OIL SPILL RESPONSE CAPACITY IN NUNAVUT AND THE BEAUFORT SEA

RESPONDING TO ARCTIC SHIPPING OIL SPILLS: RISKS AND CHALLENGES

As the Arctic warms and sea ice diminishes, the biggest threat to the Arctic marine environment from ships is from an oil spill. Less summer sea ice has already led to increases in ship traffic, yet significant legislative, capacity, information and funding gaps exist in the current spill response framework in both Nunavut, and in the Beaufort region.

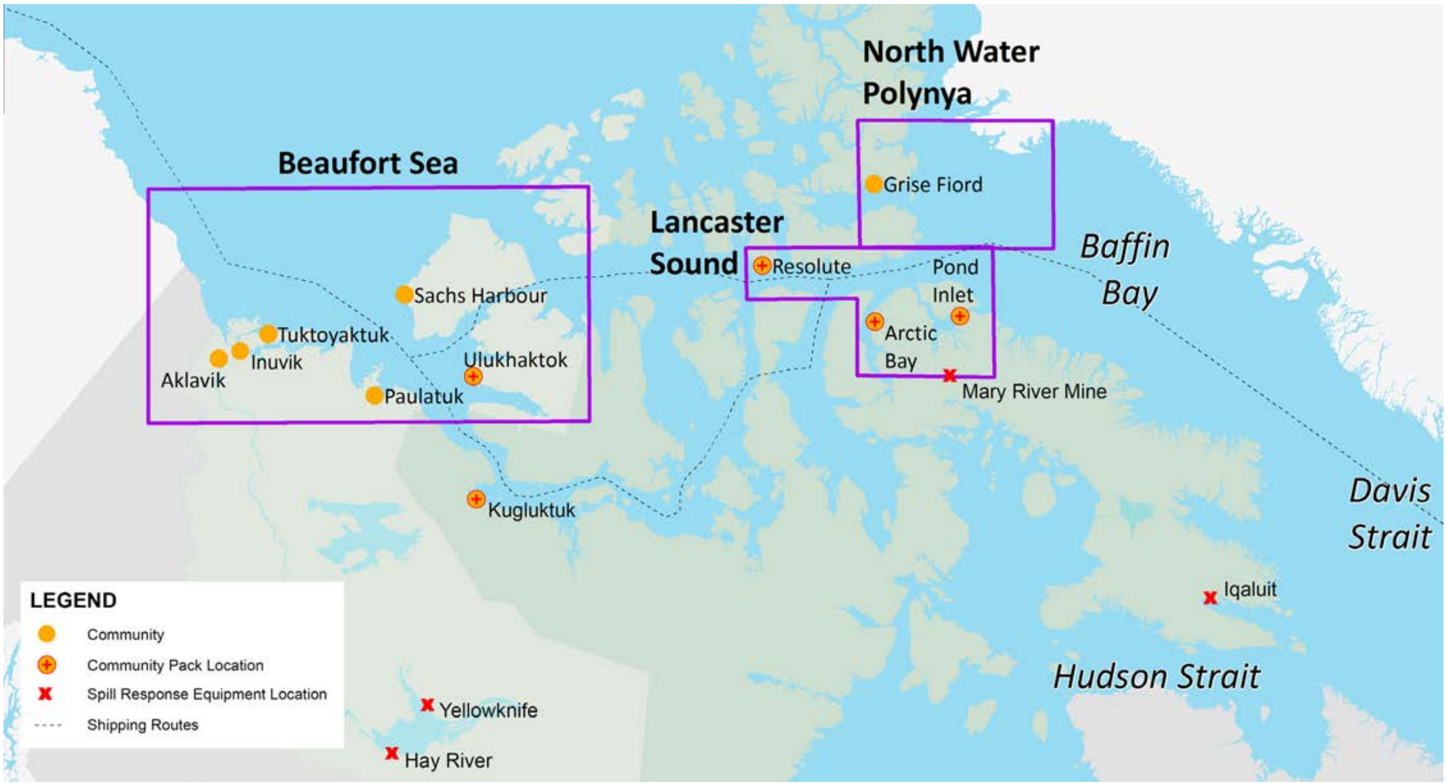
Although the Canadian Coast Guard has developed national, regional, and area response plans, these plans rely on capacities and methods that may not exist or cannot be adapted in remote communities to respond to a ship-based spill.

An Arctic shipping oil spill would devastate the surrounding marine environment, including the destruction of habitat for polar bears, seals, walrus, sea birds, as well as beluga, narwhal and bowhead whales. These consequences would be mainly borne by the communities, not the responsible parties. Arctic communities depend on healthy and clean waters for much of their food, and their cultural and spiritual well-being is tied to their environment.

WWF-Canada commissioned a series of reports to identify barriers that will prevent northern communities from effectively responding to a ship-based oil spill. Parallel reports for the western Beaufort region and Nunavut outline these barriers, and are summarized below. A third report provides a framework for developing realistic oil spill response plans for Nunavut communities. To effectively address the issues of oil spill response capacity in the North, engagement with communities is crucial to developing a framework that works within the Arctic context.

GEOGRAPHY AND POPULATION

The reports focus on remote regions above the Arctic Circle in Nunavut and the Northwest Territories, where communities generally rely on a mixed subsistence and market economy. Many people spend time harvesting land and sea mammals to supply a significant portion of their diet. Traditional knowledge is passed from generation to generation, and is an important element of northern Indigenous culture. When the environment is disrupted, it will undoubtedly have a significant impact on communities.



BEAUFORT REGION

The Beaufort region includes more than 7,500 kilometres of coastline. The area roughly corresponds with the Inuvialuit Settlement Region (ISR), one of the four Inuit regions of Canada. This region is also considered part of the southern route of the Northwest Passage.

In the Beaufort Region, the major communities are Inuvik, Tuktoyaktuk, Aklavik, Paulatuk, Kugluktuk, Sachs Harbour and Ulukhaktok. The total population of the communities is 5,767 people, of which more than half are Inuvialuit.

NUNAVUT

This report focuses on the four northernmost communities in Nunavut. Above the Arctic Circle, much of Nunavut's territory is a series of islands that make up the Arctic Archipelago. The largest of these is Baffin Island, which is home to the Mary River iron ore mine. All four communities are either on or close to the northern route of the Northwest Passage.

The total population of the four Nunavut communities is just over 2,800 people, with more than half of those living in Pond Inlet, the closest community to the Mary River mine. The vast majority of Nunavut residents are Inuit.

EXISTING ARCTIC SHIPPING OIL SPILL RESPONSE FRAMEWORK AND STANDARDS

The reports describe the framework that is in place to ensure that ships travelling through the Arctic have the capability to respond to an oil spill. It shows that while there are plans and standards in place, there are also gaps and uncertainties.

NATIONAL/INTERNATIONAL

- Canadian law requires ships to contract with a response organization that can provide equipment and personnel sufficient to clean up the amount of oil a ship is carrying, up to 10,000 tonnes. However, ships travelling north of 60 degrees' latitude are exempt from these provisions.
- Under Canadian and international law, all tankers over 150 tonnes and all other vessels over 400 tonnes must have a Ship Oil Pollution Emergency Plan (SOPEP), which includes reporting procedures, authorities to be contacted and actions to be taken. Currently, SOPEPs are not Arctic-specific and may not account for communications challenges that could arise in attempting to report a spill in the Arctic.
- Canada also has the National Marine Spills Contingency Plan, which includes a Central and Arctic Regional Plan that details the procedures, resources and strategies to be used in the event of spill.

BEAUFORT REGION

The **Canada/United States Joint Marine Pollution Contingency Plan** includes a **Joint Response Team** for both countries to co-ordinate when necessary. It also sets out procedures for Arctic nations to notify and request assistance from each other in the event of a spill, and includes commitments to maintain a national oil spill response plan.

The **Beaufort Sea and Amundsen Gulf Area Plan** identifies specific geographical priority areas and proposes tactics to protect these areas in the first 12 to 24 hours after a spill.

NUNAVUT

As part of the **Nunavut Agreement**, the **North Baffin Regional Land Use Plan** prohibits ships from coming within 10 kilometres of coastlines, and within 25 kilometres from the coastlines of Lancaster Sound, one of the most biologically productive areas of the Canadian Arctic.

The **Nunavut Land Use Plan** is expected to be completed by the end of 2017. The 2016 draft of the plan identifies several other protected areas with seasonal restrictions to protect wildlife habitat such as sea ice crossings and calving grounds.

GAPS IN OIL SPILL RESPONSE FRAMEWORK

PHYSICAL ENVIRONMENT

Arctic conditions limit the effectiveness of response equipment and often prevent any response at all. The Arctic climate is defined by major seasonal changes and sea ice for nine out of every 12 months. Cold air temperatures persist for much of the year, with most communities experiencing at least 250 days below freezing. Rain, blowing snow, fog, gale-force winds and prolonged periods of darkness limit visibility.

The presence of sea ice is the largest limiting factor in an adequate oil spill response.

During the small window when a response would be possible, several other environmental factors would impede an adequate oil spill response:

- High waves and strong winds common to Arctic waters make it impossible to contain oil using a boom, a critical tool used to prevent oil from reaching the shoreline.
- If visibility is less than one kilometre, it is extremely difficult to find and recover oil slicks.
- Recovery cannot take place during darkness, which persists through most of the winter months.
- Response ships can become unsafe to operate due to ice buildup.

The type of oil used by the majority of ships, heavy fuel oil (HFO), is also extremely difficult to remove from the environment, even in ideal conditions.

EQUIPMENT

What Exists

The Canadian Coast Guard (CCG) is the primary source of spill response in the Arctic. Community packs containing basic equipment designed for small near-shore spills (up to one tonne of oil) have been placed in Resolute, Arctic Bay and Pond Inlet in Nunavut, and in Kugluktuk and Ulukhaktok in the Beaufort region.

Both Iqaluit and Tuktoyaktuk have stockpiles of equipment, as does the Mary River Mine on Baffin Island. Additional oil spill resources are available from the CCG base in Hay River, south of Yellowknife.

Remnants of sea ice in late summer in Resolute Bay, Nunavut

WWF staff and volunteers practising the use of a boom to catch oil spills on water at the NordNorsk Beredskapssenter in Fiskebol, a training centre where people learn how to clean up oil and gas spills in water and along the coast. Lofoten Islands, Nordland, Norway.

Capacity Limits

Inadequate equipment

The largest equipment available in the Arctic can recover up to 1,000 tonnes of oil. However, tankers carrying fuel to the Mary River Mine can carry up to 4,500 tonnes of diesel, and community resupply vessels carry up to 18,000 tonnes of fuel oil.

Maintenance

Maintenance of community packs has been inconsistent. The Arctic environment renders mechanical equipment inoperable if it isn't properly maintained, so it is unknown whether the community packs are functional.

Access

Assuming the equipment is functional, accessing it would be another challenge. Some communities don't have a key for the locked storage containers because the CCG is concerned about maintaining responsibility for the equipment inside.

Transport to spill site

Even if the community can access the equipment, and it is functional, the small aluminum boats provided may not be sufficient to transport the equipment to the spill site in poor weather conditions. Larger boats better able to withstand harsh weather would then need to be located.

If the spill occurred in a community without a pack, the hamlet would need to arrange for an airplane to deliver the equipment from a nearby community and transport it from the airstrip to the spill site.

Storage and disposal

No hazardous waste facilities exist in the Arctic; all materials must be stored and transported south. Though response equipment in Iqaluit and Tuktoyaktuk is designed to recover up to 1,000 tonnes of oil, the containers in Tuktoyaktuk can only store up to 275 tonnes, with capacity in Hay River for an additional 240 tonnes. Oil cannot be removed from the environment if there is nowhere to store it.

People

The number of trained responders in northern communities is limited due to several factors. The communities are small, so there are only so many people to draw upon. In addition, people are often away from the community for long stretches, like during subsistence harvesting times, meaning a larger number would need to be trained to ensure there are always enough people available (anywhere from five to 16 community responders are necessary, depending on the equipment).

Government funding for training is currently well below what is necessary to recruit and train an appropriate number of community members. And even if enough people could be found and trained, there is little opportunity to practise or maintain skill levels.

Finally, in the event of a large spill, many responders would need to be flown in from larger centres. Small communities will likely not have the resources to house, feed and support the influx of people.

OTHER FACTORS THAT LIMIT RESPONSE

OIL SPILL BEHAVIOUR

Heavy fuel oil (HFO) is the fuel most often used by large shipping vessels. Of all the marine fuel options, it is also the most damaging in the event of a spill. The use of HFO is banned in the Antarctic, and several organizations (including WWF) are working with the International Maritime Organization to phase out the use of HFO in the Arctic.

The spreading and weathering of oil, and whether it comes in contact with ice, affects the way and the extent to which it can be recovered. Unfortunately, it is very difficult to conduct in-the-field research on how oil spills behave in the Arctic environment, so most of the information that exists is inferred from lab research.

COMMUNICATIONS INFRASTRUCTURE

Reliable communications infrasrtucture capable of providing information on weather and sea conditions, maintaining contact with on-the-ground and incoming responders, as well as being able to monitor the spill are all essential to an effective response.

The community nearest to the spill would serve as an important communications hub. However, in the Arctic, cellphone and Internet networks are quickly overwhelmed, slowing Internet speeds, preventing phone calls, and potentially leading to a complete breakdown in emergency response protocol.

It is also critical for incoming responders to have information about safe maritime routes, including the presence of sea ice and inclement weather. If communications systems are inoperable, area surveys may be needed before vessels can assist, leading to more response delays.

RESPONSE TIME

Canadian law provides response times for different levels of spills, which must be adhered to by regional response organizations. However, these standards are not in line with current response capabilities in the Arctic:

Response Equipment Type	Response Standard South of 60	Estimated Response Time North of 60
Oil spill up to 150 t	Six hours	48 hours
Oil spill up to 1,000 t	12 hours	One week

If a CCG icebreaker was in the region, it could provide additional assistance, but there are only three ships responsible for the whole of the Northwest Passage.

In 2008, the Baffin Regional Area Plan identified specific geographical priority areas (including Lancaster Sound) and proposed tactics to protect these areas in the first 12 to 24 hours after a spill. However, there are very few details or recommendations in the plan, and the CCG cautions that the strategies it outlines are untested and require an on-site assessment to confirm their validity.

A Canadian coast guard ship and a Russian converted research vessel carrying tourists in Resolute Bay, Qikiqtaaluk Region, Nunavut

CONCLUSIONS AND RECOMMENDATIONS

Shipping in the Canadian Arctic is a dangerous and precarious endeavour. Navigation is challenging, weather and visibility are often poor, sea ice is difficult to detect and the waters are inadequately charted. Yet, as sea ice melts, shipping is only increasing in the region, along with the risk of oil spills that threaten the sensitive Arctic ecosystem and the wildlife and communities that depend on it.

The extreme Arctic climate makes a successful oil spill response enormously challenging, even with unlimited personnel and equipment. However, there are several measures that could provide added safety and reduce the risk of spills, as well as increasing response capabilities:

1. Incorporate Inuit organizations into the Northern Marine Transportation Corridors Initiative

Inuit and Inuvialuit should have a greater role in decision-making that shapes the future of Arctic shipping. The Northern Marine Transportation Corridors Initiative is a CCG and Transport Canada program tasked with identifying specific shipping routes through the Arctic to improve safety. Arctic Indigenous peoples should be fully incorporated into this process.

2. Increase preventative measures

Shipping lanes should be identified using information on subsistence use and environmentally sensitive habitats. Transport Canada should then designate preferred routes, as well as areas to be avoided, and take these routes and areas to the International Maritime Organization.

3. Eliminate the use of heavy fuel oil in the Arctic

The Government of Canada, under the jurisdiction of Transport Canada, should implement a ban on HFO through national legislation, with a phase-out period to allow industry and re-supply vessels time to build new ships and integrate lighter fuels into their business models.

4. Strengthen oil spill response plans

Response plans should be made Arctic-specific and address the logistical challenges of a spill response. Ships should be required by international and Canadian law to carry equipment for an initial response to a spill, and should have effective damage control measures in place to help mitigate the longer response times often encountered in the Arctic due to extreme weather.

5. Implement southern response standards in the North

Indigenous communities in the North should not receive a lower level of protection from spills simply because there are fewer ships in the region and communities are less populated. Standards for contracting with response organizations south of 60 degrees' latitude should also be implemented in the North.

6. Develop local capacity to respond to spills

The CCG should develop a list of trained individuals in each community, and incorporate training for oil spill response in schools and community organizations. Funding is also required to develop local training organizations and advisory boards, and to ensure Indigenous voices are heard in the decision-making process. Additional resources are also needed for oil recovery storage, response boats, harbours, boat ramps and on-shore response equipment.

7. Integrate Arctic-specific measures into Canada's Oceans Protection Plan

Canada's Oceans Protection Plan commits to improving Canada's oil spill preparedness. The Government of Canada should commit to making the Arctic a top priority, and should be held accountable.

FOR MORE INFORMATION:

Andrew Dumbrille
Senior specialist, sustainable shipping, WWF-Canada
(613) 232-2506
adumbrille@wwfcanada.org

Framework for the Development of Nunavut Community Oil Spill Response Plans

© Brandon Laforest / WWF-Canada

WWF

nuka RESEARCH & PLANNING GROUP, LLC.

March 2017

Framework for the Development of Nunavut Community Oil Spill Response Plans

Report to WWF Canada

Elise DeCola and Sierra Fletcher
Nuka Research and Planning Group, LLC

Layla Hughes
Layla Hughes Consulting

Contents

Framework for the Development of Nunavut Community Oil Spill Response Plans

1 Introduction

Purpose and Scope

This is the second of two reports commissioned by WWF-Canada to address gaps in the current marine oil spill response framework in Nunavut and identify a pathway to enhance local spill response planning and capacity. The first report presents background information and evaluates the current baseline of legislation, capacity, information, and funding to support community-level oil spill preparedness commensurate with existing and potential future risks from shipping activities in this region.[1]

This second report provides background information and a suggested process for the development of community oil spill response plans for four coastal communities in Nunavut. This report also provides a primer on oil spill response techniques and methods, with a focus on the selection and application of approaches that may be appropriate for Nunavut hamlets. It outlines a "roadmap" for implementing community-based oil spill response planning in Nunavut coastal communities, with an initial focus on Pond Inlet, Arctic Bay, Resolute and Grise Fiord (see map in Figure 1). It also reviews best practice for the development of community-based spill response plans and capacity in remote arctic communities.

Together with the first report, this report will provide a basis for a strategy on marine protection from oil contamination and a framework for response preparedness. The model applied in each of these four communities can be exported more broadly across Nunavut hamlets as funding permits.

[1] The first report, *Background Information on for Community Oil Spill Response Planning in Pond Inlet, Grise Fiord, and Arctic Bay,* was completed in October 2016 by Layla Hughes.

