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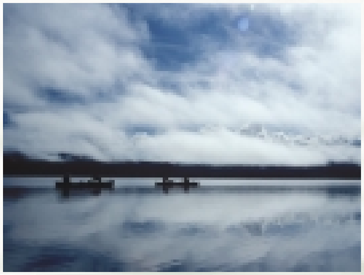
Exploration
& Production Drilling

Environment & Energy in the North



A PRIMER

About the Pembina Institute

The Pembina Institute is an independent non-profit research, education and advocacy organization. It promotes environmental, social and economic sustainability through the development of practical solutions for businesses, governments, individuals and communities. The Pembina Institute provides policy research leadership on climate change, energy policy, green economics, renewable energy, and environmental governance, as well as extensive formal and public education programs. More information about the **Pembina Institute** is available at **www.pembina.org** or by contacting

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Contents

About the Primers

The Pembina Institute's Energy Watch program has developed a series of eight primers to help northern communities understand the potential environmental and, where applicable, human health impacts of oil and gas development. The primers also aim to help these communities effectively take part in managing these risks, ensuring that governments and oil and gas developers are using the best environmental practices available.

Each of the first six primers focuses on a different phase of oil and gas development.

There are four parts to each of these primers:

1. A basic description of the activities of that phase
2. The potential environmental and human health risks of that phase
3. The best practices available to reduce those risks
4. Opportunities for citizens to get involved in deciding how developers carry out the activity.

The following are the six phases of oil and gas development addressed by the primers:

Seismic Exploration — industry activities to create a picture or map of the geology below the Earth's surface to find oil and gas reserves.

Land Disposition — the actions companies need to take to get the rights to explore for and produce oil and gas reserves.

Exploration and Production Drilling — the activities companies perform to first locate oil and gas, then to find out the size and usability of an oil and gas reservoir, and finally to reach the oil and gas using intensive production drilling.

Well Site Operation — industry practices to remove oil and gas from underground reservoirs and transport them to the surface.

Oil and Gas Processing — actions companies take to process oil and gas to prepare it for sale.

Pipeline Construction and Operation — industry activity to set up pipelines that carry oil and gas from the place it comes out of the ground to the places where consumers will use it.

The last two primers focus specifically on citizens' rights around oil and gas development projects:

Citizens' Rights and Oil and Gas Development: Northwest Territories explains the rights that citizens have related to oil and gas development in the Northwest Territories.

Citizens' Rights and Oil and Gas Development: Yukon Territory explains the rights that citizens have related to oil and gas development in the Yukon Territory.

To produce these primers, the authors reviewed the limited oil and gas development already under way in Canada's North. They also researched the current issues and practices in Alberta, northeast British Columbia, and the Alaskan North Slope, where intensive oil and gas development is already occurring.

Introduction

Just as they were about twenty years ago, companies are once again actively exploring for oil and gas reserves in the frontier regions of the Northwest Territories and the Yukon Territory. If developers decide to develop these resources, they will have to build a large capacity (or large diameter) pipeline to export the oil and gas from the far North to other regions. Once developers make a final decision to build one or more pipelines, and once regulators approve the plans, oil and gas exploration and production activity in the North will quickly increase.

Developing the oil and gas resources of the North would offer the people living there many opportunities for economic development. But it is important that companies developing oil and gas reserves, and governments and other regulators overseeing the work, make sure they do not damage the cold, slow-growing and sensitive northern ecosystems. While there will be unavoidable environmental impacts because of oil and gas exploration, developers and regulators can reduce impacts with careful planning and by using the best available technologies and practices.

Since it is the people of the North who will experience the most direct impacts, it is important that they play a strong role in setting the terms and conditions of such development. When deciding on the actions they will take, industry and various levels of government need to be respectful of and consider the needs and wishes of Northern communities.

During the past few decades, the oil and gas industry has become more aware of the environmental impacts associated with its work. Technologies and practices have become much less environmentally damaging than they were in the past. And most, though not all, companies have responded to social and environmental concerns. Despite these improvements, there are still negative environmental impacts associated with oil and gas development and production. This is especially true in areas where the activity is intensive.

When the public shares their questions, concerns and expectations about this work — directly to companies, through the media, and through regulators that inspect the work and enforce regulations — this helps to uphold and improve industry performance. When the public is able to take part in effectively influencing decisions around oil and gas exploration, this pushes companies to higher levels of performance. When the public gives their input they tend to examine all companies equally; their participation ensures that all developers follow the best practices possible.

When companies involve local people and their concerns for the long-term health of their communities and environment they can build positive relationships, increase certainty and decrease conflicts around the project, and lower their investment risk.

This primer, ***Exploration and Production Drilling***, focuses on the way industry uses exploratory drilling to establish oil and gas reservoir size and viability and the role of governments in setting and enforcing the rules to which industry must abide. It also describes the way it extracts these resources using intensive production drilling.

There are four sections in this primer:

- Part 1 provides a general description of exploration and production drilling
- Part 2 outlines the potential environmental impacts associated with exploration and production drilling
- Part 3 describes technologies and practices that can help to reduce environmental risks associated with exploration and production drilling
- Part 4 offers information on citizen rights and opportunities to influence decisions on exploration and production drilling proposals.

What is Exploration and Production Drilling?

Exploration and production drilling is the third phase of oil and gas exploration, following land disposition[1] and seismic exploration.[2]

When planning to drill an exploratory well, a company will select a location on the surface that is, as close as possible, directly above the target underground location. They begin by clearing and levelling the land to create a flat stable surface, and building access roads to the drilling site. Because they will need water during the drilling process, if there is not a natural water source nearby they will truck water into the site or drill a water well in areas that have groundwater. Often a company will set up a mobile camp on the well pad for the drilling crew to live in while the well is being drilled. The well pad is the flat gravel or ice surface area that all of the equipment sits on.

Next crews dig a reserve pit (commonly referred to as a "sump") or bring in a series of large tanks, where they will put drilling waste. Depending on regulatory requirements, workers may dispose of drilling waste on site or transport the waste out of the area by truck and dispose of it elsewhere. Finally, the crew moves the drilling rig into place and sets it up. They are now ready to begin drilling.

