects				
Arctic Bay, Pangnirtung, Qikitajuaq, Cape Dorset, Iqaluit	What is the state of oil and gas activity in Greenland?	Any other relevant matters		
Arctic Bay, Pangnirtung, Qikitajuaq, Cape Dorset, Pond Inlet	Concerns and the experiences other jurisdictions have had with oil and gas (for example, Greenland, Newfoundland, Alaska).	Any other relevant matters		Will be further considered.
Cape Dorset, Iqaluit, Pond Inlet	Potential for transboundary impacts resulting from oil and gas activities, including a spill.	Assessment of Transboundary Effects		Analysis of Potential Effects and Other Factors
Iqaluit	How would we compete with Greenland gas?	General potential economic considerations and challenges included in Objectives - Describe potential challenges		
SEA Process				
Pond Inlet	The information used for the SEA should be based on Arctic species applicable for the area.	The SEA will be focused on Baffin Bay and Davis Strait and potential transboundary effects.		Analysis of Potential Effects - Biological Environment
Qikiqtarjuaq, Iqaluit, Cape Dorset	What happens after the Final Report? Will we hear back from you? Will Nunavut be involved in any resulting processes?		The NIRB will be returning to the communities to report on the Board's conclusions and recommendations.	
Arctic Bay	Will the SEA Final Report include the concerns of community members?	Collection and Use of Information		Will be further considered.

APPENDIX B

Overview of Environmental Management[1]

Environmental Management	Inside Nunavut Settlement Area	Outside Nunavut Settlement Area
Economic and Benefits	Qikiqtani Inuit Association, Economic Development and Transportation (Government of Nunavut)[2], Crown-Indigenous and Northern Affairs Canada	Crown-Indigenous and Northern Affairs Canada
Environmental assessment	Nunavut Impact Review Board	National Energy Board
Fisheries and Marine Mammals	Nunavut Wildlife Management Board, Hunters and Trappers Organizations, Fisheries and Oceans Canada, Environment (Government of Nunavut)[2]	Nunavut Wildlife Management Board, Fisheries and Oceans Canada
Greenhouse Gases and other Airborne Pollutants	Environment and Climate Change Canada, National Energy Board, Environment (Government of Nunavut)[2]	Environment and Climate Change Canada, National Energy Board
Protected Areas (includes National Marine Conservation Areas, National and Marine Wildlife Areas, and Migratory Bird Sanctuaries	Fisheries and Oceans Canada, Parks Canada, Environment and Climate Change Canada, Transport Canada	Fisheries and Oceans Canada, Parks Canada, Environment and Climate Change Canada, Crown-Indigenous and Northern Affairs Canada, Transport Canada
Noise	Fisheries and Oceans Canada, National Energy Board, Transport Canada	Fisheries and Oceans Canada, National Energy Board, Transport Canada
Oil and Gas Activities	National Energy Board, Crown-Indigenous and Northern Affairs Canada	National Energy Board, Crown-Indigenous and Northern Affairs Canada
Shipping	Transport Canada, Canadian Coast Guard, Environment and Climate Change Canada	Transport Canada, Canadian Coast Guard, Environment and Climate Change Canada
Accidents/waste/oil spills	Transport Canada, Canadian Coast Guard, National Energy Board, Crown-Indigenous and Northern Affairs Canada, Environment and Climate Change Canada	Transport Canada, Canadian Coast Guard, National Energy Board, Crown-Indigenous and Northern Affairs Canada, Environment and Climate Change Canada

[1] Table does not represent a comprehensive list.
[2] Interest but no formal jurisdiction.

General Policy	Nunavut Marine Council, Nunavut Tunngavik Incorporated, Qikiqtani Inuit Association, Government of Nunavut, National Energy Board, Crown-Indigenous and Northern Affairs Canada, Fisheries and Oceans Canada, Parks Canada, Environment and Climate Change Canada, Transport Canada	Nunavut Marine Council, Government of Nunavut, Nunavut Tunngavik Incorporated, Qikiqtani Inuit Association