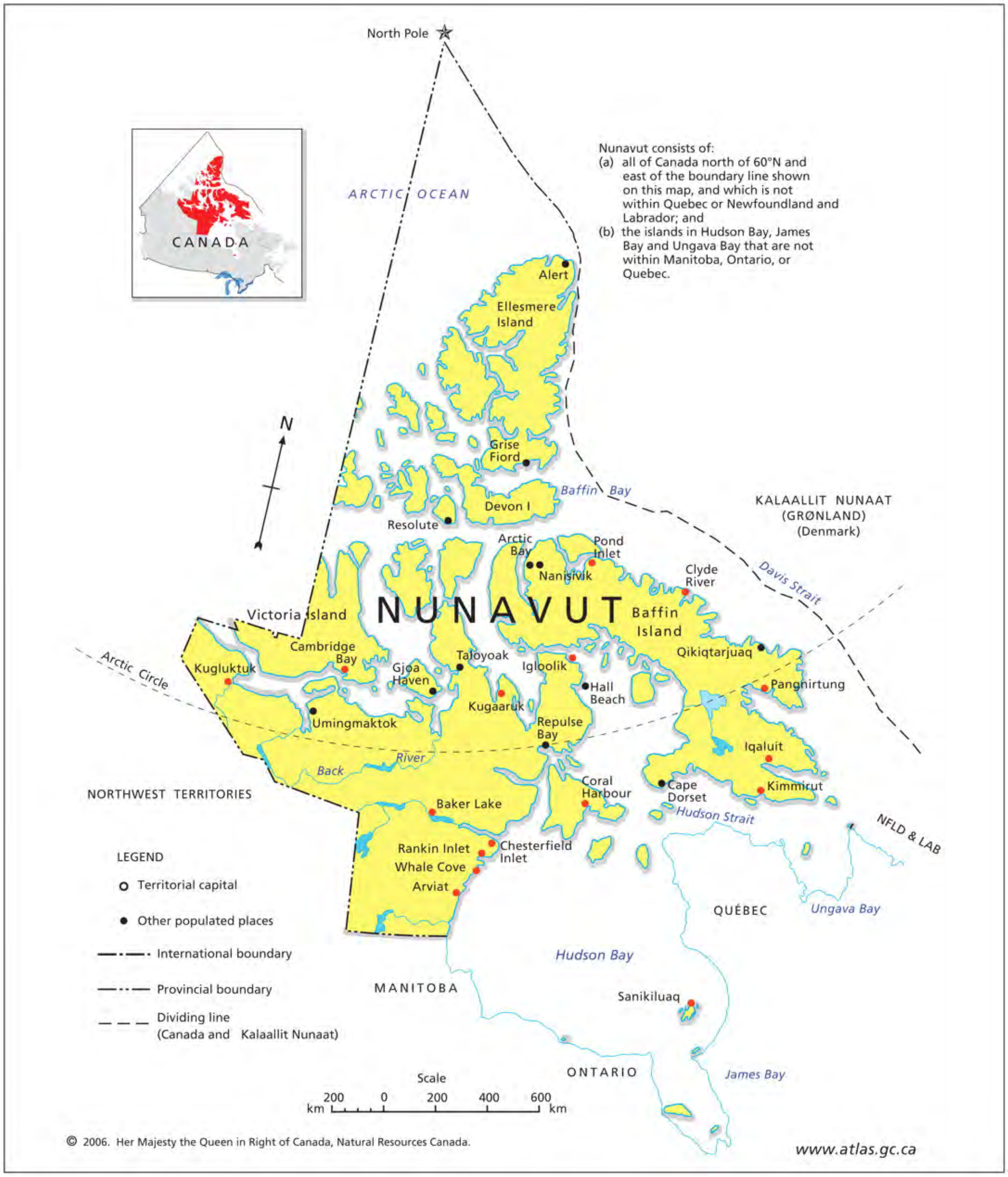


Figure 1. Map of Nunavut

About this Report

This document is not in and of itself an actionable spill response plan. It is instead a guide for local government and other partners to use in implementing a response preparedness assessment and then develop plans, stockpile equipment, and train local responders to create a community-based spill response capacity.

This report is organized into sections. Sections 1 and 2 provide context and background regarding oil spill response planning in Nunavut. Sections 3 through 5 contain a basic primer on oil spill response techniques and considerations for spill response in arctic coastal communities. Topics include: fate and behavior of oil spills in arctic waters (Section 3); oil spill response and cleanup options (Section 4); and oil spill management and response organization (Section 5). The information in Sections 3 through 5 is meant to provide a basic understanding of key issues that will inform the planning and preparedness process.

Sections 6 through 8 provide a roadmap for developing community-specific response plans. Section 6 presents a framework for oil spill response planning that builds on a conceptual model of spill risk, preparedness, and response cycles. Section 7 suggests a plan development process as well as a format and organization for plan contents. Section 8 suggests a process for evaluating existing oil spill response capacity in Nunavut communities, and building sufficient capacity to support risk-based preparedness. Section 9 presents the authors' conclusions.

This report was developed by Nuka Research and Planning Group, LLC and Layla Hughes Consulting under contract to WWF-Canada.

2 Background

Legal and Policy Framework

The first report in this series describes the regulatory framework and entities responsible for marine activities, oil spill preparedness and response, and environmental protection in Nunavut. Table 1 summarizes this information as it applies to oil spill response planning, and identifies roles and responsibilities for different government authorities as they relate to oil spills in Nunavut.

Table 1. Legal and Policy Guidance, Authorities, and Applicability to Oil Spill Response Capacity and Planning in Nunavut

Legal or Policy Guidance	Authorities	Applicability to Oil Spill Response Capacity and Planning in Nunavut
LOCAL AND REGIONAL REGIME		
Nunavut Land Claims Agreement (NLCA)	Nunavut Tunngavik Incorporated (NTI) Regional Inuit Associations (e.g. Qikiqtani Inuit Association) Nunavut Inuit Wildlife Secretariat Nunavut Wildlife Management Board (NWMB) Government of Canada: Department of Fisheries and Oceans (DFO) Nunavut Marine Council (NMC)	NLCA provides overarching policy direction for the development and review of land use plans in Nunavut, including marine areas. Land use plans govern activities such as shipping that may create oil spill risks. Regional Inuit Associations manage Inuit-owned lands and can play an important role in the development of community response as advocates for Inuit rights. Nunavut Inuit Wildlife Secretariat represents territorial wildlife issues and can help identify priority areas for community protection, contribute information about logistical concerns, play a role in the protection of wildlife during a spill, and advocate for additional support to protect Inuit wildlife resources in response planning. NWMB is the main instrument of wildlife management and the main regulator of access to wildlife in the Nunavut Settlement Area. The Board's mandate, implemented through co-management with DFO, is to help ensure the protection and wise use of wildlife and wildlife habitat for the long-term benefit of Inuit and the rest of the public of Nunavut and Canada. NMC advises and makes recommendations to other government agencies regarding the marine waters of the Nunavut Settlement Area.
North Baffin Regional Land Use Plan	Communities of Resolute, Arctic Bay, Grise Fiord, and Pond Inlet Nunavut Planning Commission (NPC) Canadian Coast Guard (CCG)	Plan requires regular meetings between CCG and communities to discuss shipping-related concerns. Establishes setbacks and limits to keep ships at a certain distance from coastlines and ice floe edges. NPC is also responsible for updating Land Use Plans.

Legal or Policy Guidance	Authorities	Applicability to Oil Spill Response Capacity and Planning in Nunavut
Nunavut Land Use Plan (NLUP)	NPC Minister of Indian Affairs and Northern Development (INAC) Nunavut Impact Review Board (NIRB)	Plan in development (due 2017). Sets out broad goals including environmental protection, conservation planning, and sustainable development. Defines land use designations, which include special management areas that may limit activities like shipping during certain times. NPC conduct conformity determinations, although INAC has authority to grant exemptions. NIRB reviews project proposals, even those exempted by INAC.
Oil spill preparedness and response policies	Government of Nunavut, Department of Environment (DOE): Environmental Protection Division (EPD) Petroleum Products Division (PPD) Arctic Regional Advisory Council (RAC) The Northwest Territories/Nunavut Spills Working Group	The Government of Nunavut is responsible for ensuring preparedness and response for land-based spills and spills that occur along Nunavut's coastlines. The EPD enforces Canada's Spill Contingency Planning and Reporting Regulations, which require spill contingency plans for fuel handling and storage facilities. The regulations require an inventory and the location of response and clean up equipment available to implement the spill contingency plan but they do not specify how much or what kinds of equipment must be included in the plan, nor whether marine or shoreline protection and cleanup equipment must be on hand. Nunavut's PPD has recently updated Oil Pollution Emergency Plans (OPEP) for fuel-handling facilities in all of the communities in Nunavut. These plans outline response techniques, including for the containment of fuel in water and in ice. The plans also provide an inventory of dedicated facility spill response equipment. The DOE has a conservation officer in every hamlet and a Regional Environmental Protection Officer in Pond Inlet. These personnel receive a 4-day spill response course focused on land-based spills but with some attention to marine spills. The Arctic RAC is comprised of representatives from local government, Aboriginal interests, the fishing industry, commercial shipping, conservation groups, and others, with a mandate to make recommendations to the Ministry of Transport on policy issues affecting regional preparedness and response. It is unclear how active or authoritative the Advisory Council is at present. The Northwest Territories/Nunavut Spills Working Group is an inter-agency group that provides coordination for spill reporting and response. The Government of Nunavut and Government of Canada (CCG) have overlapping responsibilities regarding the protection and cleanup of shorelines.

Legal or Policy Guidance	Authorities	Applicability to Oil Spill Response Capacity and Planning in Nunavut
Nunavut Emergency Measures Act	Government of Nunavut, Emergency Management	Creates ministerial authority to establish policies, criteria and other measures regarding the preparation and maintenance of emergency management programs and their testing and implementation.
Local environmental policies	Government of Nunavut, Department of Environment: Division of Wildlife Management, Fisheries and Sealing Division of Parks and Special Places	Government of Nunavut manages and protects important wildlife and habitat. Divisions within the government may have valuable expertise to contribute to the development of local response plans.
FEDERAL REGIME		
Arctic Waters Pollution Prevention Act	Government of Government of Canada: Transport Canada (TC), Coast Guard (CCG)	Prohibits pollution from ships and creates shipping safety control zones.
Canada Shipping Act	Government of Canada: Transport Canada (TC), Coast Guard (CCG)	Requires ships over 300 GT to report their geographic position under Northern Canada Vessel Traffic Service Zone (NORDREG) before entering Canadian arctic waters.
Marine Oil Spill Preparedness and Response Regime – Ocean Protections Plan	Government of Canada: Transport Canada (TC), Coast Guard (CCG)	TC sets the guidelines and regulatory structure for the preparedness and response to marine oil spills and is responsible for ensuring that the appropriate level of preparedness is available to respond to marine oil pollution incidents in Canada. In November 2016, TC announced a new initiative – Ocean Protections Plan – to strengthen oil spill prevention and response in Canadian waters.

Legal or Policy Guidance	Authorities	Applicability to Oil Spill Response Capacity and Planning in Nunavut
Federal environmental and wildlife policies	Environment and Climate Change Canada (ECCC) National Environmental Emergencies Centre (NEEC) Canadian Wildlife Service (CWS)	ECCC oversees resource conservation, protection of water resources, and weather forecasting. The ECCC coordinates environmental emergency preparedness and response for both land and marine incidents. NEEC provides environmental information and scientific advice to inform the CCG's planning for and response to a spill, including contaminant dispersion and trajectory modeling, fate and behavior of hazardous substances, oil sensitivity mapping data, and the establishment of cleanup priorities and techniques. NEEC also oversees the protection of sensitive ecosystems and wildlife such as migratory birds and fish. The CWS, which is part of NEEC, provides advice on wildlife protection, rescue and rehabilitation. In the event of a spill, the agency would also issue permits for wildlife hazing and capture, if necessary. The agency has issued response plan guidance for oiled birds, but wildlife treatment is typically provided by a third party contractor hired at the time of a spill.
Emergency Management Act	Government of Canada: Coast Guard (CCG), Transport Canada (TC) Government of Canada: Royal Canadian Mounted Police (RCMP)	CCG develops and maintains the national, regional, and area oil spill response plans, which must conform to the guidelines and regulations set out by TC. The National Marine Spills Contingency Plan (National Response Plan) outlines the responsibilities of various entities. South of 60 degrees north, the operators of a ship are responsible for responding to a spill and are required to contract with a Response Organization that supplies the equipment and personnel to conduct the response. In the arctic, where there are no Response Organizations, the CCG is the primary entity responsible for managing and carrying out a spill response. The CCG and the Government of Nunavut have overlapping responsibilities regarding the protection and cleanup of shorelines. The Royal Canadian Mounted Police (RCMP) has detachments in all four communities and has provided initial reconnaissance about marine spill locations in advance of the arrival of responders. The RCMP may also have the keys to access to the CCG's response equipment that is stored in the communities.

Inter-governmental Coordination

When an oil spill occurs, the response is typically coordinated among different levels of government and private industry. The spiller – or responsible party – typically plays an important role in directing and paying for the clean up. This makes spill response different from natural disasters or other types of emergencies.

Figure 2 summarizes some of the key roles and responsibilities for government and industry during a spill response in Nunavut. Because there are no certified Response

Organizations (RO) in the Canadian Arctic, the Government of Canada (Coast Guard) provides the spill response equipment and resources. It is possible that the responsible party might contract for additional resources from an RO or other source.

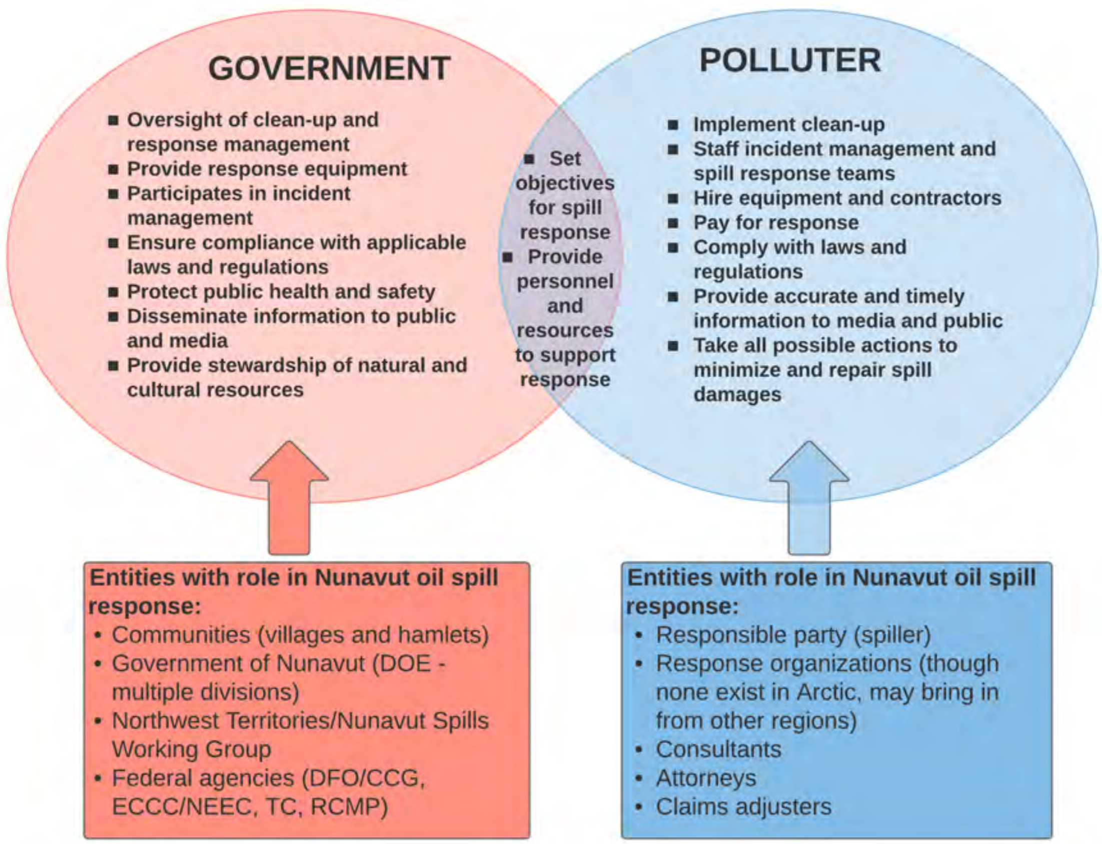


Figure 2. Roles and Responsibilities for Oil Spill Response in Nunavut

Existing Oil Spill Response Plans

A hierarchy of oil spill response plans exists to guide emergency preparedness and response for both the government and industry. For the Nunavut communities considered in this report, community oil spill response plans may be developed using the framework and process in this report. Community-level plans must fit into a hierarchy of government plans that move from local to regional to national.[2]

The industry that stores and transports oil is also responsible for developing response plans. Shipping companies are required under federal and international law to develop Shipboard Oil Pollution Emergency Plans (SOPEP) if they are over a certain size (150 GT for tankers and 400 GT for all other vessels).[3] Oil handling

[2] Area Response Plans are undergoing major revisions based on a federal initiative announced in 2016.

[3] SOPEPs must include: (1) procedures for notification in the event of a spill, (2) authorities to be notified, (3) actions to be taken by crew in the event of a spill, and (4) the point of contact on board the vessel who will

facilities in Nunavut have oil spill and emergency response plans developed by the Petroleum Products Division.

Figure 3 shows how the different levels of planning relate.

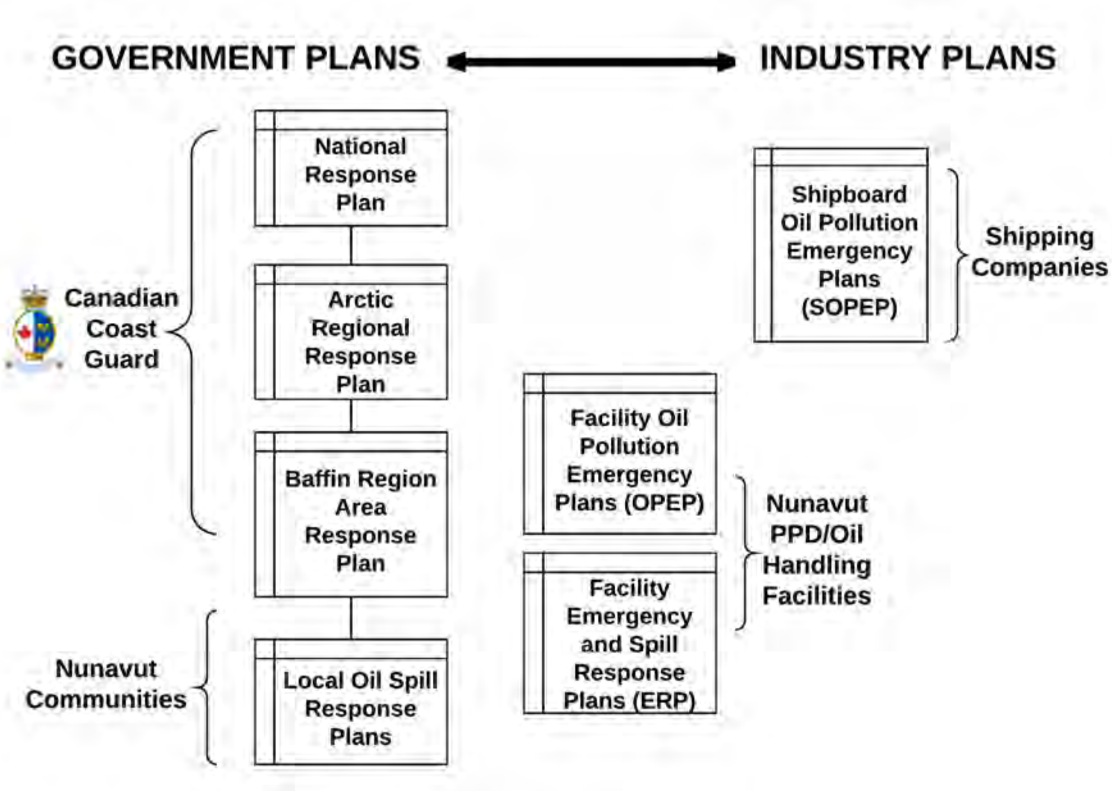


Figure 3. Hierarchy of Oil Spill Response Plans in Nunavut

The planning process and plan contents recommended in this report would supplement existing planning by focusing on the priorities and needs of Nunavut communities in oil spill preparedness and response. The intent of the Nunavut community spill response plans is to complement existing plans, while providing additional information in areas including:

- Local government and community roles and responsibilities during oil spills;
- Priorities for protecting the community's priority resources during oil spills and strategies for implementing site-specific protection plans such as geographic response plans (GRP) or geographic response strategies (GRS);[4]

coordinate with national or local authorities in responding to the spill (MARPOL Annex 1, Ch. 5, Reg. 37). They do not include any location-specific information or oil spill response resources.