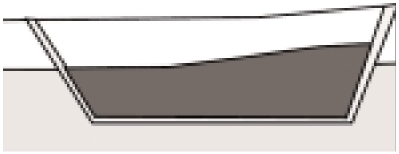
A Wellpad in Northern BC

SOURCE: WAYNE SAWCHUK

COMPANIES

***Companies** can avoid surface impacts by drilling exploratory wells using only temporary winter-only roads (ice or snow-packed roads) and ice well pads, and only build permanent gravel roads and pads when they determine there are large enough reserves to develop.*[3]

1 See the first primer in this series, Land Disposition: A Primer, for a detailed explanation of this step.
2 See the second primer in this series, Seismic Exploration: A Primer, for a detailed explanation of this step.
3 Temporary roads are also used in areas where the costs of building permanent roads and pads are very high.

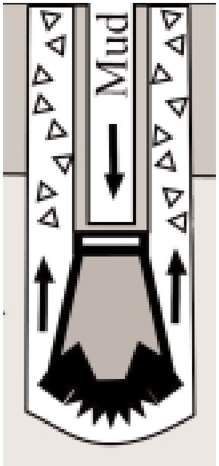


Sump used for collecting drilling waste.

SOURCE: PEMBINA INSTITUTE

Three kinds of drill bits.

SOURCE: PEMBINA INSTITUTE



Drilling mud carries rock chips back to surface.

SOURCE: PEMBINA INSTITUTE

Workers drill the well using a drill bit that is connected to a drill pipe. The drilling rig turns the pipe and, in turn, the drill bit. The rotating bit and the weight of the pipe crushes the rock underground.

Workers pump drilling "mud" through the pipe and out the drill bit into the hole. The mud displaces the rock debris (called rock cuttings) from the active drilling area and carries it to the surface. Drilling mud is a mixture of clay, water (or sometimes diesel fuel, mineral oil or other fluid instead of water), and a wide range of possible process chemicals. When drilling through permafrost, saltwater is used instead of freshwater in drilling mud because it can be cooled to temperatures below zero degrees C. The mud is prepared and stored in tanks on or near the well site and circulated into the well bore as needed. Rock cuttings from the active drilling zone are separated from the drilling mud and collected in tanks or pits; they ultimately form part of the drilling mud waste when the drilling project is complete.

After workers have drilled the first section of the well, called the "surface hole," they put a steel casing in the hole to prevent it from collapsing. Then they pump cement into the space between the outside of the casing and the drilled hole to hold the casing in place. The cement and casing also prevent groundwater from becoming contaminated with fluids moving back and forth. After setting the surface casing the crew continues drilling and cementing the "intermediate casing" in sections.

The process ends when the drillers reach the production zone — the area where the oil and gas reserves lie. They do not cement in the "production casing" until after they have tested the well and have decided to convert the well into a production well.

If developers drill into a reserve of oil or gas, they need to find out whether the reserve is large enough to be profitable for them to extract and process the resources. The workers do this by allowing the oil or gas to flow and measuring the well's productivity — that is, how much oil or gas can be brought to surface. (Only a portion of the oil and gas that is present can be extracted.)

With gas wells, for example, developers may conduct a flow test for one to four days to measure the rate and pressure of the gas reservoir. They typically do this by directing the gas to a flare and allowing it to burn for the duration of the test. They gather information from this "production test" to assess reserves, determine the size of pipeline needed, and to find out what type of processing facility will be needed.

Flare stack

SOURCE: PEMBINA INSTITUTE

The workers' test of an exploratory well may indicate that there are sufficient quantities of oil or gas to justify investing in the production and pipeline infrastructure needed to bring the resources to market. In this case the developers will convert the exploration well to a production well.

They do this by cementing the production casing and preparing the well to go into production. For a well that will not go into production, workers permanently plug the exploration well so that it will not flow, dismantle the drilling rig and move out all equipment before the spring thaw. The developers use the information they have gained through the exploration to then plan where they will locate and drill a production well from a permanent well pad.

After finding oil or gas in a new area, companies often drill multiple production wells — either into the same oil and gas formation or into similar formations in the area. Production well drilling is accompanied by construction of the permanent well-site, and pipeline and processing infrastructure needed to exploit the resource.

Before beginning production drilling, workers build an all-season well pad usually out of gravel. The access to the well pad may be by winter road or all-season gravel road. When drilling a production well, workers follow the same steps as when drilling an exploration well (described above). When they have finished the drilling, they install at the ground surface a well head that contains valves to control the flow of oil or gas from the reserve to the pipeline.

If the oil or gas contains water or other impurities that must be removed, crews may install simple processing equipment on the well pad, such as separators or dehydrators, to remove these impurities before the product enters the pipeline.

The last step is for crews to construct a small diameter pipeline that "gathers" the product from the well and transports it to a processing facility. From here it moves to a "sales" pipeline and then is sent to market.