[4] Differing terminology is used to describe site-specific oil spill protection plans in other jurisdictions. There is not a single established term in use across Canada at the time of publication.

- Capability and gap assessment for oil spill response resources at the community or hamlet level;
- Local policies and preferences regarding oil spill response tactics and techniques;
- Local and traditional knowledge that is not necessarily reflected in existing government and industry plans.
- Process for incorporating local and traditional knowledge to inform decision-making during a response.

Key Considerations for Community Oil Spill Response Planning

This section summarizes the considerations for oil spill response planning and capacity in Nunavut that were outlined in the first report (Hughes, 2016). These are fundamental to the development of a framework for local oil spill response planning.

Spill Response Capacity

The communities of Pond Inlet, Resolute, Arctic Bay, and Grise Fiord lack infrastructure, trained personnel, and response equipment to mount an effect response to a spill. Even with adequate response capacity, the weather and ice could make a response challenging.

However, the communities also have resources that could be developed and strengthened. Nunavut's Petroleum Products Division (PPD) has some equipment and trained personnel, as do the Mary River Mine and possibly the Naval facility as well. Communities can explore opportunities to work with the Nunavut PPD and project proponents to stockpile additional equipment and increase response training.

This framework for local spill response planning addresses these issues by including a process for inventorying locally and regionally available resources and evaluating the capabilities and limits for responding to potential spills. The framework also recommends options for filling gaps in preparedness.

Engagement with Other Levels of Government

Community engagement in government permitting and planning processes may help to build support for local response planning efforts. The hamlets of Nunavut can consider priorities for protecting their resources from the impacts of a spill and identify the ways in which they would like to be more involved in the federal response planning regime. These efforts can be documented in community-based response plans, which hamlets can seek to incorporate into existing and updated area plans.

In addition, communities can seek support for stronger response capacity by advocating for changes to the regulatory regime, such as for provisions that would ensure each community has equipment to respond to a spill of a certain size.[5]

This framework for local spill response planning recommends approaches for communities to work in partnership with other levels of government to assess and improve the existing regime. The framework identifies priorities and considers implementation pathways – including the need for legislative change – in order to achieve the goal of enhanced, community-based preparedness. It also considers opportunities for knowledge transfer among indigenous communities in Canada and internationally by modeling successful approaches to intergovernmental cooperation.

Local and Traditional Knowledge

The hamlets of Nunavut have community members with unique and critical knowledge of natural resources, local navigational conditions, and infrastructure/logistics that are valuable to oil spill contingency planning and response.

This framework for local spill response planning provides an initial inventory of available information and data and recommends a mechanism to incorporate local and traditional knowledge from risk assessment and planning through response and recovery. The framework also includes policy recommendations as they relate to community priorities for risk evaluation and spill response.

[5] Community response packs are equipped to respond to a 1 t spill, though as the first report has indicated spills could be much larger.

3 Fate and Effect of Oil Spills in the Arctic Environment

Numerous factors interact to determine where an oil spill will spread, how the oil will change over time, and how it could affect species or people it contacts. These include, but are not limited to, the type and quantity of oil spilled, location, and conditions at the time (winds, waves, currents, temperature, tides, and ice). Oil spilled in arctic waters will be impacted by the presence and stage of any sea ice present. A range of other factors influence the impacts to wildlife and environment.

Oil Types, Properties, and Characteristics

The type of oil and its characteristics will influence the fate and behavior of the oil, and may be an important input into the Trajectory Modeling process. The selection and implementation of response options should consider Oil Group/Type in many of the decision-making processes:

- **Group 1: Non-persistent oils; light with low specific gravity <0.8 (example: condensate)**
- **Group 2: Lightest of the persistent oils; specific gravity <0.85 (example: marine diesel oil)**
- **Group 3: Medium persistent oil; specific gravity >0.85 but <0.95 (example: some medium crude oils, intermediate fuel oils)**
- **Group 4: Heavier persistent oil; specific gravity >0.95 but <1.0 (example: heavy fuel oils, diluted bitumen)**
- **Group 5: Heaviest persistent oil; specific gravity = or >1.0 (example: bitumen, residual fuel oils)**

Lighter oils (Groups 1 and 2) tend to be more volatile, which means there may be a higher risk of fire or explosion. When lighter oils spill, they are initially more bio-available (through air and water) and can cause acute short-term harm to wildlife, but they do not persist in the environment as long as heavier oils do. Heavier oils (Groups 4 and 5) are generally less volatile, but may persist in the environment for much longer.

In the Canadian Arctic, most of the lighter oil moving on board vessels is Group 2 from the list above (diesel and marine diesel), and most of the heavier oil is Type 4 (heavy fuel oils or Bunker C).

Weathering

Oil spilled to water is quickly subject to a number of natural processes that will impact how it behaves. The weathering process may work to change the physical and chemical properties of an oil spill. Weathering is important to marine spill response because the nature and location of the oil will change over space and time as it weathers.

Figure 4 shows typical physical, chemical, and biological processes involved in oil weathering: spreading, evaporation, dispersion, dissolution, emulsification, oxidation, sedimentation, and biodegradation.

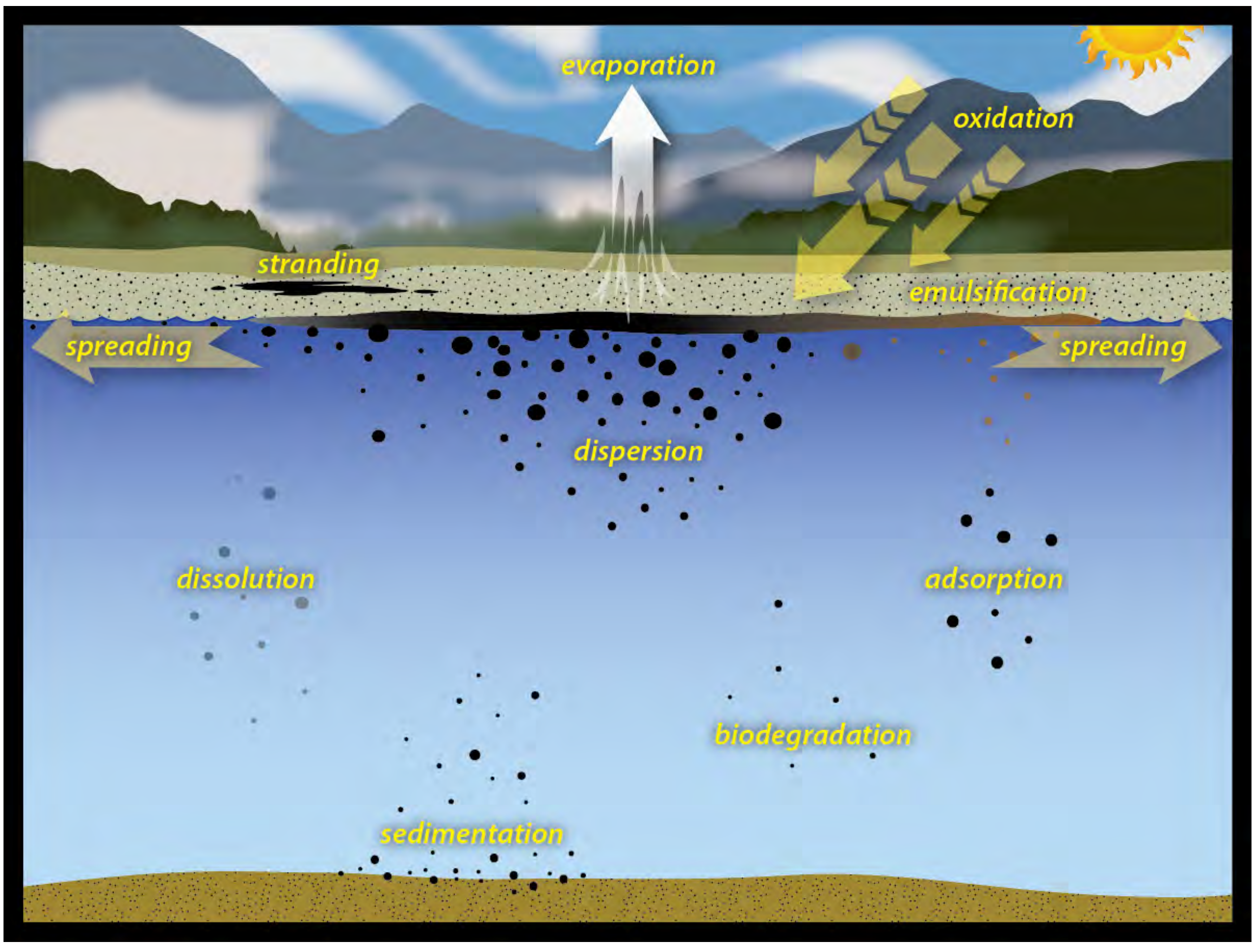


Figure 4. Basic oil Weathering Processes (based on ITOPF 2011)

Oil weathering, shown in Figure 4, involves a number of physical and chemical processes:

- **Spreading.** As soon as oil is spilled, it starts to spread over the water surface, initially as a single slick. The rate of spreading is strongly influenced by the viscosity (stickiness) of the oil, with low viscosity oils spreading more quickly. Spreading is rarely uniform and large variations in the thickness of the oil are typical. After a few hours the slick will begin to break up and, because of winds, wave action and water turbulence, will then form narrow bands or windrows parallel to the wind direction. The rate at which the oil spreads is also determined by the prevailing conditions such as temperature, water currents, tidal streams and wind speeds. The more severe the conditions, the more rapid the spreading and breaking up of the oil.

- Dispersion. Wave action may result in natural dispersion, breaking a slick into droplets which are then distributed vertically through the water column. These droplets may form a secondary slick or film on the water.
- Evaporation. Evaporation occurs when the lighter, more volatile substances within the oil mixture vaporize and enter the air column, leaving behind the heavier components of the oil. The rate and extent of evaporation is determined by the type of oil spilled, and is also impacted by environmental conditions such as temperature and wind speed.
- Oxidation. Oxidation occurs when oil contacts the water and oxygen combines with the oil hydrocarbons to produce water-soluble compounds. This process affects oil slicks mostly around their edges.
- Biodegradation. Biodegradation occurs when microorganisms, such as bacteria, feed on oil hydrocarbons.
- Emulsification. Emulsification occurs when small droplets of oil and water become mixed together. Two types of emulsions may be formed: water-in-oil and oil-in-water. Water-in-oil emulsions are often referred to as “mousse,” and are typically formed by strong wave action. Oil-in-water emulsions are more likely to cause the oil to submerge or sink as it approaches the same density as sea water.
- Dissolution. Water-soluble compounds in an oil may dissolve into the surrounding water. This depends on the composition and state of the oil, and occurs most quickly when the oil is finely dispersed in the water column. The components of oil that are most soluble in sea water are the same lighter ends that are likely to evaporate, and evaporation tends to occur more quickly than dissolution.
- Sinking or submergence. Most oils are more buoyant than water and therefore likely to float, particularly in salt water, which has a higher density than fresh water. In both marine and freshwater environments, sedimentation

may occur, where particles of sediment or organic material adhere to the oil and sometimes make it heavier than water, causing it to sink or suspend below the surface. Heavier oils (Group 4 or 5) are more likely to sink because their density is higher.

Behavior of Oil in Ice

When oil is spilled into waters where sea ice is present, weathering processes are different than those exhibited in ice-free waters. The presence of sea ice and cold ambient temperatures will generally slow the weathering process. If the oil is frozen or trapped in the ice, the weathering process may halt completely until the oil is thawed and exposed to air and water, allowing the weathering process to resume (Evers et al. 2004). Evaporation rates will be slowed by cold weather, and may be completely arrested if the oil is buried in snow or ice (Singsaas et al. 1994). If the type of oil and the presence of waves lead to emulsification, the volume of the oil-water mixture will increase the size of the slick and other weathering processes will slow (NRC 2003).

Spilled oil may not spread as far in the presence of ice floes or irregularities in the ice surface because the ice may create natural barricades to oil movement (Evers et al. 2004). However, oil can move hundreds of miles from the spill site if it is trapped under or within a piece of ice. Trapped oil may not be released until complete melting takes place (NRC 2003). Conversely, the oil itself can impact ice formation by acting as an insulator (to slow ice formation) or speeding ice formation by reducing wave activity. In general, the presence of oil is considered to slow early ice development (Ross in Wilson and Mackay 1987).

Oil trapped *under* ice may freeze and remain there as it cannot evaporate. The oil will move with the ice until the spring melt and may ultimately be released some distance from the spill site. This process has been referred to as “encapsulation” or an “oil-ice sandwich” (Evers et al. 2004, NRC 2003). Oil trapped under multi-year ice could remain in the marine environment for many years (AMAP 1998) and may not be released until it slowly migrates to the surface.

Oil spilled on the surface of an ice sheet tends to pool in ice depressions, and may be trapped under snow cover. However, oil spilled on top of the ice surface will be exposed to the air and subject to evaporation (Owens et al. 1998).[6] Figure 5 shows how oil and ice may interact.

[6] A spill to solid ice is an unlikely scenario for a ship-source oil spill.

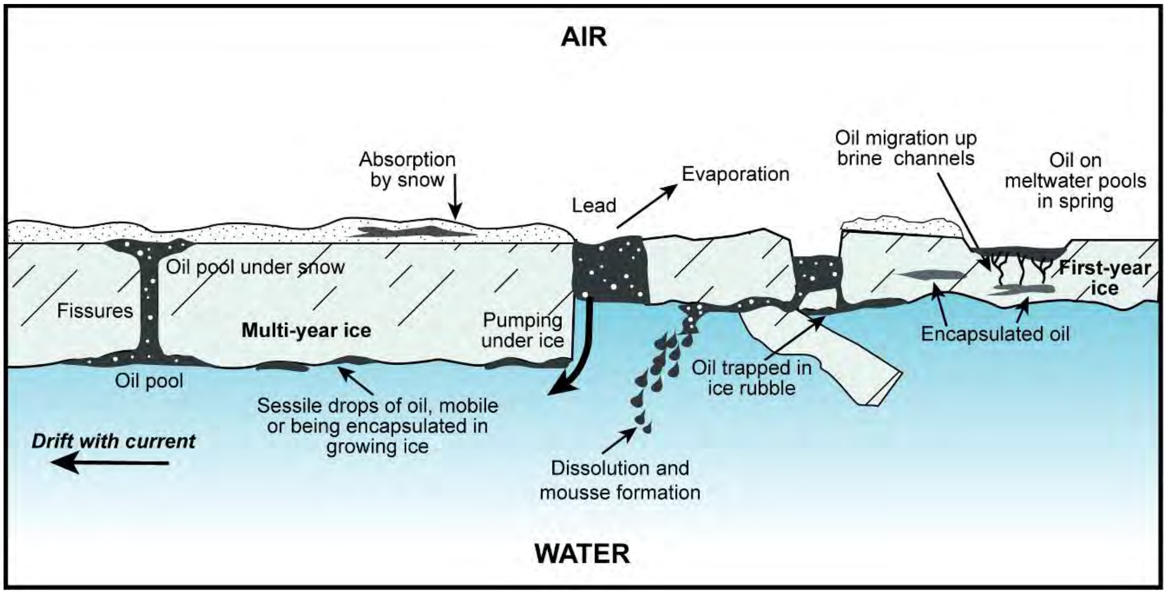


Figure 5. Oil-ice interactions (Bobra and Fingas in AMAP 1998)

Areas of open water such as polynyas or leads can also change oil behavior by allowing the oil to spread more rapidly than it would on the ice surface or below the ice, causing the oil to pool in these areas (Arctec in Wilson and Mackay 1987). The weathering process will resume once the oil is exposed to open water, air, and wind in the polynyas and leads, unless it is encapsulated by freezing water conditions. Water moving in or out of a lead can cause a “pumping” action, which moves oil out from under ice and into the lead. Pumping of oil into leads can be a dominant oil transport mechanism in the early hours of the spill (Reed et al. 1999).

Ultimately, any oil that moves during initial spreading or while frozen in ice could end up on the shoreline. Here the hydrocarbons can mix with the sediment, form emulsions, or cover beaches, depending on the quantity and state of weathering. Oil released under—or moving to—fast ice could reach the shoreline but be invisible to observers until break-up (AMAP 1998).

When the spring melt starts, oil tends to move upwards through the ice and ends up pooling on top of it where weathering processes will take place and the remaining oil will eventually be released to the water wherever the sheet of ice ends up (AMAP 1998). As ice begins to melt, brine channels open up in the areas where sea salt was concentrated by its exclusion from the ice formation. These opening channels can allow oil trapped in the ice, or under it, to rise to the surface (NRC 2003). This oil purging process will accelerate as spring temperatures rise above freezing. Thus, oil will increasingly appear on the surface of the ice and develop into thick pools of weathered oil. (Dickins and Buist 1999)

Predicting the Interaction of Oil and Ice

Oil spill modeling is often used to assess how or where an oil spill might migrate in a given area. While oil spill trajectory models can take into account factors such as wind, currents, temperature, and tide stages, it is more difficult to predict how oil will behave when spilled to ice-infested waters. Standard models used to predict the fate of oil spilled in ice-free waters are inadequate for modeling the fate of oil in sea ice conditions. Despite considerable research into the fate and behavior of oil in sea ice, there has been little progress in integrating this data into existing oil spill models. (Khelifa 2010)

Vulnerabilities of Arctic Ecosystems to Oil Spill Impacts

The arctic ecosystem provides vital habitat to marine mammals, polar bears, birds, and fish and a myriad of smaller organisms that support a complex food web. The Arctic Ocean is not a homogenous environment, and certain areas are especially important to the ecosystem. Among the most important are the openings in the ice, both at recurring polynyas (patches of open water within the sea ice), and at the edge of the primary ice pack. This edge moves hundreds of miles as the ice expands and retreats with the seasons. Additional important ecological areas are likely to be found in areas where the seafloor community is especially diverse or productive. Other important areas include the migration corridors of whales and other marine mammals, the areas under ice where some northern fish species spawn and leave their eggs to incubate over winter and hatch in the spring, as well as the sea bottom areas where some birds and marine mammals are known to feed. (AMAP 2008)

In the Canadian Arctic, Ecologically and Biologically Significant Areas (EBSAs) have been designated to draw attention to areas with particularly high ecological or biological significance. These designations are assigned by Fisheries and Oceans Canada based on assessments performed in 2011 and 2015 (DFO, 2015). Figure 6 below shows a map of the Eastern Arctic EBSAs.