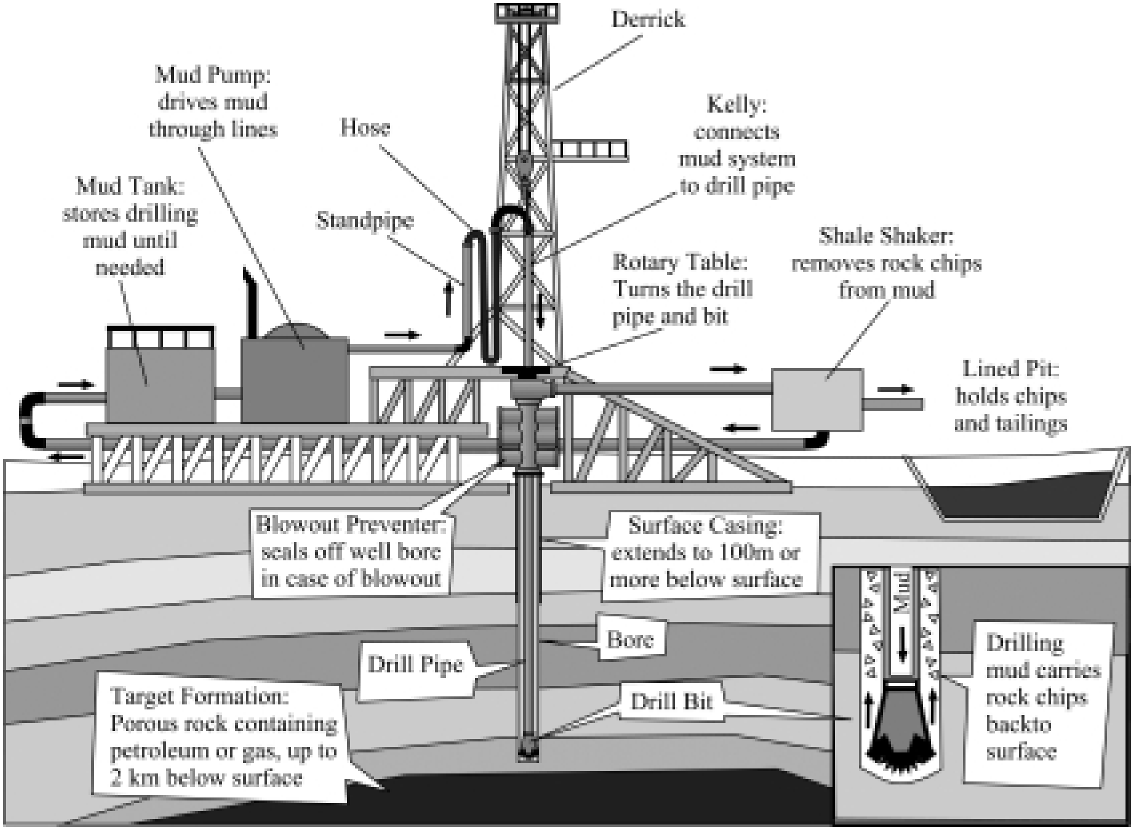
A Separator

SOURCE: PEMBINA INSTITUTE

Drilling Rig near Inuvik

SOURCE: ENVIRONMENT CANADA

Exploration drilling is often unsuccessful and there may not be any oil or gas where workers have drilled. This is referred to as drilling a dry hole. The risk of drilling a dry hole varies from formation to formation and decreases as knowledge is gained from both successful and unsuccessful wells in a given formation. Dry holes are usually abandoned at the time of drilling.



Drilling Rig

SOURCE: PEMBINA INSTITUTE CREDIT: DAVE MUSSELL

Environmental Impacts

Canada's North is a diverse landscape. It contains seven distinct ecological areas:

Arctic Cordillera Ecozone	mountains, rock, ice and glaciers, few plants and animals
Northern Arctic Ecozone	barren plains, permafrost, some rock, seabirds and muskox
Southern Arctic Ecozone	shrubs, meadows, lakes, large mammals
Taiga Cordillera Ecozone	mountains, arctic shrubs and flowers, wetlands, valleys, waterfalls, canyons, rivers, wide range of mammals
Taiga Plains Ecozone	low-lying plains, large rivers, rich diversity of plants, birds and mammals
Taiga Shield Ecozone	coniferous forest, bedrock, lakes, wetlands, meeting of the boreal and arctic zones
Boreal Cordillera Ecozone	mountains and valleys separated by wide lowlands

Since each area in the North is unique, oil and gas development will impact each area differently. The nature and extent of environmental impacts will depend upon the regional ecosystem type, local terrain characteristics, the presence or absence of tree cover and permafrost, and the type of soil.

This section identifies potential environmental disturbances that may result from seismic exploration. Some impacts are common to all areas; others are particular to an area that may be sensitive in some way. For example, in tundra areas of the North that have few trees or are treeless, such as parts of the Mackenzie Delta, the concerns will be different than in heavily treed areas.

Disturbance of the Land Surface

Developing access roads, well pads, and associated facilities to support drilling activities disturbs the surface of the land.

The cumulative impacts from old well sites, newly drilled wells, seismic surveys, building pipelines and other activities that cause land disturbance is a key concern in oil and gas producing regions of Canada. When developers create roads, camps, equipment storage areas, and other clearings, this leaves breaks or separations in ecosystems. Fragmentation of the landscape disrupts habitat and affects the movement of wildlife. Drilling can also impact the land if vehicles compact the soil or damage the vegetative mat.

Camp Farewell staging area NWT

SOURCE: ENVIRONMENT CANADA.

The time that it takes for reclamation of exploratory well pads and roads can vary significantly, depending upon on the time of year the company drills, the surface preparation and equipment transport methods they use, and the sensitivity of the soil/vegetation complex. Companies may leave production wells, pads and roads open and active for years or decades before they finally abandon the wells and reclaim the surface. Some areas may experience multiple waves of oil and gas exploration and production before the reserves are finally depleted and the surface reclaimed. This wave effect occurs because, over time, as pipeline and processing infrastructure in an area is expanded, production costs generally come down making the smaller reserves of oil and gas in an area economic to produce.

Permafrost

In arctic environments, the extent of surface disturbance depends on the type of soil and whether the soil is permafrost (a permanently frozen layer of soil underlying the "active layer" on top that melts and re-freezes each year). Permafrost soils are easily damaged. They are very sensitive to changes in temperature. Human activities, including the operation of large equipment, can result in dramatic reshaping of the land through rutting of roads, "melt-outs" and subsidence (settling of the land).

ARCTIC CARIBOU

Surface disturbances can impact wildlife, especially at key stages in their life cycle.

SOURCE: CPAWS YUKON CHAPTER

Arctic caribou usually travel in large herds. Because there typically isn't any forest to protect them, they won't be impacted by the linear disturbances caused by seismic activity in a forest. But, without the forest as a barrier, they may be more sensitive to disturbances they can see and hear. As a result, arctic caribou may potentially show stress-related responses, including not resting, not paying attention to predators, not eating, losing weight, and having calves that are low in birth weight. Responses of caribou to seismic activity will likely depend on the duration, intensity and extent of the development.

To learn more about the impacts of oil and gas exploration on arctic caribou, see the companion publications entitled "Resources and Contacts".

Disturbing, compressing or removing any surface material and vegetation can result in increased soil temperatures in summer months. This can seriously damage the permafrost.

Wildlife

Areas where there are a lot of cutlines and access roads are known to impact wildlife and wildlife movement. Oil and gas drilling activity may affect the size of wildlife populations, the location of herds, and their traditional migratory paths. While the amount of clearing associated with wells, pipelines and access roads is less than the clearing associated with seismic exploration the local impact is greater on some species. For example woodland caribou have been found to avoid wells to a distance of one kilometre compared with 250 metres for seismic lines.[4]

Vegetation

In addition to wildlife, trees and other plants are affected by land disturbance caused by exploration and production drilling. When vegetation in arctic regions is damaged or removed it takes a long time to grow back. This is because the growing season is short and in these areas soils don't produce a lot of nutrients to sustain the plants. Compared to more southern parts of Canada, northern Canadian forests take more time to recover from surface disturbances like roads and well pads.