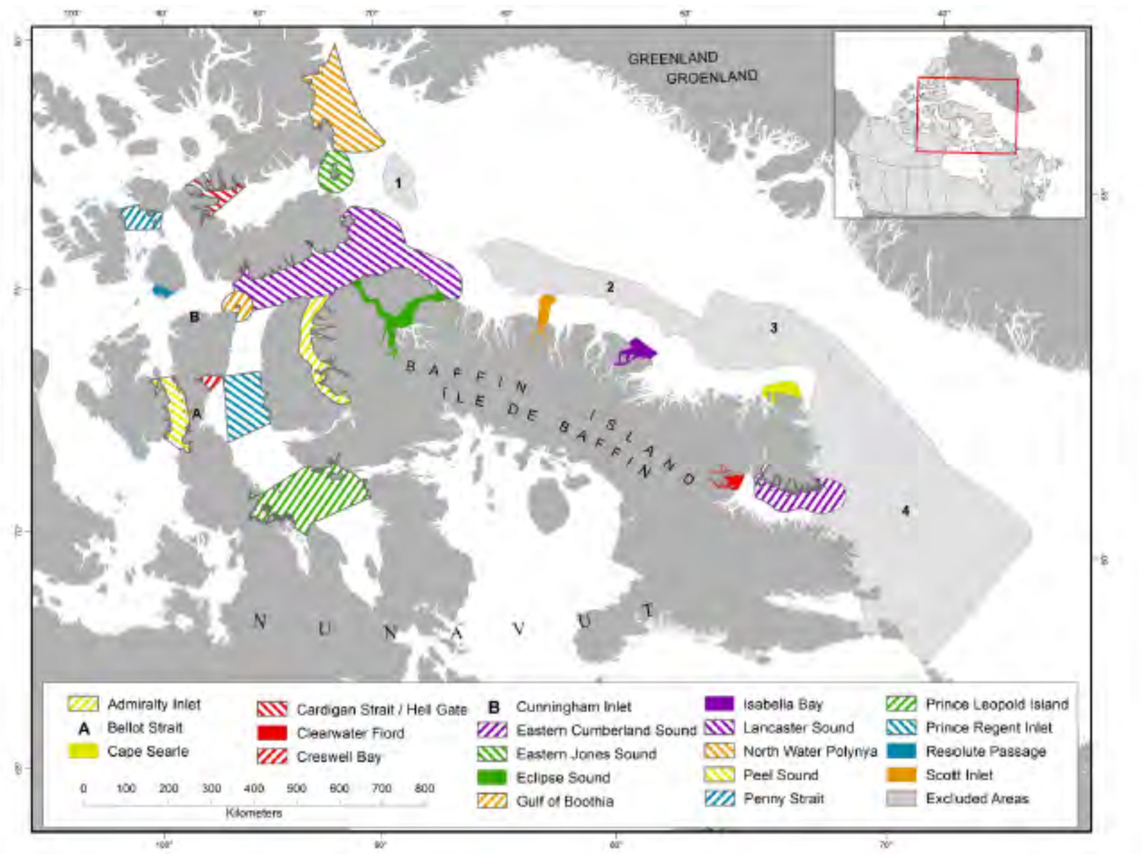


Figure 6. Ecologically and Biologically SignificantAareas (EBSAs) in Canada's Eastern Arctic Biogeographic Region (DFO, 2015)

Oil Toxicity

Oil is composed of thousands of chemical compounds, with varying levels of toxicity to wildlife and habitat, based on a number of different factors. Generally speaking, the water-soluble fractions (WSF) and volatile organic compounds (VOC) of oil are the most acutely toxic components, as they are the components of oil that evaporate into the air or mix into marine waters and often cause direct harm to organisms. These components – which include benzene, naphthalene, xylene, toluene, and others – are toxic to wildlife and to humans. As oil remains in the environment and weathers, the WSFs and VOCs are typically lost, and the remaining oil tends to have proportionately higher levels of polycyclic aromatic hydrocarbons (PAHs). PAHs are also toxic to both humans and wildlife, and have the potential to linger in the environment for years. (AMAP 2008)

The most obvious toxic impact of spilled oil is direct contact with wildlife and habitat. Images of oiled birds and shorelines dominate typical media coverage of major oil spills. Yet, toxic impacts from spilled oil persist beyond direct oiling; and the long-term toxicities and complex interactions between spilled oil and ecological processes are still the subject of significant of considerable research and debate (AMAP 2008). While oiled wildlife provides the most vivid images of a spill's impact, the level of ecosystem harm is much greater than the acute mortality would suggest. Long-term ecosystem impacts come from chronic exposure to oil in sediments and beaches, reduced fitness of animals exposed to sub-lethal doses of oil, and impacts through the food web (AMAP 2008).

Plants and animals are exposed to oil toxicity through a number of different pathways. Typically, mammals are exposed primarily through ingestion of contaminated food and water, inhalation of VOCs, or dermal absorption of hydrocarbons through the skin or fur. In mammals, oil is metabolized in the liver, reducing the overall concentration of PAHs and other toxic compounds to much lower levels in the organs and tissues. The by-products of hydrocarbon metabolism may also have toxic effects to the mammals. Oil toxicity exposure pathways and metabolism in birds are similar to those in mammals, with the additional exposure pathway of transferring oil through the surface of incubating eggs. Fish and aquatic species can be exposed to waterborne hydrocarbons through the gills, through ingestion, or by physical contact. Plant species (both terrestrial and marine) can be exposed through direct contact (deposition) on the plant structure, or absorption through the stomata or roots (Albers 2003 in AMAP 2008). Figure 7 depicts typical exposure pathways for mammals, fish, birds, and plants.

Wildlife impacts from oil toxicity occur at both the individual and the group level. Individual impacts include death, disease, impaired reproduction, genetic alterations, changes to endocrine or immune functions, hypothermia, and a range of other biological disorders. Group-level impacts include changes to local population sizes, community structures, and overall biomass (Albers 2003 in AMAP 2008).

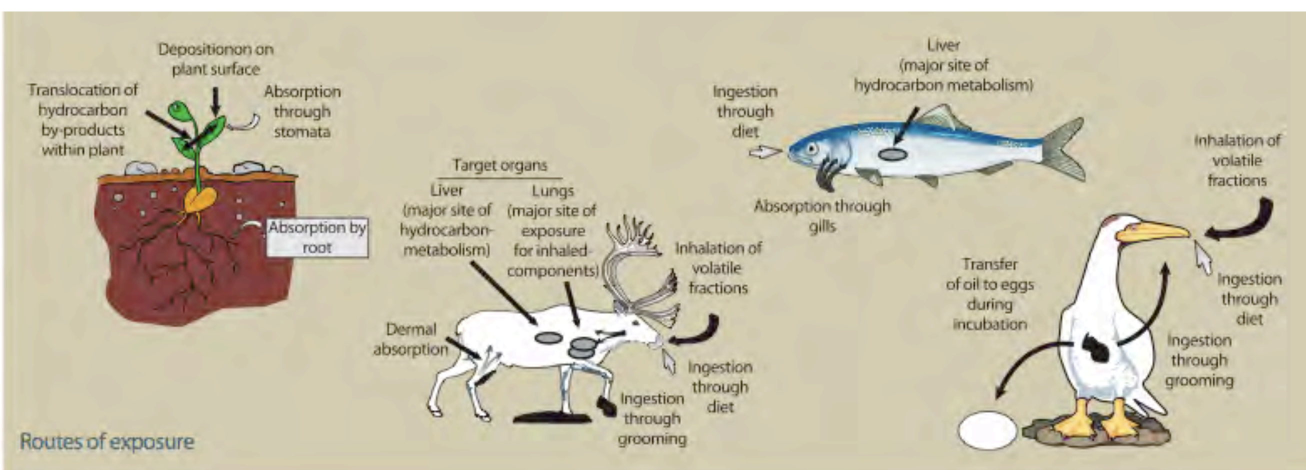


Figure 7. Exposure Pathways to Oil Toxicity (from AMAP 2008)

The persistence of oil is particularly problematic in cold environments where biological degradation is greatly slowed down. In an experimental oil spill on Baffin Island, the biological degradation was determined to be "negligible" after two years (Humphrey et al. 1987). Twenty years later, although most of the original hydrocarbons had degraded, some samples had not degraded, and contained toxic oil similar in composition to freshly spilled oil. (Prince et al. 2002). Metabolic rates of bacteria are slowed down in cold waters, and oil-degrading bacteria are relatively rare in the arctic (AMAP 2008).

Life phase is also a consideration in evaluating the potential toxicity of spilled oil. One lesson from the aftermath of the *Exxon Valdez* spill was that fish embryos and larvae are far more sensitive to oil than adult fish, making previous toxicity calculations a drastic underestimate of impact. Chronic exposure to weathered oil was toxic to young pink salmon and herring at concentrations 1,000 times lower than the level required to have acute effects on adult fish, showing substantial impacts at concentrations as low as 1 part per billion (ppb) (Peterson et al. 2003). Some of the effects did not show up until much later in the life of these fish. Hydrocarbons are rapidly taken up from the water by filter-feeding invertebrates like clams and mussels (Majewski and Scherer 1985 in AMAP 2008), and are consumed with contaminated sediments by bottom-feeding invertebrates. The contaminants are known to bioaccumulate in their organs.

Invertebrates metabolize hydrocarbons more slowly than vertebrates, and in areas with contaminated sediments, they can be continually re-exposed (AMAP 2008b). After the *Exxon Valdez* spill, clams and other invertebrates living in subtidal and intertidal areas with contaminated sediments remained contaminated for over a decade, impacting animals that fed on them (Peterson et al. 2003). Studies in Prince William Sound from 1999-2003 showed that some species, including harlequin ducks and sea otters, were still ingesting toxic oil compounds from their food sources, and had not recovered as expected (Peterson et al 2003).

There are still a number of unknowns regarding how oil spills might impact arctic ecosystems. Most of the published data on oil spill impacts is based on research from past spills to arctic and cold water regions. Based on this relatively small data set, we have a limited understanding of the actual and potential negative impacts of spilled oil to the natural environment and the human populations that depend upon this environment (AMAP 2008).

4 Marine Oil Spill Response and Cleanup Options

When oil is spilled to the marine environment, there are several approaches that may be used to contain and recover the oil and clean the impacted area. Oil spill response plans inform decisions about which response option to use, but the decision is ultimately made at the time a spill occurs. Understanding how these different response options work and what their pros and cons are will help to inform Nunavut communities in developing response plans and building local response capacity (equipment and training).

Mechanical Recovery

Mechanical recovery refers to the use of containment and recovery systems to corral floating oil and then recover it from the environment. Mechanical recovery is the only response option that physically removes a portion of the oil from the environment. It is labor and equipment intensive, and it tends to become less and less effective as time passes and the oil slick spreads and moves.

Figure 8 depicts on-water mechanical recovery operations.

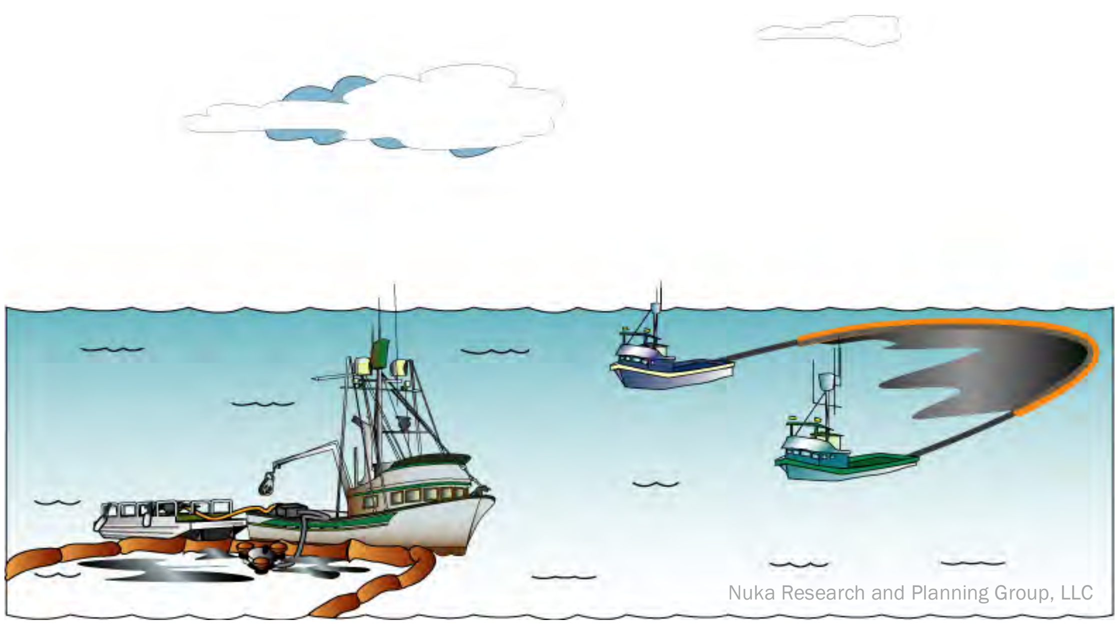
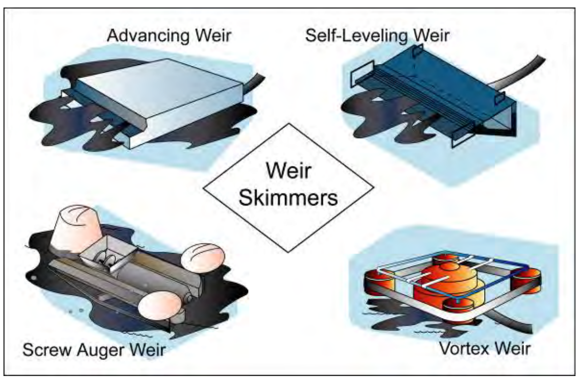


Figure 8. Illustration of on-water mechanical recovery operations

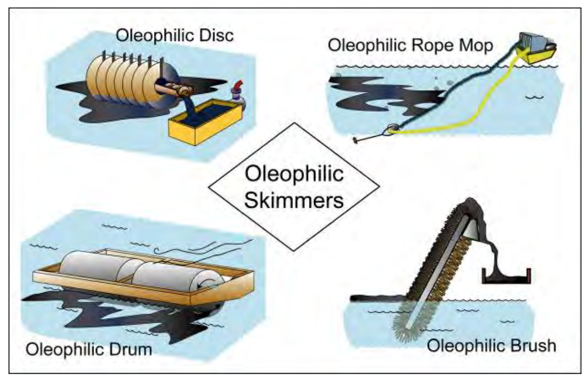
Boom is the most common type of on-water barrier used to intercept, control, contain, and concentrate spreading oil. Boom comes in a variety of forms and may be deployed in a number of possible configurations. Sea ice may act as a natural containment barrier under certain conditions.

Skimmers are used to remove floating oil from the water surface. Like booms, there are many models of skimmers, but all fall into one of three categories (Figure 9).

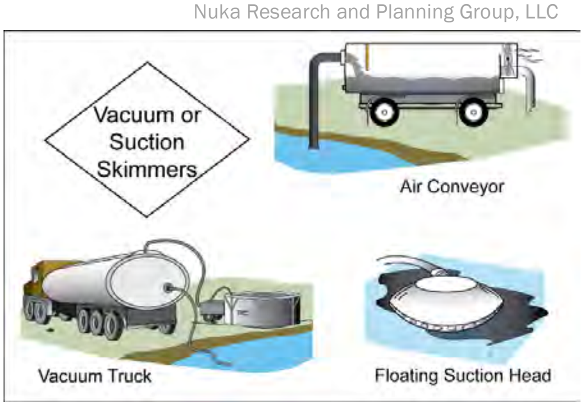
- **Weir skimmers** draw liquid from the surface by creating a depression in the water into which oil and water pour. The captured liquid is pumped from the sump to storage.
- **Oleophilic skimmers** pick up oil adhered to a collection surface, leaving most of the water behind. The oil is then scraped from the collection surface and pumped to a storage device. The collection surfaces in oleophilic (oil-attracting) skimming systems include rotating disks, brushes and drums, or continuous belts or ropes.
- **Suction skimmers** use a vacuum to lift oil from the surface of the water. These skimmers require a vacuum pump or air conveyor system. Like weir skimmers, suction skimmers may also collect large amounts of water if not properly operated. Most suction skimmers are truck-mounted and work best on land. However, suction skimmers for the marine environment have been made by converting fish pumps to oil recovery purposes, or loading a vacuum truck on a vessel.



Nuka Research and Planning Group, LLC



Nuka Research and Planning Group, LLC



Nuka Research and Planning Group, LLC

Figure 9. Different Types of Oil Skimming Systems

Storage devices are an important component of mechanical recovery. Some skimmers are more efficient than others, but all skimmers will recover more than just oil: water is also collected. If there is not enough storage capacity for recovered fluids, recovery must stop. Oil storage devices for the marine environment include: tanks, bladders, tankers, and barges. Portable oil storage devices may be stored onboard or can be towed by a vessel.

Considerations for Nunavut Spill Response

Mechanical recovery is limited by environmental conditions such as visibility, darkness, sea state, and temperature. Environmental conditions in Canada's Eastern Arctic regions may limit or preclude spill response altogether. As soon as any part of the recovery system – personnel, vessels, boom, skimmers – becomes limited, the entire recovery system is limited. Limitations can reduce effectiveness or preclude operations altogether. Sea ice can pose particular challenges to mechanical oil spill recovery systems.

Sea ice in its various forms affects the functionality of both boom and skimmers, the primary components of mechanical recovery. Sea ice also impacts vessel operations and may limit or preclude the ability to operate certain classes of vessels. Cold weather conditions can further complicate mechanical recovery, causing efficiency losses for both personnel and equipment (Abdelnour and Comfort 2001).

The limits of mechanical recovery systems in sea ice conditions have been correlated to the percent coverage of sea ice. However, as ice concentrations increase, the potential for the sea ice itself to serve as oil containment increases. Dickins and Buist (1999) found that ice concentrations of 60% or higher provide "an effective means of reducing oil spill spreading." Conditions ranging from 30% to 70% coverage may present the biggest challenge to mechanical response, as conventional booms are likely to be ineffective, but ice conditions are not sufficient to afford natural containment of spills (Evers et al. 2006, Glover and Dickens 1999).

While the spreading rate is diminished by sea ice, the recovery rate can be severely impacted by the inability to logistically access the oil accumulations, because of weather, visibility, vessel, mechanical and human limitations. Positioning the skimmer can be challenging in ice conditions as well. Limits to vessel operations at higher ice concentrations make recovery operations extremely difficult. Mechanical recovery operations in sea ice are generally more effective on a small scale, such as collecting oil from small leads within ice floes using portable over-the-side skimmers or mobile units.

Analysis of spill response capacity for Nunavut hamlets should consider how the conditions likely to be encountered in various areas or times of year may impact the success of oil spill response operations. During times of year when mechanical recovery may not be possible, the planning process should consider whether there are other options for preventing or mitigating potential oil spills.

Spill Treating Agents

Spill treating agents (STA) include chemical dispersants and surface washing agents. Environment and Climate Change Canada published regulations in 2016[7] that identify acceptable STA. Two agents are identified as appropriate for use in Canada:

- **Corexit® EC9500A** is the dispersant that was used in the Deepwater Horizon well blowout in 2010, and is also authorized for possible use in the U.S. and other countries.
- **Corexit® EC9580A** is a surface washing agent that is suitable as a hard-surface cleaner on shorelines and manmade structures. It is also authorized for possible use in the U.S. and other countries.