4 Dyer, S.J., J. P. O'Neill, S. M. Wasel and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. J. Wildland Management. 65:531-542.

Damage to Soil and Water

North Yukon: new tracks have been created to avoid further damage to old tracks

SOURCE: NIKI WILSON

Exploration and production drilling can cause damage to both soil and water quality, as outlined in detail below. Drilling waste is a particularly large problem at this stage of oil and gas exploration and poses significant threats to soil and water quality.

Drilling Waste

Well drilling generates large volumes of oilfield waste in the form of drilling mud and drill cuttings that must be stored, handled and, ultimately, disposed. Spills and leaks of drilling fluid, hydrocarbons or water produced during drilling operations can also generate oilfield waste.

Most drilling mud is fresh- or salt-water–based clay, but they can also be oil-based.

In permafrost regions companies must cool the drilling mud in order to prevent thawing of the permafrost around the well bore while drilling. Oil or salt-water–based drilling muds are used in permafrost regions because they can be cooled below zero degrees Celsius. Most oil-based mud contains diesel oil in place of water and is referred to as "invert mud." Invert mud is extremely toxic. Developers use oil-based muds if, while drilling for oil and gas, there is a risk of encountering a subsurface rock formation that is sensitive to water (this is rock that, if it comes into contact with water, may become hydrated and expand or disintegrate). Mineral oil and canola oil are less toxic alternatives to diesel oil, but they are more expensive.

The chemical composition and toxicity of drilling muds vary depending on the types of salts and chemicals that are added to them. Many potentially toxic compounds are added to drilling mud or used to lubricate pipe connections to speed up the drilling process and to reduce complications. Some of the

DRILLING MUDS

Drilling muds *may also contain the following additives:*

- *bactericides*
- *corrosion inhibitors*
- *defoamers — silicone or alcohol based*
- *surfactants*
- *lubricants — mineral or synthetic oils*
- *flocculants and inhibitors — alcomer, polyacrilomides*
- *viscosifiers — bentonite clay, xanthan gum*
- *fluid loss and loss circulation agents — calcium carbonate, starch, polyanionic cellulose, sawdust*
- *pH control agents —caustic soda, citric acid, soda ash*

added substances may contain organic compounds or heavy metals that are toxic, build up in the environment, and take a very long time to break down. Drilling mud may also become contaminated with hydrocarbons or high levels of salts that come from the rock formations below the Earth's surface.

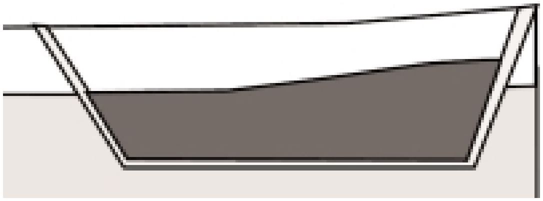
When workers dispose of drilling mud and liquids, either on or below the Earth's surface, they can contaminate soil, subsoil, surface waters and groundwater. Even if the crew safely disposes of the mud itself, spills or leaks can occur and contamination may result. In addition, all drilling mud contains clay and fine material that, when disposed of, may eventually enter a water body and cause siltation (clouding of the water and deposits of fine particles on the bottom).

Storage tanks for storing drilling waste

SOURCE: PEMBINA INSTITUTE

The way crews dispose of drilling mud will greatly depend on the characteristics of the area, including climate,[5] land use, and proximity to sensitive areas, as well as on the regulatory requirements of the jurisdiction where they are working. Alberta, for example, allows companies the option of discharging some types of drilling waste directly into the environment. This means developers may dispose of

5 In cold northern climates materials break down more slowly than in warmer southern climates due to a shorter growing season, lower ambient temperatures, and less developed topsoil.



Sump used for collecting drilling waste.

SOURCE: PEMBINA INSTITUTE

ALASKA

*In **Alaska**, companies operating in the environmentally sensitive North Slope region must adhere to a policy of "zero environmental discharge." This means that they must contain all drilling mud in tanks until disposing of them by injection into deep disposal wells. Developers working in the North Slope region recondition and reuse up to 80% of their drilling mud. During construction, they use clean sand and gravel processed from well cuttings.[7]*

NORTHWEST TERRITORIES

*Burial of drilling waste in permafrost soils, the standard approach used in the **Northwest Territories** in the 1970s, has proven to be problematic. A recent assessment of sump performance by S. V. Kokelj and GeoNorth Ltd. for the Department of Indian and Northern Affairs Development indicated that approximately 50% of sumps constructed in the Mackenzie Delta region during the 1970s have collapsed or are actively collapsing.[8] The Canadian Association of Petroleum Producers' Northern Canada Environment Committee (NCEC) has recently conducted some reassessment work on sumps in the North and plans to release its findings after evaluating the data in 2003. A technical advisory group[9] made up of industry and government representatives is currently assessing why sumps have collapsed or are collapsing with the goal of determining if the practice can be improved. The advisory group is also looking at alternative methods for drilling waste management.[10]*

drilling muds either on-site or off-site. Allowed disposal practices are based on "loading rates" — estimates of how much waste the environment can handle without irreparable damage occurring. Regulators set these rates on the assumption that the contaminants (salts, metals, hydrocarbons) will become diluted in the environment. These practices increase the concentrations of contaminants in the immediate area in which they are disposed. In addition, contaminants may move from the disposal location into ground and surface waters.[6]

Offshore disposal of drilling mud and cuttings also represents a risk to ocean ecosystems. Oil-based muds contain compounds that are harmful to marine life and that can build up in the marine

6 Guide 50, Drilling Waste Management (Alberta Energy and Utilities Board, October 1996). Currently under review (August 2002).
7 U.S. Department of Energy Comments to the Bureau of Land Management, U.S. Department of the Interior on the Northeast National Petroleum Reserve. Alaska Draft Integrated Activity Plan/Environmental Impact Statement, March 12, 1998.
8 Drilling Mud Sumps in the Mackenzie Delta Region: Construction, Abandonment and Past Performance. Submitted the Department of Indian Affairs and Northern Development, Northwest Territories Region, by S. V. Kokelj and GeoNorth Ltd. April 30th, 2002.
9 Northern Drilling Waste Disposal Technical Advisory Group led by Environment Canada was convened in 2002.
10 "Sumps - A Cause for Concern?", Paula Pacholek, Environment Canada & Robert Jenkins, DIAND. Petroleum Technology Alliance Canada Conference held on May 13, 2002.

food chain.[11],[12] The National Energy Board (NEB) allows companies to dispose of water-based drilling muds and cuttings at sea.[13] Companies are not allowed to dispose of oil-based muds at sea, except under exceptional circumstances. The NEB guidelines specify that all muds should be recovered and recycled, re-injected down the hole from which they were taken, or transferred to shore for disposal. However, where re-injection or transport of drill solids is not technically possible, the solids may be treated and then discharged at sea.

Recent studies in the North Sea have suggested that environmental impacts may be attributed to constant exposure to produced water discharges (produced water is water that comes to the surface with oil or gas). This has prompted some regulatory agencies and members of the environmental community to request a zero discharge limit for produced water.[14]

Fuels

Fuels and oils can leak from vehicles and fuel storage areas. Workers may accidentally spill fuels and oil when refuelling their equipment. This can also happen when crews clean equipment. Temporary tanks and pipelines can leak at connections. In each case, chemicals can leach into soil and water and contaminate them. This is especially true of cleaning solvents.

Many other sources of potential soil contamination in the form of leaks, spills and discharges can happen at active drilling sites and during well servicing operations. While each individual leak or spill may be small, the accumulated addition to the soil at a drilling site can cause significant contamination and can increase reclamation and remediation costs.

Sedimentation

When crews remove vegetation from the land, or when their equipment damages permafrost, this can lead to soil erosion. Soil that would have been held in place by trees and other vegetation is now steadily worn away from the surface by rain, snow and wind and deposited as sediment into lakes, rivers and streams. This is called sedimentation.

Sedimentation can cause serious damage to surface water bodies. It can cover critical aquatic habitat for fish and insects. Nutrients in the sediment, such as phosphorous and nitrogen, can increase nutrient levels in the water. Sediment can also raise water levels and block the flow of water, leading to flooding and habitat damage.

11 A Survey of Offshore Oilfield Drilling Wastes and Disposal Techniques to Reduce the Ecological Impact of Sea Dumping by Jonathan Wills, M.A., Ph.D., M.Inst.Pet., for Ekologicheskaya Vahkta Sakhalina (Sakhalin Environment Watch); 25th May 2000. http://www.offshore-environment.com/drillingwastecontents.html (October 2002).

12 Countries in the North Sea area permit the discharge of synthetic-based mud (SBM) drill cuttings only in exceptional circumstances, but the U.S. Environmental Protection Agency decided that the treatment of SBM drill solids with the best available technology and ocean discharge was preferable to shipping the solids ashore for treatment and disposal. National Energy Board, 2002. Offshore Waste Treatment Guidelines, Backgrounder, p. 5. Online at (August 30, 2002)

13 National Energy Board, 2002. Offshore Waste Treatment Guidelines and Backgrounder. (August 30, 2002).

14 Cranford, P.J. (Editor), 2001. Scientific Considerations and Research Results Relevant to the Review of the Offshore Waste Treatment Guidelines. Scientific Advice from DFO Atlantic Zone to DFO Management, Fisheries and Oceans Canada.

Water Crossings

Roads and cutlines that cross or come too close to the edges of water bodies can damage vegetation and soil on the banks of watercourses. Both permanent and temporary stream crossings can become barriers to fish, preventing them from travelling up- or downstream if not properly designed and maintained.

Snow or ice crossings that are not properly removed before spring could become impassable barriers to fish movement. In addition, bank and bed erosion can occur when the spring waters are forced to flow around the blocked watercourse.[15]

To cross streams and creeks, companies often install concrete or steel drainage pipes, called "culverts," instead of bridges. Culverts can pose barriers to fish, preventing them from travelling upstream. On the downstream side, water flowing through the culvert may erode the streambed, causing depressions and making a small waterfall too large for fish to jump over.

Removal of vegetation can lead to soil erosion.

SOURCE: WAYNE SAWCHUK.

Undisturbed river bank

SOURCE: CPAWS YUKON CHAPTER

15 Cott, Pete and Peter Moore. 2002. Working near water: Considerations for fish and fish habitat. Appendix 3: Protocol for temporary winter access water crossings for oil and gas activities in the Northwest Territories. Inuvik, Northwest Territories: Department of Fisheries and Oceans.

SOUR GAS

Gas is considered "sour" if it contains hydrogen sulphide (H2S). H2S is acutely toxic to humans at low levels. Exposure to levels of 1,000 ppm cause instantaneous death. Sour gas is found in most places where oil and gas is currently produced in Western and Northern Canada. Sour gas is found in the southern parts of the Northwest and Yukon Territories. To date, no sour gas has been detected in the Mackenzie Delta region of the Northwest Territories.

If the culvert is too narrow, the force of the water flowing through the culvert can be too strong for fish to move through while trying to travel upstream.

Damage to Air Quality

The largest source of air emissions from drilling occurs when developers have found a gas well and conduct a production test called a "flare test" to determine its production capacity. A flare test of a productive gas well can release more pollutants in four days' time than would a large gas plant over the course of a month. Flaring can produce very high ground level concentrations of pollutants that could damage vegetation and affect human and animal health. Flaring releases typical "products of combustion," but some gas is released unburned, and some is converted into "products of incomplete combustion." Products of combustion include carbon dioxide, nitrogen oxides, and sulphur dioxide (if gas is sour). Products of incomplete combustion and unburned gas can include a range of harmful substances, such as benzene and other BTEX aromatics,[16] polycyclic aromatic hydrocarbon compounds (PAHs), methane, and hydrogen sulphide (if gas is sour).

After they drill a gas well to the target zone and before they bring it into production, companies conduct production tests to determine if the well is economic. Since, compared to the past, companies can more effectively gather high quality data about well and rock formations during the drilling, as well as use any pre-existing reservoir data from previous well production tests, it takes workers much less time to test new wells. Furthermore, if workers are testing in regions where there is already a pipeline network in place, they can direct the gas produced by the well during a well test directly into a pipeline, and avoid flaring altogether.Many wells require stimulation work to enhance the ability of the hydrocarbon to flow into the well. This entails pumping special fluids into the well that must be recovered when the flow starts again. During this fluid recovery stage (often called cleanup), the well cannot flow into the pipeline because the

16 BTEX aromatics consist of benzene, toluene, ethylbenzene, and xylene.

RISKS TO PUBLIC HEALTH

For workers, one of the dangers of exploration and production drilling is the risk of exposure to hydrogen sulphide (H_2S) in sour gas.17 H_2S is very toxic to humans and at high enough levels can cause instant death. Other risks include uncontrolled release and explosion of hydrocarbon vapours and liquids. Companies are normally required to develop emergency response plans (ERPs) to address these risks.