Dispersants

Dispersants are chemicals that can be applied to a floating oil slick to break it up into smaller droplets. Dispersant chemicals contain solvents and surfactants and they work much like dish soap. By breaking the oil into smaller droplets, it can more easily disperse into the water column.

Dispersants are most commonly used in offshore oil spill response. The major trade-off with dispersant use is that the oil is not removed from the environment; it is simply diluted. However, dispersants can break up a floating oil slick to reduce exposure to wildlife that may be concentrated in the area (e.g. rafting birds). If a slick can be dispersed offshore before it reaches coastal areas, it may result in less oil reaching beaches and fouling shorelines. Dispersants are applied through a sprayer from a vessel or a low-flying aircraft, as shown in Figure 10. A second aircraft may be used as a spotter to help target the application.

[7] *Regulations Establishing a List of Spill-treating Agents (Canada Oil and Gas Operations Act)*; Canada Gazette Vol. 150, No. 212, June 15, 2016.

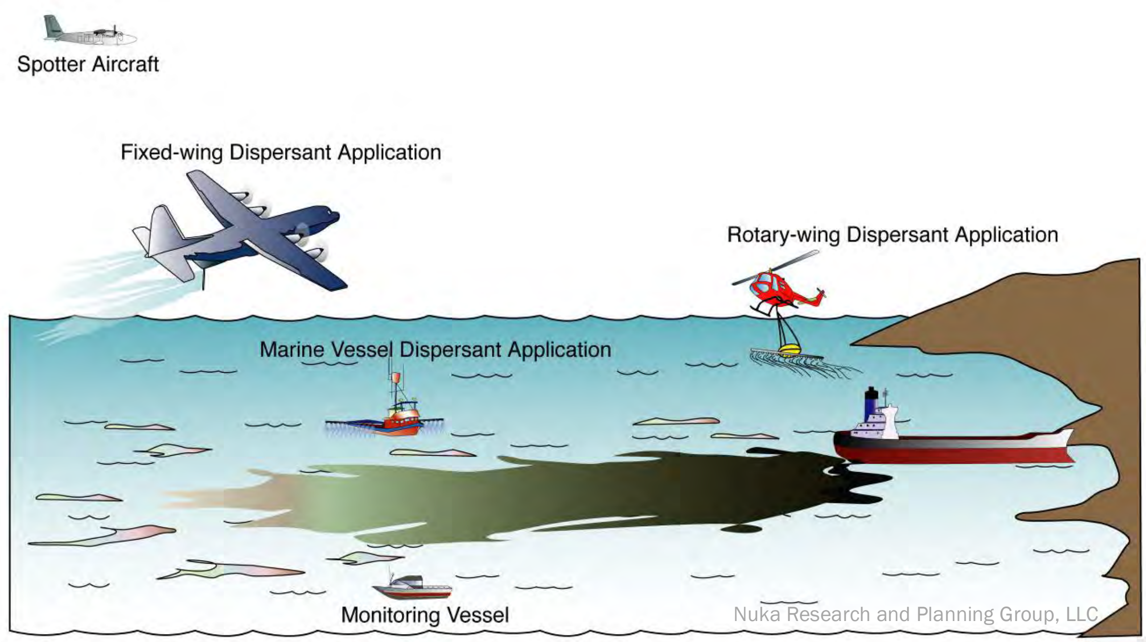


Figure 10. Illustration of Dispersant Application

Dispersants are typically not used in waterbodies with closed circulation or in depths less than 20m. Dispersants generally do not work as well in fresh water or in cold water. Dispersants work best on fresh oil. If oil has been weathered for more than a couple of days, dispersants typically are not effective. Wave energy can help to mix dispersants, but any wind or visibility conditions that would limit safe air operations might preclude dispersant application. There has been research suggesting that dispersed oil may be more toxic to some species.

The dispersant tactic is also limited by environmental conditions and weather. Aerial application of dispersants requires low winds and good visibility. Dispersants cannot be applied during periods of darkness.

Surface Washing Agents

Surface washing agents have similar chemical properties to dispersants, but are developed for use on oiled shoreline or substrate. They are applied to the substrate neat or diluted and used to release the oil from the substrate. Oil that is treated with a surface washing agent may be recovered using sorbent materials or by remobilizing and refloating the oil for recovery from the water surface.

Considerations for Nunavut Oil Spill Response Plans

The use of spill treating agents in arctic regions is still a source of some disagreement among experts. It is generally understood that cold waters, variations in salinity, and reduced mixing action in the presence of sea ice will reduce the effectiveness of spill treating agents in waters where ice is present. Toxicity is also an issue that weighs into response decision-making, particularly in arctic environments, which may be slower to recover from exposure to toxic chemicals. Chemically dispersed oil has been demonstrated to be more toxic to some marine organisms than untreated oil (Fuller and Bonner 2001, Singer et al. 1998, Gulec and Holdway 1997). Researchers have also found that the undispersed oil residue that is left behind following a dispersant application may be more toxic than the untreated oil (Lindstrom et al. 1999)

Despite ongoing studies, there is some consensus in the spill response community that dispersants are not a proven technology for use in most sea ice conditions (Evers et al. 2006). A review of dispersant use in oil spill response conducted by the U.S. National Academies of Science recommends that additional studies are required to understand the physical and chemical interactions of oil, dispersants, and ice before dispersants can be considered a mature technology for use in sea ice (OSB 2005). A report on oil spill response technology in ice-covered waters recommends additional study into the potential use of dispersants in sea ice, including the potential use of icebreaking vessels to add mixing energy, which is the energy required to mix dispersants with surface oil so that they may work as intended (Dickins 2004).

Before any decision is made to apply dispersants in Nunavut, serious consideration should be given to whether there is a realistic expectation that they will be effective.

In-Situ Burning

In-situ burning involves corralling a pool of oil to a minimum thickness and then lighting it on fire. In-situ burning is also used more commonly offshore, but this tactic is also sometimes used inland and in coastal marshes. In-situ burning requires special fire-resistant boom, which is towed and set using the same techniques and equipment as mechanical recovery. The pooled oil is ignited using a torch-like device that can be thrown from a vessel or dropped from an aircraft, as shown in Figure 10. A controlled burn is then conducted, during which much of the oil will burn off.

As in mechanical recovery, oil containment for in-situ burning can be accomplished either with natural barriers (e.g. topographic features on land, snow berms, sea ice) or man-made booms. However, fire boom used for in-situ burning must be constructed of fire-resistant materials. Response vessels may tow fire boom in a U-shaped configuration that is also commonly used during mechanical response (Figure 11). Alternately, oil may be encircled in stationary fire boom or pooled in ice leads and burned.

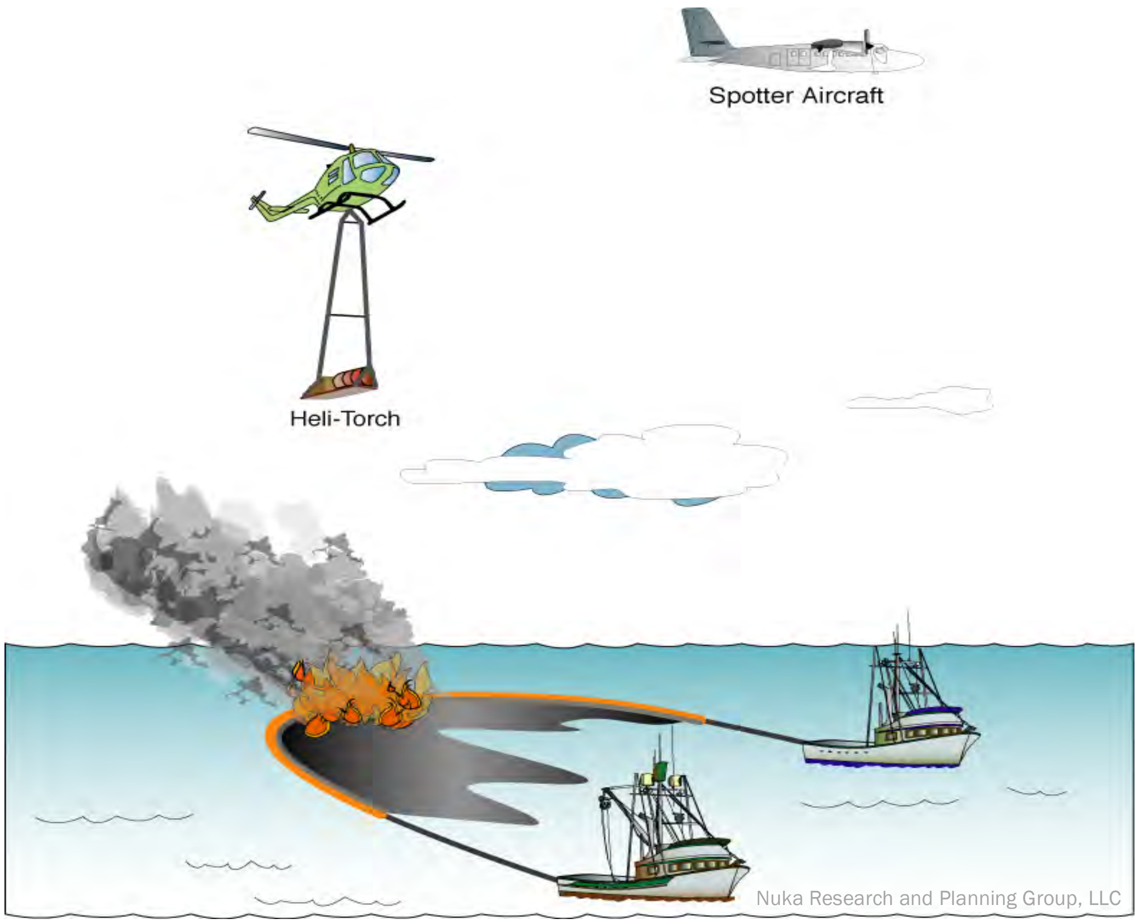


Figure 11. Illustration of In-situ Burning Operations

Successful ignition and burning require adequate slick thickness for ignition, minimal wind and waves, and oil that has not emulsified (incorporated water) too much. It is important to remember that the oil is not actually removed from the water; it is transferred to the atmosphere in the form of smoke. No burn will consume 100% of an oil slick. Residue left in the water is typically heavier than the original oil and may submerge or sink. It may be possible to collect in-situ burn residues, but in reality this is typically not done.

Because of the smoke plume created by in-situ burning, it is important to ensure that there are no vulnerable populations (human or wildlife) downwind of the burn. In-situ burning is often discussed as the preferred response option for arctic oil spills because it can be deployed in sea ice.

In-situ burning can also impact the surface microlayer, which is approximately the upper few hundredths of an inch of the water surface. This important ecological niche that provides habitat for many sensitive life stages of marine organisms. Eggs and larval stages of fish and crustaceans, and reproductive stages of other plants and animals develop in this layer, which often contains dense populations of microalgae with distinct species compositions from the phytoplankton in the layers below (Shigenaka and Barnea 1993). To date, no published studies address the potential impact of in-situ burning on the surface microlayer in polynyas.

In-situ burning is subject to all of the same weather limitations that effect mechanical recovery – wind, sea state, and sufficient visibility for both vessels and aircraft to safely operate. Since oil that has been contained for burning could also potentially be recovered with skimmers, it is important to consider whether there is a compelling reason to burn the oil rather than remove it by skimming.

Considerations for Nunavut Oil Spill Response Plans

Numerous published articles and reports refer to the potential use of in-situ burning in sea ice conditions. The general consensus is that leads in broken and pack ice provide an opportunity to burn, because the ice acts as a natural containment barrier to the slick and the open water in the lead provides an ideal burn opportunity. The reduced efficiencies of mechanical recovery are also frequently cited as rationale for using in-situ burning in ice leads.

Prior to the Deepwater Horizon oil spill, in-situ burning had not been widely used. It still has not been used for a cold climate on-water spill response; therefore, the body of information regarding in-situ burning in arctic regions is based primarily on experimental data. The presence of sea ice appears to slow the rate of in-situ burning and create slightly larger quantities of residue than in open water (Fingas 2004, Buist et al. 2003). However, in-situ burning studies in slush ice showed efficiencies as high as 50% for weathered crude oils and 80% for fresh oil (Buist et al. 2003).

Like mechanical recovery, the appropriateness of in-situ burning as a response option is related to the percentage of ice coverage. The major difference between the two techniques is that the natural containment provided by ice floes at higher ice concentrations may be conducive to in-situ burning if ignition can be attained. At ice coverage up to about 30%, in-situ burning generally requires the use of manmade fire booms to contain the oil to the desired thickness. In this way, in-situ burn operations will face many of the same constraints as mechanical recovery. Boom-towing vessels must be able to maneuver and position boom to contain the oil to the desired thickness. An ignition source must be deployed from a vessel or aircraft.

When ice coverage is above 60-70%, in-situ burning may be accomplished using the ice floes as natural containment. In this case, the ignition source will most probably be from an aircraft, unless ice-breaking or ice-reinforced vessels are available and capable of maneuvering in the vicinity of the spill. Ice conditions in the 30% to 70% range are considered to be the “most difficult from an in-situ burning perspective”

(Evers 2006). In this range, natural containment by the ice is less likely, and containment boom deployment is generally not possible.

Research into the use of herding agents, chemicals used to improve slick thickness, is ongoing, with a focus on use of herding agents in the presence of sea ice (Evers 2006, Buist et al. 2010). In-situ burning relies on good visibility and weather. In-situ burns cannot be ignited when visibility conditions or darkness preclude flight operations.

If in-situ burning is to be considered for spill response in Nunavut, it will be important to pre-plan for how ice conditions, temperature, and visibility may influence its potential effectiveness. Adequate equipment must be available to ignite the burn (ignition system and aircraft or vessel to deploy it from). The potential for smoke plumes or sunken residue to have secondary impacts on resources should also be assessed.

Shoreline Cleanup

Shoreline cleanup is the process used to remove oil that has stranded on a shoreline, typically with mechanical or manual techniques (although spill treating agents may be applied). Shoreline cleanup typically follows an assessment, conducted using the Shoreline Cleanup Assessment Technique (SCAT) process. SCAT teams assess the extent and severity of shoreline oiling and make recommendations for cleanup.

Shoreline cleanup occurs post-impact, but the success of shoreline cleanup operations is still important to reducing overall adverse impacts from a spill. Removing oil from contaminated shoreline areas prevents it from remobilizing or cross-contaminating additional resources.

The shoreline cleanup process is iterative, requiring systematic surveying of impacted areas before, during, and after cleanup. There are several techniques that may be used, alone or in combination, to clean up oiled shorelines (Figure 12).

- **Manual and Mechanical Removal,** where oil and contaminated materials are removed using machinery, hand tools, or a combination of both.
- **Washing, Flooding, and Flushing,** where water, steam or sand is used to flush oil out of impacted shoreline areas.
- **Sediment Reworking and Surf Washing,** where various methods are used to accelerate natural degradation of oil by manipulating the sediment.

- **Chemical treating agents,** where chemicals are applied to contaminated areas, typically in combination with other treatment methods.

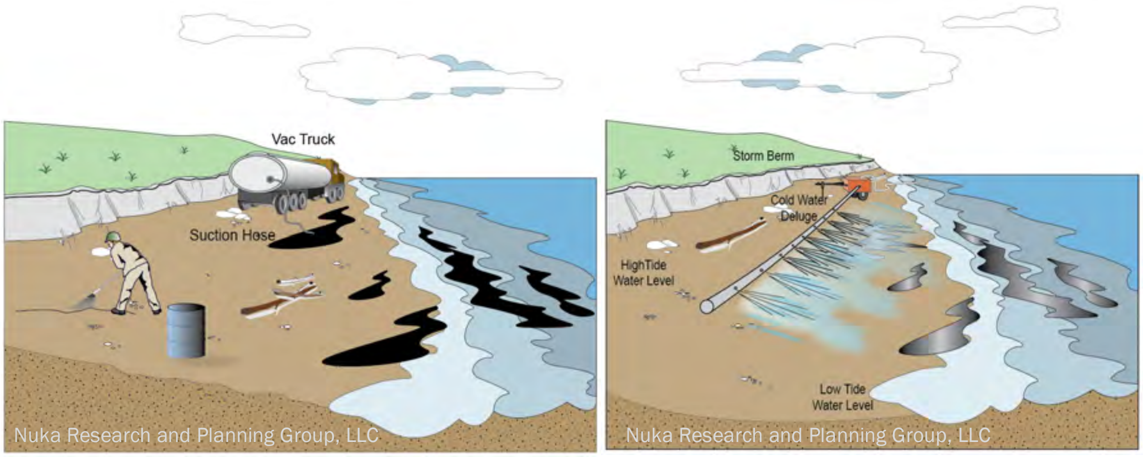


Figure 12. Examples of Shoreline Cleanup Techniques

During the shoreline assessment and cleanup process, affected shorelines are typically divided into **segments**, based upon shoreline type and sensitivity. Shoreline cleanup techniques and endpoints are established for each segment based on the degree of oiling. It is critical that the SCAT process encompass all impacted or potentially impacted shoreline segments.

While shoreline assessment and cleanup occurs post-impact, it may be possible to undertake **shoreline protection** ahead of an oil spill. The most common type of shoreline protection planning involves Geographic Response Plans (GRP), site-specific strategies that identify specific tactics and resources for protecting high priority sites.

Considerations for Nunavut Oil Spill Response Plans

Arctic shorelines present particular challenges for shoreline cleanup, because of their unique and often fragile geomorphology, and the fact that shoreline access may be limited by shorefast ice or lack of road infrastructure.

Nunavut community response plans should include an assessment of shoreline types, and development of shoreline segmentation/pre-SCAT mapping. Nunavut community members may acquire training to participate as part of the SCAT process; Environment and Climate Change Canada has developed manuals to guide arctic SCAT.

Development of GRP for Nunavut communities should be done in a cooperative process that includes local and traditional knowledge. GRPs and GRSs can also be used to assess spill response capacity (i.e. ensure that adequate equipment is sited locally to support GRP deployment).

Natural Recovery (No Response)

Sometimes weather conditions may mean that it is not possible to mount an on-water response. In other cases, responders may determine that response actions would do more harm than good, and opt for no response. For example, in high waves it may be preferable to allow the oil to disperse naturally rather than adding chemical dispersants to the environment unnecessarily.

Regardless of *why* response activities are not implemented, the spill will spread and weather. Oil spill response plans should consider mitigating measures if a spill response is precluded by conditions (i.e., if on-water response is not possible how will the slick be monitored and shoreline areas protected or cleaned up) and consider that there may be times where no response is considered to be the most appropriate cleanup approach. Risk-based preparedness (discussed in Section 6) should consider whether there may be times when a spill risk exists but no cleanup would be feasible.

Supporting Activities

Regardless of the technique applied, there are a number of other functions that should be incorporated into a spill response, and addressed in plan development:

- **Spill Surveillance and Tracking.** Oil spill response operations require surveillance and spill tracking to identify the location, spreading, and condition of the spilled oil in order to select and apply the appropriate response equipment and tactics. This may be done with human observers in aircraft or vessels, with remote sensing technologies, through satellite tracking, or any combination of those techniques. Plans should consider the capability available to support spill surveillance and tracking, and identify any limits to its potential utility.