ERPs are intended to prevent lethal exposure to H_2S from the well site in the event of a well "blowout" — an uncontrolled flow of sour gas to the surface resulting in a release of H_2S to the air. ERPs are normally based on worst-case well data in the area. Regulators can also reduce risks to human health by establishing "setbacks" — the minimum distances that workers must keep between the activity or facility and other types of industrial, commercial or residential developments. Setbacks vary according to the type of oil and gas activity or facility. Other types of developments must also abide by the setback distances and not encroach on oil and gas activities and facilities.

pressure is too high. In this case, it is generally flared for a short duration.

Diesel engines used to power drilling rigs are another source of air emissions. The primary emissions of concern are nitrogen oxides, particulate matter, and greenhouse gases.

Other Environmental Impacts

Disruption of Other Activities

Disruption of wildlife or increased access may impact individuals carrying out subsistence and commercial hunting and trapping. In treed areas such as southern parts of the Northwest and Yukon Territories, the clearing associated with exploration and production drilling may result in a loss of commercial timber.

Wildlife Disturbance

Ground and air traffic noise can greatly disturb wildlife and sometimes cause them to leave an area completely, wandering into other areas that are unsafe or already inhabited by other wildlife.

Increased Access

Opening previously inaccessible areas often increases access for hunting, fishing and other recreational pastimes. This can increase pressure on wildlife and set back restoration efforts.

17 H2S is not found in all oil and gas formations. For example the gas reserves that have been found in the Mackenzie Delta in NWT are "sweet" (i.e., they do not contain H2S).

Using the Best Practices Available

Oil and gas exploration involves activities that will result in some environmental damage. Regulators and developers can minimize disruption of the environment by using "best practices and technologies" available — the most environmentally effective standards, practices and technologies that have been proven to minimize environmental damage.

Overall, best practices aim to ensure community sustainability. When companies use best practices they take a "triple bottom line" approach, considering the economic, environmental, and social impacts on the community of any action they take. In each of these areas, regulators and developers design best practices to minimize damage to the community's well-being and to increase its viability. This document focuses primarily on environmental best practices.

In oil and gas development there are three types of best practices:

- those that apply to the principles of how the work is planned and carried out
- those that refer to the practices and standards used in the field
- those that have to do with the equipment that is used.

With exploration and production drilling, many of the best practices refer to choices that industry should make before they start drilling. Compared to the past, companies plan more carefully, reduce surface disturbance by doing more of their work in the winter, use less environmentally damaging methods of waste disposal, and generate fewer air emissions. All of these practices together serve to reduce surface impacts of exploration and production drilling.

At this stage of oil and gas exploration, regulators can also use best practices to protect ecologically significant areas and to preserve the overall ecological health of an area over the long term. This includes considering immediate and future cumulative impacts of any proposed development. Regulators can apply best practices in the steps leading up to exploration and production drilling, especially during the planning phases before the work is approved.

When exploration and production drilling is completed, companies should work quickly to restore as many disturbed areas as possible. This will prevent erosion, degradation of soils and sedimentation in water bodies. When oil and gas has been depleted, companies should abandon the wells and reclaim the well pads, pipeline corridors, and access roads as quickly as possible to minimize the overall area disturbed by oil and gas and other industrial development in the region.

Best practices that minimize the risk of environmental impacts from exploration and production drilling specifically aim to:

- avoid surface impacts when exploring for reserves
- minimize the surface disturbance "footprint" required to drill for oil and gas reserves
- minimize impacts on land and wildlife by timing drilling activities appropriately
- create zero discharge of drilling waste solids or liquids to the environment
- minimize the risk of accidental release of wastes
- recycle or treat wastes rather than disposing of them
- avoid emissions from test flaring

The particular suite of practices and measures adopted for a specific exploration or production drilling project should reflect local circumstances. Not all of the best practices or measures listed below are appropriate in all cases. Also note that pipelines, waste treatment facilities and other types of oil and gas infrastructure may not be present in some regions in the North until production activity starts.

Planning

Developers can minimize overall surface impacts by planning their access routes to well sites at the seismic stage. They can also reduce damage by maximizing their use of existing roads, trails and cutlines. In areas that have already been impacted by development, companies can avoid more degradation and erosion and help the recovery of vegetation by planning to use low-impact practices.

Winter Access Only

Especially in sensitive areas such as arctic regions, crews can significantly reduce impacts caused by access for exploration drilling by using low-impact winter-only roads (ice or snow-packed roads). Winter-only access roads should be routed and designed to:

- use only existing cutlines, clearings, areas cleared by forestry companies or areas cleared by forest fires
- use treeless areas as much as possible
- minimize the number of creek crossings
- avoid sensitive wildlife areas such as raptor nests and bear dens
- avoid protected areas
- consider the use of lakes and other water bodies for winter access
- avoid steep slopes near watercourses
- detour around eskers[18] that may be important to local wildlife
- avoid pingos,[19] typically found in the Mackenzie Delta. Pingos are sensitive to surface disturbance. For this reason the Inuvialuit Land Administration has adopted a minimum setback restriction that prohibits operation of machinery, vehicles and equipment within 150 metres of these landforms.

In general, crews should minimize activity in the spring and summer to avoid potential damage to surface soils and aquatic environments.

18 An esker is a narrow, winding ridge of gravel or sand, deposited by the melting waters under a glacier.
19 Pingos are ice-cored hills formed as a result of water and ice pressure in permafrost terrain.

Minimize Wildlife Impacts

Developers should schedule drilling activity to avoid disturbing wildlife during crucial periods in their life cycles, such as mating and migration. In addition, crews can minimize wildlife disturbance by using specialized drilling rigs that require fewer transport trips.

Coordination with Traditional Activities

Oil and gas developers should conduct their exploration, development and production operations in ways that do not conflict with traditional activities of the surrounding community.

Animals can be sensitive to drilling activity especially at certain times of year

SOURCE: CPAWS YUKON CHAPTER

A company could, and often is required to, develop and implement plans to monitor the effects of its activities on communities, in consultation with the community and appropriate regulatory agencies.

In addition to mitigating impacts on traditional land use practices, the oil and gas industry may need to develop procedures to coordinate with traditional activities in oil- and gas-producing areas for environmental and safety reasons. These procedures, developed in consultation with affected local communities and appropriate regulatory agencies, would cover such topics as entrance to facilities, the use of roads, and the discharge of firearms. Regulators and developers should offer ongoing public education and training to make community members aware of the procedures.

Emergency Response Planning

Emergency response plans (ERPs) are plans to avoid or reduce risks in cases of emergency. They usually apply to sour wells and other sour facilities due to the potential release of hydrogen sulphide (H2S), but they can also apply to facilities with vapour release or explosive hazards.

Good ERPs include the following:

- Clearly defined criteria for notifying and evacuating non-essential personnel and members of the public in the surrounding area in the event of an emergency.

- A system to notify community members that may be on the land and difficult to contact in an emergency situation.
- Special measures to deal with sensitive individuals residing in the area such as pregnant women, children, elderly persons or asthmatics.
- Special measures to account for the long distances that emergency response personnel in the North may need to travel to reach the affected area.
- Specific criteria to guide a decision to ignite an uncontrolled sour gas release. Burning reduces the hazard to human health by converting the H_2S in sour gas into sulphur dioxide.
- Planned actions that are based on a realistic assessment of the company's resources available to deal with a worst-case scenario.
- Decision-making authority for evacuation and well ignition delegated to on-site personnel to prevent delays.
- Adequate advance staff training to ensure the ERP will be carried out successfully.

Waste Management Planning

Companies proposing new projects in Alaska's North Slope region must prepare waste management plans that meet regulatory waste prevention and reduction goals for all phases of exploration and development. The appropriate authorities must approve these plans before the project can proceed.[20] This policy ensures that companies give adequate consideration to waste management at the detailed design phase of the project, and avoids crises related to processing waste or stockpiling it.[21]

Individual companies and local municipalities, governments and other oil and gas operators can work together to put in place a centralized waste management plan. This plan can ensure that waste management infrastructure with the highest standards of environmental protection is available.

Low Ground Compaction Techniques

Camps

When drilling wells, crews often set up camps where they live and work during the project. Camps typically consist of a number of buildings that are taken into an area on skids. These camps can have negative environmental impacts, including damage to the land surface.

- Periodic full-scale and realistic testing of the emergency response plan, involving field and headquarters personnel.
- Best available technology to prevent accidental releases. For example, on sour gas rigs, crews should use "shear rams" to prevent blowouts — devices that, as a last resort, are designed to cut off gas flow by severing the casing pipe.

20 Appendix B Stipulations, Record of Decision, Northeast National Petroleum Reserve – Alaska, Final Integrated Activity Plan/Environmental Impact Statement, October 1998.

21 "Stockpiling" refers to the prolonged use of temporary waste storage facilities or devices that may not be designed to accommodate large volumes of wastes for extensive periods of time and may have inadequate water run-on/run-off control and groundwater protection and monitoring.

Environmental damage from camps can be minimized. Putting ice pads underneath the camp units in permafrost areas can prevent thawing of the vegetative mat. Companies can put each camp unit onto separate skids so that smaller equipment can be used to move the camp. This will reduce high-ground-pressure damage caused by large equipment.[22]

If camps need to be serviced by air, crews should build airstrips on frozen water bodies. For lighting the airstrips, crews can use portable beacons instead of flare pots, which can leak fuel. Fuel storage and refuelling should not take place on the water body.

Equipment

Crews can use low-ground-pressure vehicles in sensitive areas to prevent soil and vegetation impacts. Companies typically use Rolligons (balloon-tired vehicles) or Nodwells (tracked vehicles) for winter transportation of equipment and supplies in sensitive areas such as Alaska's North Slope region.

Companies generally use low-ground-pressure all-terrain vehicles to build the first lift or layer of temporary ice roads and pads on land. This lift is approximately five centimetres thick for roads and pads. The first lift is built to support the weight of the higher-ground-pressure vehicles that crews will use to build roads and well pads. These include water haul trucks, loaders, and graders.

Crews will continue to build up the thickness of the ice until it is ready to be used as a road. The final ice thickness will depend on the load that the road is required to bear (Indian and Northern Affairs Canada guidelines require oil and gas exploration roads and pads to be 15 to 20 centimetres thick).[23] If crews build ice roads across lakes or rivers, they must make them wider and thicker than roads on land to spread the weight of the load.

Crews should not compact or remove snow cover from fish-bearing water bodies except at approved ice-road crossings. If workers move vehicles across or remoe snow from ice-covered water bodies it can result in the freeze-down, or thickening, of the ice cover, effectively reducing the amount of unfrozen water space in deep-water pools where fish are over-wintering. To avoid this impact, whenever possible crews should cross waterways where the water is very shallow. Before spring break-up, the team must "V-notch"— cut a V-shaped opening in the middle of the water channel — all ice road crossings or remove them.

Workers should not take water from a water body that is entirely surrounded by land where the volume of water withdrawn would impact fisheries. Crews should not take water out of water bodies that are between 1.5 and 3.7 metres in maximum depth, as such lakes may provide over-wintering habitat for fish.

22 Janet C. Jorgenson and Philip Martin (U.S. Fish and Wildlife Service Fairbanks, Alaska), "Effects of Winter Seismic Exploration on Tundra Vegetation and Soils," NPR-A Symposium Proceedings (Anchorage, Alaska, 1997).

23 In the Northwest Territories, the Government of Northwest Territories Highway Maintenance Standard, Ice Road Construction, sets the standards for public roads, but the ice thickness requirements are also used as a guide for private roads.

For water bodies deeper than 3.7 metres, workers should not remove more than 5% of the total volume of free water (that is, the volume remaining when allowing for the thickness of the of ice).[24] When removing water crews must use fish screens with a mesh size of 1/10 inch to prevent the capture of fish. The limitations on the withdrawal of water from lakes for the construction of ice roads are designed to ensure protection of over-wintering fish.