- **Wildlife Response.** Oil spills may cause harm to a range of wildlife species, including birds, fish, mammals, and invertebrates. Some species may be collected for cleaning and rehabilitation, while others may simply require removal and disposal to prevent secondary contamination. Oiled wildlife response is a specialized function that typically includes government coordination and support from specialized contractors. Plans may identify local resources for implementing wildlife response, and may contain locally specific information about species distribution and abundance that would inform wildlife response.

- **Logistics and Site Access.** Effective spill response requires logistical support to transport equipment and trained personnel to the spill site, deploy and operate the equipment, and decontaminate the equipment when response operations are complete. Spill responders will require basic support such as lodging, food, and protection from the elements. Spill responders must be able to safely access the spill site in order to deploy the equipment. Accessing the spill site is often one of the biggest challenges, particularly in remote areas. Plans should pre-evaluate logistics and identify places that are suited to support spill response operations and the personnel who deploy them.

- **Communications.** Communications may be considered as a subset of logistics, but it is critically important for remote arctic communities in particular. In order to coordinate an oil spill response, communications systems must be in place for field and command personnel to communicate, and for on-water resources to coordinate with aerial reconnaissance. Communications infrastructure (VHF radio, cell phones, satellite communications, internet) must be adequate to support the communications surge that is often associated with a spill response.

- **Waste Management.** Oil spill response may generate a significant volume of liquid and solid wastes. Some or all may be oil contaminated, requiring special permits or handling. In communities with limited infrastructure, the transfer, storage, and ultimate disposal of oil spill wastes may quickly overwhelm the response. Plans should consider the regulatory and permitting context for waste collection, storage, and disposal, including oily wastes. Options for storing large quantities of liquid or solid oily wastes should be considered.

Selecting Oil Spill Response Options

Determining the spill response option that is most likely to be effective for a given scenario requires a basic understanding of how each option works, its strengths and weaknesses, and the practical and logistical constraints. With all response options, time is critical. As soon as oil is spilled to water, it begins to spread, evaporate, and emulsify. As time passes, it generally becomes more difficult to track, contain, and recover or treat spilled oil. Therefore, the quick mobilization and deployment of response equipment and trained personnel is important to the overall response effectiveness. Table 2 summarizes the factors to consider when selecting a response option, with specific consideration of how arctic conditions may influence response effectiveness.

Table 2. Considerations for selecting oil spill response options

Response Option	Considerations		
	Benefits	Drawbacks	Arctic Conditions
Mechanical Recovery **Using mechanical or manual techniques to contain, collect, recover and store oil.**	• Removes oil from environment • Protective booming may prevent or mitigate shoreline impacts • Low potential for adverse environmental impacts • Well accepted approach, no special approvals needed • Useful on wide range of oil types • Longer window of opportunity for weathered oil than dispersants and in-situ burning • Basic equipment readily available • Recovered product may be re-processed or recycled	• Recovery rates may be low • Treat smaller geographic area than dispersants • Usually does not remove 100% of oil before impacting shoreline • Most labour and equipment-intensive • Not feasible in high seas or heavy weather (generally, seas >2 m or winds >30 kt) • Requires substantial storage for recovered oil and oily wastes • Lighter oils (group 1-2) may evaporate before mechanical recovery can be deployed. • Containment of highly volatile oils may create safety risk.	• Ice may damage boom or clog skimmers and pumps • Vessel manoeuvring can be more difficult or dangerous • Ice may enhance natural containment • Machinery may freeze • Freezing sea spray may accumulate and cause safety risk • Cold temperatures make oil more viscous
Spill Treating Agents **Applying chemicals to enhance natural dispersion of oil into the water column by breaking oil into smaller droplets.**	• Disperses surface oil that could harm birds, mammals and wildlife • Prevents oil from spreading to shoreline • High coverage rate on sea surface • Large volumes of oil can be treated • Reduces vapours at water surface • No recovered oil storage required • Less labour-intensive than mechanical recovery • May be used in conditions where containment and recovery not operationally feasible • Most appropriate for group 1-3 oils	• Potential water column impacts and toxicity of dispersant or dispersed oil to marine fauna • Does not directly collect and remove oil from the environment • May reduce effectiveness of containment and recovery • Limited window of opportunity • Requires specialized equipment and expertise • Typically not used in near shore environments • Effectiveness varies by oil type and dispersant formula – cold temperatures, lower salinity and heavy oil (group 4-5) limit effectiveness • Potential for adverse commercial or subsistence fishery impacts	• Oil under ice may not be accessible • Ice may dampen mixing energy • Cold temperatures and low salinity may reduce dispersant effectiveness • Vessel manoeuvring can be more difficult or dangerous

Response Option	Considerations: Benefits	Considerations: Drawbacks	Considerations: Arctic Conditions
In-Situ Burning **Igniting pools of oil and using controlled burns to reduce total volume.**	• May be used to treat oil not readily accessible to mechanical containment and recovery • Lighter oils (group 3 and below) may burn more readily than heavier oils.	• Not typically effective if oil slick spread too thin or highly weathered • Fire safety and suppression required • Smoke plume may impact human or wildlife population • Burn residue may sink and impact benthos	• Cold temperatures or certain ice conditions may impede ignition or burning • Ice may enhance option by providing natural containment • Burn residue and soot may impact environment
Shoreline Protection and Clean-up **Applying various response techniques to remove oil that has stranded on a shoreline.**	• Protective booming may prevent or mitigate shoreline impacts • Shoreline protection typically relies on local resources • Remove shoreline oil • Reduces potential for remobilization • Reduces secondary oiling of fauna • Many techniques non-aggressive with minimal adverse impacts • Can be used for detailed cleaning of sensitive or priority sites	• Protective booming requires advanced warning and knowledge of spill trajectory • Removal or treatment occurs after shoreline impacts • Slow, labor and equipment-intensive • Some methods are aggressive and potentially harmful • Recovery rates may be low • Significant waste generation • Possible secondary contamination from clean-up personnel or equipment	• Certain types of arctic coastline are vulnerable to damage from people or equipment • Shoreline access may be limited by presence of ice or lack of road infrastructure • Encroaching ice may disrupt shoreline cleanup and expand temporal scope of spill response and impacts
Natural Recovery (No Response) **Allowing natural processes (physical, chemical and biological) to break down oil.**	• No intrusive removal or cleanup methods that could harm environment • Can be part of initial "monitor and evaluate" approach to monitor spill and inform future response option selection • May be suitable option if low threat to environment/people • Most appropriate for lighter oils (groups 1-2)	• Oil remains in environment longer duration; extended possible impacts • Untreated oil subject to changes in weather or trajectory that could threaten priority areas • Oil may impact shorelines, fauna, habitat, and cultural resources • Perception of 'no response' • Generally not preferred for heavier oils (groups 4-5)	• Cold temperatures may slow natural recovery • Oil trapped in ice may remain in environment longer, travel unpredictably

5 Oil Spill Response Management and Decision-making

Response Phases

The oil spill response process can be broken into four phases: (1) pre-spill planning and preparedness; (2) initial response actions; (3) emergency response and response management; and (4) the final project management phase in which recovery and restoration are undertaken. Figure 13 shows this overall process.

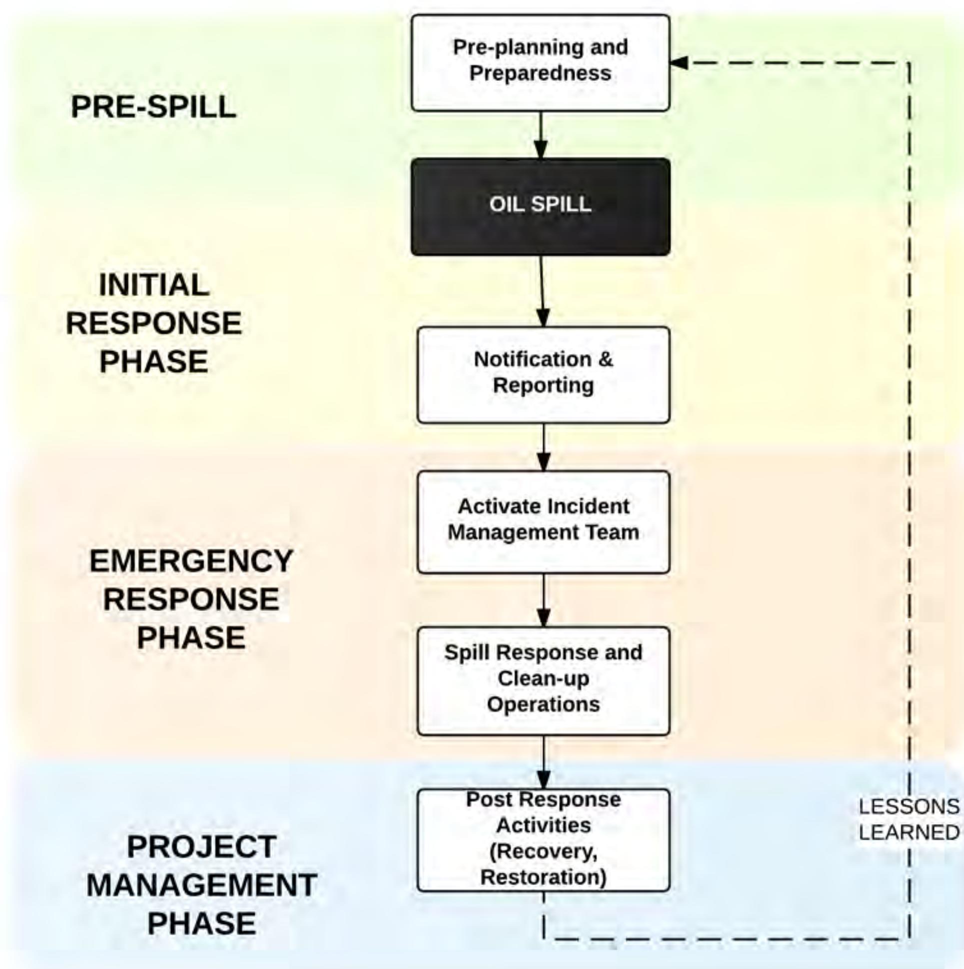


Figure 13. Oil Spill Response Process and Phases

Nunavut community oil spill response plans should span these four response phases. Lessons learned from plan implementation, both during actual events and during drills or exercises, should be considered in updating and improving the plan.

Pre-spill

Planning and preparedness activities occur during the pre-spill phase. Activities such as the spill response plan development and capacity analysis described in this report fall into that category.

Initial Response

For Nunavut hamlets, the initial response phase begins with notification of an incident. The community may be notified of the spill by the responsible party, the Government of Nunavut, or the Government of Canada. It is also possible that Nunavut community members may be the first to detect a spill, and in that case the notification would flow from the community to Nunavut and federal authorities.

During the initial response phase, which is typically chaotic, other parties with direct roles in cleaning up the spill will begin to mobilize resources and set up command posts. Nunavut community members may assume first responder roles, deploying equipment to contain the spill or protect high-value areas, based on the availability of equipment and trained personnel.

The initial response phase may last from minutes to hours. It transitions into the emergency response phase.

Emergency Response

The emergency response phase encompasses the active cleanup and spill management process. An incident management team is organized, a command post established, and field operations initiated to undertake the cleanup. Depending on the size and severity of the oil spill, the emergency response could take hours, days, weeks, or months. The emergency response phase typically ends when the field cleanup is complete and the incident command post is demobilized. The emergency response phase will transition to a project management phase.

Project Management

The final phase of an oil spill response is the long-term project management. This phase begins when the active response is completed, and may encompass a range of activities such as ecological damage assessment, social and cultural impacts assessments, restoration projects, claims, and other activities. Under current laws, there is no standard requirement for how a polluter must engage with the project management phase; instead, plans are developed collectively with input from response partners.

Response Organization and Roles

Oil spill incident management and field response is organized under a single structure using the Incident Command System (ICS). ICS is a standardized on-site management system designed to enable effective, efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure. ICS is used to manage an incident or a non-emergency event, and can be used equally well for both small and large situations. The federal government has recently adopted ICS as the official approach to organizing oil spill response and management. Nunavut community personnel should be trained to different levels of ICS depending upon their role in the organization.

Figure 14 shows a high-level organizational chart showing the main components of ICS. The Unified Command is the consolidated leadership of the spill response, and may include all levels of government along with the polluter. The Unified Command is supported by a Command Staff of advisors. There are four main Sections in the ICS structure, and within each section there may be numerous sub-units. Because ICS is scalable and meant to be tailored to the individual incident, not all positions are activated for all incidents. An ICS team may consist of only a few people for a small event to hundreds or thousands of people for a large, complex spill response.

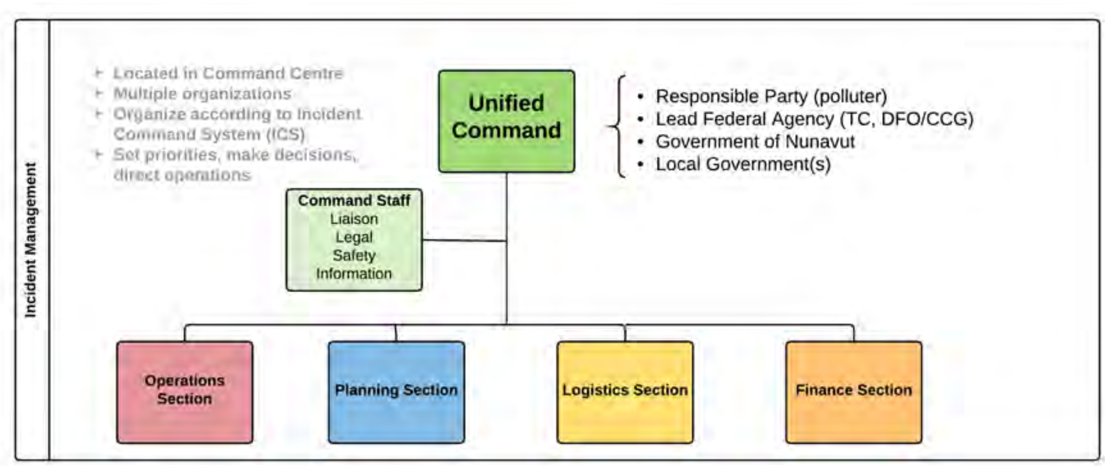


Figure 14. Basic Incident Command System Structure

Response Implementation

ICS not only provides an organizational structure for oil spill response, it also provides a process for implementing and managing the response.

Unified Command Decision-making

The decision-making that drives oil spill cleanup occurs on an ongoing basis within the command post. Typically, the Unified Command will establish a set of incident objectives, which provide the overall framework for the response. These may change as the response progresses. The Planning Section will be responsible to develop an Incident Action Plan for each operational cycle (which could be 12 hours, 1 day, 1 week, or other duration depending upon the scale of response). The Incident Action Plan (IAP) sets the course for how the response will be implemented during the next operational cycle. It typically ties all response actions back to the incident objectives. Once the Unified Command approves the IAP, the Operations Section implements it with support from Logistics and Finance.

6 Nunavut Community Oil Spill Response Planning Framework

Cycle of Preparedness and Response

Figure 15 depicts oil spill preparedness and response as a cycle of interrelated activities. This conceptual approach is often used to develop oil spill response plans and capability, both by government and industry. It is offered here as a framework for organizing and developing community-level plans in Nunavut.

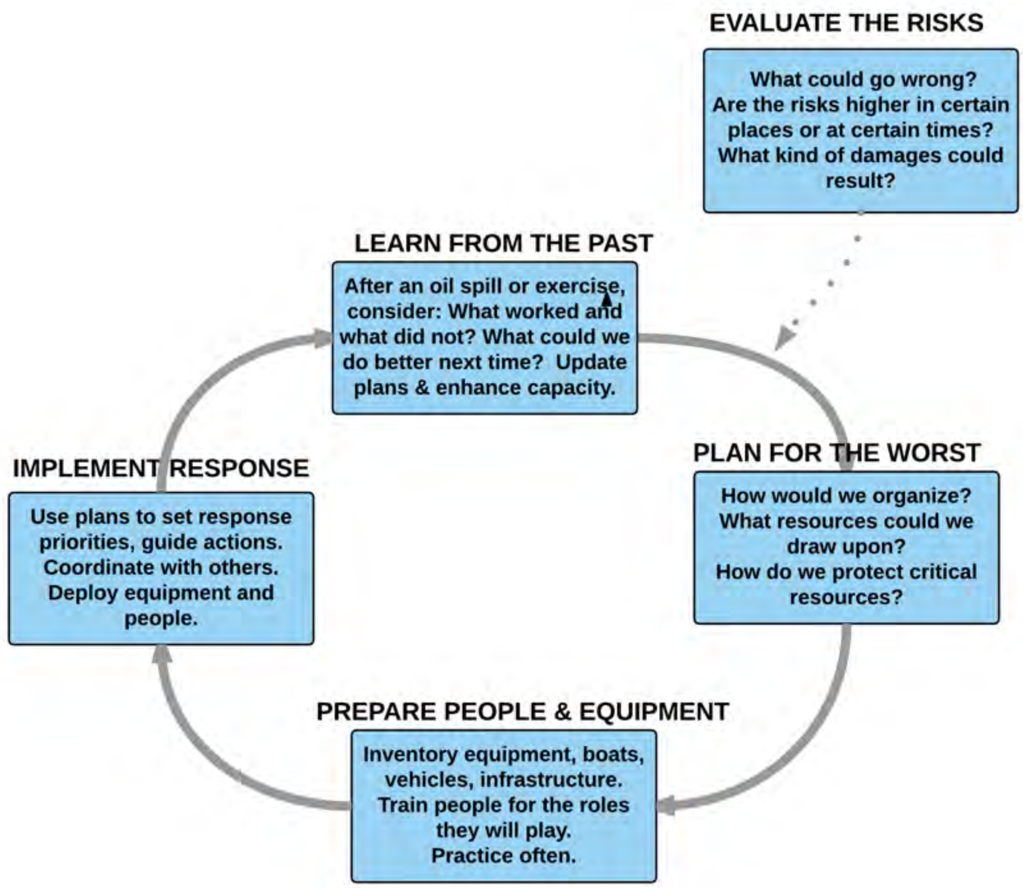


Figure 15. Oil Spill Preparedness and Response Cycle

Step 1: Evaluating the Risks

EVALUATE THE RISKS

What could go wrong? Are the risks higher in certain places or at certain times? What kind of damages could result?

Marine oil spill preparedness should be risk-based, to ensure that the response planning and capacity is appropriate to the types of oil spills that might occur. At its most basic, risk is defined as the product of likelihood and consequence. Risk evaluation, whether formal or informal, addresses the following questions:

- What could go wrong?
- How likely is it?
- What kind of damages could result?

Oil Spill Risks

Oil spill risks in Nunavut arise from two main sources: oil-handling facilities in Nunavut communities and ship-source spills. There is no exploration or development of oil and gas resources in Nunavut at present, but there have been oil leases in the region in the past. Table 3 describes the hazards that may influence oil spill risks in Nunavut.

Table 3. Hazards that may create oil spill risks for Nunavut communities

Hazard	Potential incidents	Potential products spilled	Factors impacting likelihood
Vessel spills	Tanker or tank barge groundings, collisions, or alisions that result in partial or complete loss of cargo Fuel oil spills from non-tank vessels Spills that occur during vessel refueling/bunkering operations	Fuel oil (bunkers), diesel fuel, gasoline or aviation fuel	Number of vessels, frequency of transits, navigational hazards, severe weather, safety record, bunkering practices, age and condition of ships, crew proficiency, prevention practices, compliance with regulations
Oil-handling Facility spills	Tank leak or rupture that reaches marine waters Spill or leak while transferring oil to vessels Spill or leak from facility piping that reaches marine waters	Diesel, gasoline, aviation fuel	Volume of oil stored, age and condition of tanks and equipment, hazards (seismic, weather), safety record, personnel proficiency, prevention practices, compliance with regulations

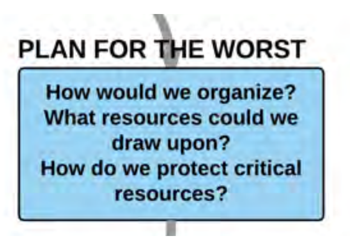
Local oil spill response plans should identify specific hazards and potential spill volumes, and based preparedness activities around these risks.

Oil Spill Consequences

The consequences of an oil spill are a function of many complex and inter-related factors. The specific spill scenario – location, timing, volume and type of oil spilled – all impact the consequences. Oil spill consequences have historically been described based on discrete impacts to specific receptors. However, oil spill consequences also transcend individual receptors and impact ecosystems and communities.

Groups and individuals may perceive the consequences of an oil spill differently, depending upon their perspective, priorities, and risk tolerance. Community response plans should reflect the risk perceptions and tolerance of local communities. The concept of prioritizing certain areas or resources may be challenging for Inuit residents, because of a deeply felt connectedness to the whole of water, land, and resources that has been in place for generations.

While Nunavut communities would be profoundly impacted by any oil spill, it is critical to consider the prioritization process as part of oil spill contingency planning and response, because once oil reaches the water it will not be possible to contain or clean it all up and decisions must be made quickly. Detailed mapping of cultural heritage and archaeological sites, subsistence resources, ecological sensitivities, and other environmental considerations – e.g. shoreline sensitivity to oil or seasonal changes – should support local spill response planning.



Step 2: Planning for the Worst

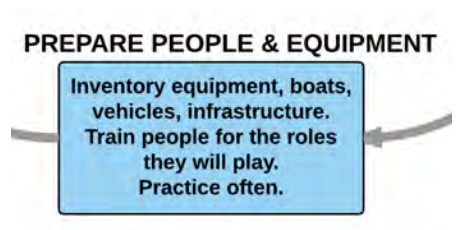
A hypothetical worst-case scenario can be used as a planning tool to ensure that oil spill preparedness and response capabilities match the potential severity of the worst possible event. Transport Canada's Tanker Safety Expert Panel has described a worst-case scenario for a ship-source spill as "the complete discharge of a tanker's oil cargo along with its bunker fuel, or for a non-tank vessel, the complete release of its bunker fuel." (Transport Canada 2013) It is important to consider that while the full release of a ship's cargo or bunker constitutes the largest possible spill volume from that vessel, consequences are not entirely tied to the size of the spill but also determined by factors such as the timing and location of the release. Thus, a smaller spill could do the same or greater harm than a worst-case spill of the same type of oil.

As Nunavut communities develop oil spill response plans, they should consider the factors that may influence the severity of adverse impacts from an oil spill, and use this information to develop one or more scenarios. Table 4 identifies some of the factors that may constitute a "worst-case" oil spill based on the severity of potential impacts to local waters, lands, and resources.

Table 4. Factors that may contribute to the severity of oil spill impacts to Nunavut communities

Factor	Influence on Oil Spill Severity
Location	Oil spills that occur in or near high priority areas, such as archaeological sites, hunting or fishing areas, sensitive habitat, cultural sites, or other areas of high value to the community may have greater impacts. Oil spills that impact polynyas or other highly productive sea areas may be particularly damaging.
Timing	Often, ecological sensitivities experience seasonal variations. Certain times of year are more critical to fish/wildlife and to habitat, either because of critical life phases, feeding or reproductive behaviors, or other vulnerabilities. Harvesting traditional foods is also a cyclic activity, and may be more vulnerable to oil impacts at certain times of the year or phases of the tide cycle. An oil spill that occurs during a critical time period, such as fish spawning, bird nesting, bird or mammal migration, marine mammal mating or calving, or intense feeding may be particularly devastating.
Sea Ice Conditions	Oil spills that occur at the beginning of ice season can be particularly difficult to clean up or contain, and the oil may end up trapped or encapsulated in the ice through the winter, causing re-injury when the ice begins to melt. Conversely, shorefast ice may prevent oil from impacting shorelines. Oil and ice interactions may be difficult to predict or foresee.
Trajectory	The trajectory – or direction and speed with which an oil spill spreads and travels – is influenced by a number of factors, including winds, tides, bathymetry, and shoreline geomorphology. The tidal cycle is particularly important to determining the severity of an oil spill. Similarly, certain prevailing wind patterns could drive the oil toward highly sensitive or high priority sites.

Step 3: Preparing People and Equipment



Section 4 of this report identifies key functions that are required to implement an oil spill response. It is important to recognize that oil spills are **multi-jurisdictional** incidents that may include a mix of government and private resources, so Nunavut hamlets should not presume that the full burden of preparedness is on their community.

As part of the scoping process discussed in Section 6 of this report, each hamlet should consider the desired level of preparedness for the community, based on a number of factors. In considering the optimal level of preparedness, it is important to be realistic about the link between preparedness and outcome. **No amount of oil spill planning or preparedness will guarantee zero adverse impacts from an oil spill.** Balancing the ideal preparedness level against the burden associated with maintaining it is a judgment call that each Nunavut community must make in preparing an oil spill response plan.

Inventorying local resources is an important component of this step. In preparing their response plans, Nunavut communities should consider whether there are resources already in place, including:

- Oil spill response equipment
- Heavy equipment
- Infrastructure: roads, air strips, boat launches, harbours, fuel sources
- Vessels, trucks, aircraft
- Trained people
- Facilities to house and feed responders
- Facilities to support command centres

The inventory process will be useful in identifying gaps in community preparedness and establishing priorities for filling those gaps. This process is discussed in Section 7 of this report.

Step 4: Implementing the Response

Response implementation is accomplished by applying the information in the plan during an actual event. Section 4 of this report describes the general flow of events during an oil spill incident, and summarizes how the Incident Command System structure is used to organize responders and decision-makers.

The plan should clearly describe the level to which Nunavut community members and government leaders intend to be active during and oil spill response. The level of involvement may be situational, and may call for coordination among hamlets if a large spill threatens to impact large areas of the Nunavut region. As noted in Step 3, Nunavut hamlets will not have singular authority or responsibility for the overall spill response. The plan provides an opportunity to consider how and where the community can integrate most effectively to ensure that interests of the community are considered in response decision-making.

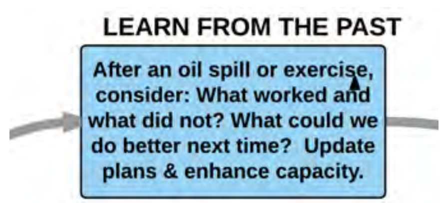
Oil spill response plans should identify how and where each hamlet intends to interact with the spill management team and field response. Areas where local communities are typically active include the Unified Command (local government may assign a representative with decision-making authority); Operations Section; Planning Section; Logistics Section. The types of functions where Nunavut communities may play a role in spill response include, but are not limited to:

- Protecting public health
- Establishing cleanup priorities

- Prioritizing sensitive areas for GRP deployment
- Deploying and maintaining GRPs
- Protecting cultural resources
- Participating in SCAT teams
- Conducting sampling and monitoring
- Developing communications materials for local communities
- Organizing community meetings to provide updates on the spill response
- Supporting spill logistics
- Establishing priorities for long-term environmental monitoring
- Establishing priorities for restoration of damaged resources
- Assisting with cost reimbursement for local injured parties
- Assisting with community healing/community impacts analysis

Some of these roles and activities will overlap with functions that a hamlet provides day-to-day, while others will require additional planning or preparedness specific to oil spills. An important consideration when assigning local personnel to spill response functions is how their daily jobs or responsibilities will be impacted, and whether backfill would be needed.

Step 5: Learning from the Past



While the plan development process includes the use of hypothetical incidents as a tool to support preparedness and build capacity, actual incidents (or near incidents) almost always yield important lessons learned that can shape future enhancements to response plans and the capacity to implement them.

In the event that an oil spill response plan is implemented for an actual spill or during a simulated spill/exercise, this experience should yield important information that can be used to enhance planning. In some cases, there will be lessons learned that Nunavut hamlets can address directly, while other issues may require consideration or action by other levels of government or industry. Plans should include a clear mechanism for review and update triggered by events where the plans are used and applied.

7 Oil Spill Response Plan Roadmap

There are many ways to organize an oil spill response plan. This section recommends an approach to organizing plan contents, but is meant to be adapted as needed through in-person workshops and with direct input from impacted community members, stakeholders, and all levels of government.

Suggested Process

There is no single right or wrong way to develop or organize an oil spill response plan. It is most important to ensure that the plan is useful to its intended audience, and it would make sense to develop it in a format similar to other emergency response plans, if they exist. Because of the multi-jurisdictional nature of oil spill response, it will also be important to harmonize all community plans with Nunavut, federal, and industry oil spill contingency plans (see Figure 3 in Section 2).

Scoping

Before plan contents are developed, the planning process should be clearly established. Key steps in the scoping process include:

1. **Establish a planning team.** Identify a core group to develop and vet plan contents. Participants may include: local community members with relevant subject matter expertise and a stake in oil spill preparedness and response; representative(s) from Governments of Nunavut and Canada; individuals with oil spill contingency planning and spill response expertise; local industry representatives; and others with an interest or stake in the process.

2. **Establish preparedness goals.** These goals should describe a desired state of preparedness for the Nunavut community. This may include issues such as: ensuring protection of high value sites and resources; ensuring participation in Unified Command; advocating for certain response options; maintaining spill response resources; alignment with other community priorities or programs; and other issues of importance to the community. Strategic objectives may help to shape the specific contents of each community's plan and may serve to focus the plan development process.

3. **Evaluate the current state of planning and knowledge.** Before Nunavut communities develop oil spill response plans, it is important to assemble all of the existing plans, maps, regulations, policy, and other doctrine that relates to oil spill response planning in the community. Section 1 of this report contains a list of general authorities that apply to oil spill planning, but there may be additional knowledge or information specific to environmental sensitivities, wildlife, subsistence use, or other mapped or

documented information that is relevant to oil spill response planning. Section 8 describes an approach to collating this information. Inherent in this process is also the need to identify any **gaps** in knowledge or information, and consider how or whether the gaps may be filled to better inform oil spill response planning. In this way, contingency planning is necessarily an iterative process.

4. **Inventory local oil spill response capacity.** A community response plan should specify the equipment, resources, and personnel that exist for first-strike oil spill response. A process for conducting this assessment is outlined in Section 8. As with knowledge and information, an assessment of response capacity should identify any gaps in oil spill preparedness, and the plan should capture this information with the intent that the plan gets updated as oil spill response capacity is enhanced or improved.

Contents

Figure 16 describes suggested contents for Nunavut community oil spill response plans, based on the information provided in this report. For each section of the plan, recommended contents are described and potential resources that may be used to develop the information are identified. The process of developing the plan should include a consideration of these components, which are discussed further in this section.

Pre-Spill Information and Actions

While some components of a plan are meant to direct emergency oil spill response activities, there should also be information in the plan that is meant for use in preparing for the spill. Nunavut community response plans should include a discussion of the administrative, legal, regulatory, and policy framework for oil spill preparedness and response in each hamlet, and should link the plan to other applicable plans and policies. The plan should include information about oil spill risks, and may include or reference qualitative or quantitative risk analyses. The plan should clearly assign authorities and roles related to the implementation of the plan, and these roles and responsibilities should be clearly understood by the individuals and organizations involved.

NUNAVUT COMMUNITY OIL SPILL RESPONSE PLANS

	Recommended OSRP Components	Potential Information and Resources
PRE-SPILL: Activities that occur separate from oil spill incident	**Introduction:** Purpose and Scope, Administration of Plan, Updates, Distribution, etc. **Oil Spill Risks:** Identify type and scale of oil spills that may impact community **Spill Response Framework:** Legal, Organizational, and Operational framework for responding to oil spills	• Outcome of initial scoping discussions • Section 1 from this report • Risk assessments for projects in or near communities • Other oil spill response plans
INITIAL RESPONSE: Activities that occur during first few hours of response	**Notification and Reporting:** How the Community is notified, internal notification and activation of responders and other personnel, internal & external reporting **Organization and Staffing of Incident:** Roles that may be filled by community personnel in field and command centre	• Nunavut Emergency Management plans and policies • TC and CCG emergency notification and reporting processes • ICS training for community members with a role in response
EMERGENCY RESPONSE: All emergency response actions taken from the time the Community begins to assign resources to respond to the spill and its impacts	**Incident Objectives:** How response objectives are established (IAP process) and strategy for community's input and participation **Health & Safety:** Plan for evaluating human health & first responder safety risks; initiation of monitoring; communicating risks to community members **Implementation of Protection Strategies:** Plans for deploying equipment and personnel to implement GRP or other protective measures **Local Coordination:** Incorporating local and traditional knowledge, coordinating volunteers **Documentation & Finance:** inventory and process for assigning and tracking resources., cost accounting	• First strke spill response training and equipment for Nunavut hamlets • Geographic Response Plans for high value or high priority sites • Forms and tools for documenting activities during oil spill • Pre-identified logistics for deploying resources, command centre locations, etc.
PROJECT MANAGEMENT PHASE: Activities that occur once the I emergency response phase complete.	**Response Termination:** Setting endpoints for on-water response, shoreline cleanup. **Restoration & Recovery:** Community priorities and expectations for restoring injured resources, assessing damages **Long-term Monitoring:** Processes for monitoring and sampling to evaluate long-term impacts to community health, environment, ecology	• Baseline studies • Environmental monitoring • Community impacts analysis • Community healing • Post-response lessons learned

Figure 16. Suggested Contents and Resources for Response Plan Development

Key actions associated with developing pre-spill information for a Nunavut community response plan include:

- ✓ Specify the type and severity of oil spills that may impact the hamlet.
- ✓ Explain how the plan relates to other plans and policies.
- ✓ Identify the individuals or organizations with roles in implementing the plan in the event of an oil spill.
- ✓ Include an official promulgation by community leaders or government that adopts the plan for the hamlet.
- ✓ Include administrative details such as how often the plan will be reviewed and updated, schedules for exercises or training, etc.

Initial Response Phase

The initial response phase begins when an oil spill is detected or reported, and generally covers the first hours or days of an incident as a formal response is ramped up. Nunavut community oil spill response plans should describe processes and procedures for notifying local government leaders, emergency responders, and other levels of government that the spill has occurred. An plan may include contact lists and checklists for key information to collect when an incident occurs. The initial response phase may include first-strike response actions by community-based responders. The capabilities and planning in place to guide these initial response actions should be presented in the plan. These components of a plan should also lay a foundation for how community members and government leaders will organize into assigned roles to support the oil spill response – both in the field and in the command centre – as the response transitions into a sustained emergency.

Key actions associated with developing initial response information for a Nunavut community plan include:

- ✓ Contact lists and procedures for notifying key officials and organizations within the hamlet, the Government of Nunavut, the Government of Canada, and other organizations with a role in oil spill response.
- ✓ A checklist of key information that should be conveyed when reporting the incident (i.e. location, type of product spilled, source, on-scene weather conditions, etc.).
- ✓ Assignment of roles and responsibilities for spill cleanup and response management functions.

Emergency Response Phase

As the incident progresses, a spill response organization will be established with a range of functions necessary to contain and clean up the spill, manage logistics, document and pay for the response, and obtain technical expertise and scientific data to support decision-making. Nunavut community plans should include relevant information that will support response decision-making. This may include the description of spill response tactics and techniques appropriate to the local environment, and may also contain site-specific GRPs that apply these tactics to pre-identified sites that are high priorities for protecting from oil spill impacts. Emergency response information may include checklists that help response personnel to fulfill their assigned duties. The emergency response organization should be specified, assigning individuals or organizations to ICS functions as appropriate. The plan should include inventories of response resources and may pre-identify key logistical considerations such as potential command centre locations, potential equipment storage and staging areas, and key access points for boats or responders.

Key actions associated with developing emergency response information for a Nunavut community plans include:

- ✓ Develop position-specific checklists to guide response personnel in performing their assigned duties.
- ✓ Identify preferred or prohibited response options.
- ✓ Develop GRPs that overlay oil spill response tactics with environmental and cultural sensitivity information to potential prevent or mitigate impacts to high priority sites.
- ✓ Include maps with key logistical information, including transportation infrastructure (roads, airstrips, boat ramps) and other information that will make it easier to implement spill response actions.
- ✓ Include an inventory of equipment, resources, and trained personnel that may support a local oil spill response.
- ✓ Include action plans that address specific functions that the local community might assume during a spill response, such as public information, volunteer coordination, or protection of health and safety.
- ✓ Identify priorities and procedures for collecting data during a spill response, such as scientific sampling, documenting the location and extent of the spill, or other information that may be important to impact assessment.

Project Management Phase

The emergency response phase typically ends when gross oil removal/cleanup is ceased. The decision to end the active cleanup phase is typically triggered when decision-makers agree that cleanup "endpoints" are achieved, meaning that impacted areas have been cleaned to the satisfaction of all levels of government, or when there is consensus that any further cleanup would cause more harm than good. As the active spill response concludes, the spill response transitions to a project management phase. The activities that occur during this phase may have significant implications as to how well the impacted resources recover and how injured parties are compensated for damages.

Key actions associated with planning for project management activities within a Nunavut community response plan include:

- ✓ Identify local priorities for assessing impacts and damages to natural and cultural resources, wildlife, habitat, and other critical resources.
- ✓ Establish expectations for restoration of injured resources and habitat that are consistent with local natural and cultural resource planning and protection priorities.
- ✓ Consider the claims and damages process and identify resources to help the hamlet and community members to seek compensation in a fair and expeditious manner.
- ✓ Establish expectations for long-term monitoring of ecological, cultural, and subsistence resources.

Plan Implementation and Administration

Once an oil spill response plan has been developed, it is important to ensure that the plan remains updated and that its contents are familiar to the people who will use it during a response. This extends beyond the community and local government, and includes other levels of government as well as industry.

Distribution

Ideally, community plans will be developed with input from other levels of government and other stakeholders. However, even if this is the case, it is still important to share the final plan with a wide constituency, including potentially publishing all or most of the plan in a manner that makes it publicly accessible. Broad distribution of the plans will help to ensure that community members, key partners, and external stakeholders understand local plans and priorities.

Training and Exercises

Once each plan is complete, individuals who will be expected to implement all or part of the plan must become familiar with its contents. This is typically achieved through a mix of training and exercises. Training sessions may be done in a classroom setting, online, or through independent study. Exercising a response plan can be accomplished through a variety of approaches, ranging from discussion-based tabletop workshops to full-scale field exercises where people and equipment are deployed. Exercising is especially important for GRPs, to make sure that the tactics and strategies can be effective and are appropriate to the risks.

Update Cycle

Oil spill response plans should be living documents that are periodically reviewed and updated. To ensure this, the plan should specify an update cycle. Typically, plans are scheduled for update once every 1 to 5 years, with allowances for more frequent updates in the event that risks change or lessons learned from incidents or exercises require plan amendments.

Assigning plan update and administration to a position or department within local government will typically ensure that there is someone focused on maintaining and updating the plan contents.

Tools and Resources to Support Plan Development and Ongoing Preparedness

There are significant additional information, planning tools, and other resources available to support the process of developing community response plans for Nunavut hamlets. Table 5 lists a few key resources that may inform oil spill response planning generally, with a focus on issues relevant to Nunavut and the Eastern Arctic.

Table 5. Select references to support plan development and preparedness in Nunavut

Reference	Description
Oil Properties	
ECCC Oil Properties Database	Searchable database of physical and chemical properties of a range of oil types, federal government.
OSHA Occupational Chemical Database	U.S. government searchable database that includes petrochemicals and focuses on human exposure risks and protective measures.
Behavior of Oil and Other Hazardous Substances in Arctic Waters	Arctic Council compilation of knowledge on how hazardous substances, including oil, behave when spilled in arctic environments.

Reference	Description
Oil Spill Contingency Planning	
Oil Spill Preparedness and Response: an Introduction	International oil industry publication on basics of oil spill preparedness and response.
Contingency Planning for Marine Oil Spills	International tanker owners' high-level planning guidance for marine spills, including some discussion of local oil spill response plans.
Oil Spill Response Strategies and Tactics	
NOAA Spill Tools	Website with publicly accessible job aids (developed by U.S. government) and tools for spill response including trajectory modeling, selecting response options, and estimating oil slick thicknesses.
Characteristics Coastal Habitats: Choosing Spill Response Alternatives	U.S. government publication that identifies spill response considerations for different environments.
Spill Tactics for Alaska Responders (STAR) Manual	Printed tactics guide and three-part video series demonstrating basic oil spill response tactics, including safety and logistics. Developed by State of Alaska.
Field Guide to Oil Spill Response in Arctic Waters	Arctic Council publication describing oil spill response tactics specific to arctic environments. (1998 publication, update underway)
Response strategy development using net environmental benefit analysis	Good practice guidelines for incident management and emergency response personnel in applying the concept of net environmental benefit analysis in spill response decision-making, developed by oil industry.
Guidelines and Strategies for Oily Waste Management in Arctic Regions	Arctic Council publication recommending strategies for dealing with oily wastes generated during oil spill response in arctic regions.
At-sea Containment and Recovery Good Practice Guide	Basic principles of on-water containment and recovery of floating oils, developed by oil industry.
Use of Booms in Oil Pollution Response	International primer on use of booms as floating oil containment, developed by oil industry.
Use of Dispersants to Treat Oil Spills	International primer on use of chemical dispersants in oil spill response, developed by oil industry.
Use of Skimmers in Oil Pollution Response	International primer on how skimmers can be used in on-water spill recovery, developed by oil industry.

Reference	Description
Safety Data Sheet for Corexit 9500A Technical Product Bulletin Corexit 9500A Safety Data Sheet for Corexit 9580A Technical Product Bulletin Corexit 9580A	Safety Data sheets which provide manufacturer information about the use, storage, application, and potential effects of spill treating agents approved for use in Canada.
Joint Industry Project on Arctic Oil Spill Response	Website containing multiple reports, periodically updated, summarizing research and development of new technologies for oil spill response in arctic environments, developed by international industry-government initiative.
Shoreline Cleanup	
Shoreline Countermeasures Manual	U.S. Government publication describing techniques and tactics for cleaning up oiled shorelines.
Cleanup of Oil from Shorelines	International tanker owner's publication on shoreline cleanup techniques and tactics.
Shoreline Response Video	Instructional and informational video on oil spill response developed by WWF Finland.
A Guide to Shoreline Cleanup Techniques	International primer on shoreline cleanup techniques, developed by oil industry.
Protection of Environmentally Sensitive Resources and Wildlife Response	
Sensitivity Mapping for Oil Spill Response	International primer on how to characterize and map shorelines for oil spill sensitivity, developed by oil industry.
Oiled Wildlife Response Protocols in the Central Baltic Sea	Protocols for handling oiled wildlife in Baltic region, geared at non-technical audience.
Use of Volunteers in Oil Spill Response	
Guideline for Use of Volunteers during Oil Spills	U.S. guidance document on oil spill volunteer management.
Tasks Suited to Volunteers in Oil Spill Response	Finnish publication on utilizing volunteers appropriately during spill response.
Planning Guidelines for Convergent Volunteer Management	Canada/U.S. joint guidance document for incorporating volunteers into oil spill response.
Managing and Organizing Volunteers in Oil Spill	Finnish publication on volunteer management during oil spills.

Reference	Description
Response	
Oil Spill Response Volunteers	Document developed by State of California based on experience with convergent volunteers during oil spill response.
Oil Spill Impacts	
Seafood Safety After an Oil Spill	U.S. government publication on evaluating and communicating potential seafood safety impacts from oil spills.
Oil Spill Monitoring Handbook	Handbook developed by Australian government for development and implementation of post-spill monitoring.
Sampling and Monitoring of Marine Oil Spills	International guide on conducting oil spill sampling and modeling, developed by oil industry.
Good Practices for Collection of Biodiversity Baseline Data	International guide on collecting baseline data on biodiversity to inform oil spill impact analysis, developed by oil industry.
European Union Certification Requirement for Fish	Process for post-oil spill seafood safety evaluation in Europe.
Coping with Technological Disasters Guidebook and Peer Listening Program	Developed by State of Alaska based on experiences of coastal communities dealing with community impacts from Exxon Valdez oil spill. Encourages community-based approach to healing.
Economic Assessment and Compensation for Marine Oil Releases	Good practice guide for dealing with post-oil spill compensation of impacted parties, from perspective of spiller/industry.
Oil Spill Exercises	Guideline for planning and conducting oil spill exercises, developed by oil industry.
Long-term Environmental Monitoring Program	Example of program in place in Prince William Sound, Alaska to monitor oil spill impacts post-Exxon Valdez oil spill.

8 Building Nunavut Coastal Community Oil Spill Response Capacity

Best Practices for Local Oil Spill Response Planning

This report draws largely from the authors' experience as practitioners of oil spill and emergency response planning in North America, Europe, and Australia. Through firsthand experience developing oil spill response plans and all-hazards plans for local governments, First Nations, and Alaska Native villages, it has become apparent that locally-developed plans are critical to ensuring that community members who bear considerable risks from oil transportation and storage activities have a rigorous and understandable process to plan and prepare for response.

In recent years, there has been additional work to consider the challenges and opportunities for preparing arctic communities for oil spills. A 2013 workshop that focused on the Bering and Anadyr Straits in the U.S. Arctic[8] identified a number of key themes:

- Dedicated funding sources are needed to secure training, equipment and infrastructure;
- Meaningful community input into community-specific response plans and associated Geographic Response Plans is needed;
- Training programs focused on community-based oil spill emergency response are required;
- Adequate infrastructure, equipment, and logistical resources must be available in the region;
- Effective communications plans must be in place within communities and between communities, agencies, organizations, and responsible operating bodies;
- Cross-border communication and cooperation is necessary; and
- Improved understanding of legal authority, protocols, and roles around subsistence food security are critically important.

All of the recommendations above should be considered by Nunavut communities as they establish priorities, develop plans, and build capacity for local oil spill response.

[8] *Community and Oil Spill Response in Bering and Anadyr Straits*, workshop report from November 7-8, 2013. https://www.arcus.org/20004

Preparedness Goals

Capacity-building within Nunavut hamlets should be driven based on the preparedness goals that each community articulates (see discussion in Section 6 of this report). It is important to be realistic in setting goals, and to align preparedness to risk – both the probability and potential consequences of oil spills to local communities. In order for these goals to drive meaningful preparedness, they must be derived from within the community.

Evaluating Capacity

Inventory Equipment and Infrastructure

Evaluating oil spill response capacity begins with an inventory of resources within a community. This may include both government-owned and private resources. Private resources that could be used in oil spill response may be owned by oil handling facilities, construction companies, waste management or remediation contractors, or other industries. Inventories should consider oil spill cleanup equipment but also consider support resources such as vessels, all-terrain vehicles, aircraft, trucks, and other utility items.

It is also important to evaluate the infrastructure capabilities and constraints that may influence overall capacity. For example, port access, airstrips, and road access are all important considerations for mounting a spill response. There must also be adequate infrastructure to feed and house responders.

If road or other travel corridors connect the community to others, it may be useful to inventory resources in nearby communities, accounting for travel time and logistics to transport them. Regional resources that are maintained by other levels of government should also be inventoried, but again it is important to consider the time and logistical support needed to transport those resources.

Catalogue Knowledge and Data

One of the critical roles that local communities play in oil spill preparedness and response is as a holder of local and traditional knowledge about the ecology, environment, natural and cultural resources, and human use. Likewise, local knowledge about environmental conditions, shoreline properties, weather, oceanography, and ice conditions may be critical to planning and implementing a response. In the event that there are no oil spill trajectory models capable of predicting spill movement, local knowledge about tides and currents can provide valuable insight into where oil may move or how it may behave. Where models do exist, local knowledge may be used as a ground truth for model assumptions and outputs. It is just as important to inventory this knowledge and plan for its implementation into local oil spill response as it is to keep track of equipment and logistical support.

Traditional knowledge is sometimes sensitive in nature. Pre-planning can be helpful in identifying the types of traditional knowledge that is valuable to oil spill preparedness and response, and to working through information or data-sharing protocols ahead of time.

Survey Personnel

Oil spill response is a very human-intense activity. People are needed to operate equipment and also to manage the spill response. A major oil spill response typically involves the influx of personnel into a community, but for remote arctic regions like Nunavut, local community members are also valuable assets. Before a person can provide spill response support, they must receive appropriate training and have the requisite protective equipment. Identifying local community members who have specialized training or knowledge is a first step to building a local capacity.

Considerations for Evaluating and Filling Gaps

Once existing capabilities have been inventoried, they can be compared against the established preparedness goals to begin to identify existing gaps. Considerations for moving forward include:

- Consider whether there are specific types of oil spill clean-up equipment or technologies that are missing; if so, determine how and where could they be acquired, and at what cost.
- Identify infrastructure improvement projects that would enhance oil spill preparedness and response capacity.
- Specify the necessary level of training for local and regional oil spill responders to achieve the preparedness goals.
- Determine whether there is critical information that is not known, such as baseline environmental data, weather or observational data.
- Evaluate whether sufficient maps and resource/vulnerability data to inform site-specific planning. Develop additional maps as needed.
- In the event that gaps are identified, identify pathways to fill them, such as planning, training, funding, equipment, or research and development.

- Consider whether there are identified gaps that cannot be filled and if so, identify other preventative measures that could be taken to mitigate risks that result from preparedness gaps.

9 Conclusion

WWF-Canada commissioned this report to support oil spill planning and preparedness for Nunavut communities as they face the potential for new risks as shipping and resource development activities expand in the region. Oil spills are unique emergencies because they require coordinated response across multiple levels of government, in collaboration with the polluter. While many of the authorities for preparing for and responding to oil spills lie with the federal government, communities bear a significant risk and a strong stake in mitigating oil spill impacts if and when they occur.

Nunavut hamlets face a number of significant challenges in preparing for oil spills, including limited infrastructure, remoteness, harsh arctic climate, and a lack of a dedicated response organization in the region. At the same time, oil spills present a significant risk of adverse impacts to ecological resource, socio-cultural values, and local food sources. For all of these reasons, Nunavut communities must approach oil spill preparedness in a manner that promotes self-sufficiency and self-determination.

The oil spill preparedness and response challenges that Nunavut communities face are not unique; remote communities across the arctic and along Canada's northwest coast are faced with many similar challenges. Over the past several years, indigenous and rural coastal communities in British Columbia faced the potential for increased risks from shipping projects, and efforts to enhance community preparedness for oil spills have begun. Similarly, other arctic nations have also considered the challenges of preparing for oil spills and ship-source emergencies. Nunavut hamlets may benefit from a knowledge exchange with other communities that are facing similar challenges.

As WWF-Canada continues to support Nunavut in developing community oil spill response plans and capacity, it is critical to coordinate and communicate with other levels of government and industry, and to strive for a harmonized and transparent approach.

10 Acronyms and Abbreviations

CCG	Canadian Coast Guard
CWS	Canadian Wildlife Service
DFO	Department of Fisheries and Oceans
DOE	Department of Environment (Government of Nunavut)
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
EPD	Environmental Protection Division (Government of Nunavut)
GRP	Geographic Response Plan
GT	Gross tons
IAP	Incident Action Plan
ICS	Incident Command System
INAC	Minister of Indian Affairs and Northern Development
NEED	National Environmental Emergencies Centre
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement
NLUP	Nunavut Land Use Plan
NOAA	National Oceanic and Atmospheric Administration (U.S.)
NORDREG	Northern Canada Vessel Traffic Service Zone
NPC	Nunavut Planning Commission
NTI	Nunavut Tunngavik Incorporated
NWMB	Nunavut Wildlife Management Board
OPEP	Oil Pollution Emergency Plan
OSRP	Oil Spill Response Plan
PAH	Polycyclic aromatic hydrocarbon
PPB	Part per billion
PPD	Petroleum Products Division (Government of Nunavut)

RAC	Regional Advisory Council
RCMP	Royal Canadian Mounted Police
RO	Response Organization
SCAT	Shoreline Cleanup Assessment Technique
SOPEP	Shipboard Oil Pollution Emergency Plans
STA	Spill treating agent
STAR	Spill Tactics for Alaska Responders
TC	Transport Canada
VOC	Volatile organic compound
WSF	Water-soluble fraction

11 References

Abdelnour, R. and G. Comfort. (2001). *Application of ice booms for oil spill cleanup in ice infested waters.* Fleet Technology Limited. Kanata, Ontario. April.

AMAP (1998). *AMAP Assessment Report: Arctic Pollution Issues*. Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway.

AMAP. (2008). *Assessment 2007 – Oil and Gas in the Arctic: Effects and Potential Effects.* Arctic Council Report. Oslo, Norway.

Buist, I., Dickins, D., Majors, L., Linderman, K., Mullin, J. & Owens, C. (2003). *Tests to determine the limits to in situ burning of thin oil slicks in brash and frazil ice.* Proceedings of the Twenty-sixth Arctic and Marine Oil Spill Program (AMOP) Technical Seminar. Environment Canada, Ottawa, ON. June 10-12.

Buist, I., et al. (2010). *New herding agents for thickening oil slicks in drift ice for in-situ burning.* Proceedings of the 33rd Arctic Marine Oil Spill Program Technical Seminar on Environmental Contamination and Response. Halifax, Nova Scotia. Environment Canada. Pp. 1085-1108.

Department of Fisheries and Oceans (DFO). (2015). *Ecologically and biologically significant areas in Canada's Eastern Arctic Biogeographic Region, 2015.* Canadian Science Advisory Secretariat, Central and Arctic Region Science Advisory Report 2015/049. December.

Dickins, D. & Buist, I. (1999). *Countermeasures for ice-covered waters.* Pure Applied Chemistry: Vol. 71, No. 1. pp. 173-191.

Dickins, D. (2004). *Advancing Oil Spill Response in Ice-covered Waters.* Report to Prince William Sound Oil Spill Recovery Institute and US Arctic Research Council.

Evers, Karl-Ulrich, Kristin R. Sørheim and Ivar Singsaas. (2006). *Oil Spill Contingency Planning in the Arctic—Recommendations*. Arctic Operational Platform (ARCOP).

Fingas, M. (2004). *Weather windows for oil spill countermeasures.* Prepared for Prince William Sound Regional Citizens' Advisory Council.

Fuller, C. and J.S. Bonner, J.S. (2001). *Comparative toxicology of oil, dispersant and dispersed oil to Texas marine species.* Proceedings of the 2001 International Oil Spill Conference: pp. 1243-1241.

Glover, N. and D. Dickins. (1999). Oil spill response preparedness in the Alaska Beaufort Sea. Reprint of material presented in 1996 Symposium on Oil Spill Prevention and Response and 1999 International Oil Spill Conference.

Gulec, I. and D.A. Holdway. (1997). *Toxicity of dispersant, oil, and dispersed oil to two marine organisms.* Proceedings of the 1997 International Oil Spill Conference: pp. 1,010-1,011.

Hughes, L. (2016). *Background Information on for Community Oil Spill Response Planning in Pond Inlet, Grise Fiord, and Arctic Bay.* Report to WWF-Canada. October.

Humphrey, B., D.R. Green, B.R Fowler, D. Hope, and P.D. Boehm. (1987). *The fate of oil in the water column following experimental oil spills in the arctic marine nearshore.* Arctic 40 (Supp. 1): 124-132.

International Tanker Owners Pollution Federation Limited (ITOPF) (2011). Use of Dispersants to Treat Oil Spills. *ITOPF Technical Information Paper 4*, London, England.

Khelifa, A. (2010). A summary review of modeling oil in ice. *Proceedings of the Thirty-third AMOP Technical Seminar on Environmental Contamination and Response.* Environment Canada. June 7-9, 2010. Halifax, Nova Scotia.

Lindstrom, J.E., D.M. White, and J.F. Braddock. (1999). *Biodegradation of dispersed oil using Corexit 9500.* A report produced for the Alaska Department of Environmental Conservation Division of Spill Prevention and Response. 30 June.

National Research Council (NRC) (2003). Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. The National Academies Press. Washington, DC.

Ocean Studies Board (OSB). (2005). *Oil spill dispersants: efficacy and effects. Committee on Understanding Oil Spills: Efficacy and Effects.* National Research Council. National Academies Press, Washington, DC.

Owens, E.H., L.B. Solsberg, M.R. West, and M. McGrath (1998). *Field Guide for Oil Spill Response in Arctic Waters.* Prepared for Emergency Prevention, Preparedness, and Response (EPRR) Working Group. Arctic Council.

Peterson, Charles H., et al. (2003). *Long-term ecosystem response to the Exxon Valdez oil spill.* Science*: 302.* 19 December.

Prince, R.C., E.H. Owens, G.A. Sergy. (2002). *Weathering of an Arctic oil spill over 20 years: the BIOS experiment revisited.* Baffin Island Oil Spill. Marine Pollution Bulletin, Nov; 44(11): 1236-1242.

Reed, Mark et al. (1999). *Oil spill modelling towards the close of the 20th century: overview of the state of the art.* Spill Science and Technology Bulletin. Volume 5, Number 1.

Shigenaka, G., and N. Barnea. (1993). *Questions about in situ burning as an open-water oil spill response technique.* National Oceanic and Atmospheric Administration. HAZMAT Report 93-3. 42 pp.

Singer, M.M., George, S., Lee, I., Jacobson, S., Weetman, L.L., Blondina, G., Tjeerdema, R.S. Aurand, D. & Sowby,.M.L. (1998). *Effects of dispersant treatment on the acute aquatic toxicity of petroleum hydrocarbons.* Archives of Environmental Contamination and Toxicology. Vol 34: 177-187.

Singsaas, I., P.J. Brandvik, P.S. Daling, M. Reed, and A. Lewis. (1994). *Fate and Behaviour of Oils Spilled in the Presence of Ice - A Comparison of the Results from Recent Laboratory, Meso-Scale and Field Tests.* Proceedings of the 17th Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Environment Canada, Ottawa, ON, Canada, pp. 355-370.

Transport Canada. (2013). *A review of Canada's ship-source oil spill preparedness and response regime: Setting the course for the future.* Ottawa, ON: Tanker Safety Panel Secretariat.

Wilson, D.G. and D. Mackay. (1987). *The Behaviour of Oil in Freezing Situations.* Prepared at the University of Toronto for the Environmental Protection Directorate, Environment Canada, Report No. EE-92, Ottawa, ON, Canada.