Once the crew has determined that economic oil or gas reserves are present, they will build permanent well pads to extract the oil and gas. Companies should avoid building permanent roads whenever possible, especially in sensitive or very boggy areas. Instead, they can use temporary winter-only roads for drilling, and for well servicing, after the well has been put into production. In some areas of northeast British Columbia companies have successfully used helicopter and remote-control operation for summertime operation of well sites.

Fishermen on lake

SOURCE: CPAWS YUKON CHAPTER

Low Impact Drilling Techniques

To reduce risks of contaminating surface water bodies, workers should, where possible, locate drilling sites well above the highest water mark of rivers, streams, and lakes.

Exploratory-Only Well Drilling

In sensitive areas, to avoid the cost and environmental impact of building all-season roads or well pads for wells that may be dry, companies may drill wells for exploratory purposes only. They will build permanent roads or pads only if they find economic quantities of oil and gas. In northern regions companies drill exploratory-only wells from well pads made of ice instead of soils and gravel, and access these only by winter roads to avoid land disturbance. If companies take longer than one winter to finish exploration, they can cover the well pad with a network of insulating panels to preserve it over the summer. Companies will build permanent production facilities, gravel well pads, and roads only if there are suitable reserves to justify development of a production well site.

24 Department of Fisheries and Oceans Protocol for Water Withdrawal for Oil & Gas Activities in the Northwest Territories, August 1, 2002.

EXPLORATORY-ONLY DRILLING

Winter roads and ice pads are needed for exploratory-only drilling. Workers build ice roads on dry land by first compacting snow on the surface. They next use tanker trucks to put water on the surface, followed by chipped or crushed ice, and then more water. Producers in Alaska have found that by using ice chips they can increase their rate of road construction from 3.8 centimetres per day to 11.4 centimetres per day. When the ice is about 30–40 centimetres thick and has been allowed to weather, workers use a road grader to scar the surface. Then the road is ready for use. Crews use similar techniques to build ice well pads.[25]

Exploratory-only well road in British Columbia.

SOURCE: WAYNE SAWCHUK

When drilling an exploratory-only well, workers can use a drill bit that produces a small-diameter well bore (the hole that is created by drilling). This is called "slim-hole" drilling. When crews use slim-hole drilling, they reduce their drilling time, minimize the amount of drilling mud and water they use, and reduce the amount of drilling waste they produce. Any drilling mud and waste that they do produce can be stored in tanks and later transported off-site to a treatment facility. If there isn't a treatment facility available, workers may consider disposing of the drilling wastes in the well bore of an exploratory well when it is being abandoned.

Winter Access to Production Wells

All-season gravel roads usually accompany production well pads. However, developers can avoid building permanent roads and their associated impacts: they can complete drilling and servicing during the winter using winter-

25 U.S. Department of Energy Comments to the Bureau of Land Management, U.S. Department of the Interior on the Northeast National Petroleum Reserve – Alaska Draft Integrated Activity Plan/Environmental Impact Statement, March 12, 1998.

only roads; workers can operate the well site remotely; and companies can transport people and goods to the well by air or low-impact overland methods.

Directional Drilling

Drilling crews are able to drill wells on long sloping angles by using hydraulic mud-driven motors located inside the drill bit to turn the bit as it drills through rock. Using this technology, drillers can drill into rock formations that may contain oil or gas that are several hundred metres or more away.

Using this technology companies can access large areas of reserves using multiple wells from a single surface location. This drastically reduces surface area impacts and linear disturbances. Directional drilling can also be used to access reserves that are located beneath sensitive areas and water bodies without disturbing the surface.

When companies drill multiple wells from a single pad location they significantly reduce the amount of energy they use because they reduce the number of well pads and roads that they need to build. Multiple well pads also allow companies to more efficiently recover solution gas and vent gases from production wells as they can combine the small volumes generated by each well together on site.

Directional drilling is used in Alaska's North Slope region to minimize surface impacts. BP drills as many as 28 oil wells from a single surface location in its Badami Development Project. Oil wells onshore are typically less than 11 metres apart and offshore are about three metres apart. In future projects the wells will likely be even closer together.[26] In their Alpine Project, ARCO Alaska Inc. used two production well pads to support 100 to 150 wellheads.[27]

Closed Loop Drilling Fluid System

A closed loop drilling fluid system[28] uses a series of storage tanks, instead of a conventional sump, which is normally an unlined pit used to store drilling wastes. Although using a tank system is more expensive than using an open pit, it eliminates the need to build and reclaim a pit, prevents drilling waste contaminants from contacting soil and groundwater, and results in more efficient use and re-use of drilling fluids.

Optimally, the closed loop drilling fluid system separates drilling waste into three parts: clear liquids, recycled drilling mud, and rock cuttings.

Companies operating in Alaska's North Slope region have used closed loop drilling fluid systems in their basic project designs. BP has committed to zero discharge of drilling wastes. As well, to reduce drilling pad size and impacts to tundra wetlands and to eliminate the potential for contaminant release from its Badami Development Project, it has committed to not use sumps.[29]

26 BP Exploration (Alaska) Inc., Environmental Performance on Alaska's North Slope, February 1998.
27 U.S. Department of Energy Comments to the Bureau of Land Management, U.S. Department of the Interior on the Northeast National Petroleum Reserve – Alaska Draft Integrated Activity Plan/Environmental Impact Statement, March 12, 1998.
28 U.S. EPA Sector Notebook Project, Oil and Gas Extraction, October 1999
29 BP Exploration (Alaska) Inc., Environmental Performance on Alaska's North Slope, February 1998

The US Bureau of Land Management effectively made the use of closed loop drilling fluid systems a minimum standard for new oil and gas exploration in Alaska's North Slope region when it incorporated this requirement into its Environmental Assessment for the 1999–2000 Winter Exploration Drilling Program.[30]

Low-Impact Drilling Waste Disposal Methods

Companies operating in the North Slope region of Alaska must dispose of drilling waste (liquids, used drilling muds, rock cuttings) in approved deep disposal wells. Central "grind and inject" facilities mix drilling waste liquids with finely ground drilling waste solids and inject this mixture into deep wells.[31]

Injecting drilling wastes into deep underground reservoirs is also a proven method of waste disposal for offshore drilling operations. Workers can inject waste underground at the rig platform itself or they can transport the waste to shore for injection there.

Electric-Powered Drilling Rig

Drilling rigs are usually powered by large diesel engines, but can be powered by electricity. BP designed its Liberty and Northstar production drilling projects in Alaska's North Slope to use electrical power generated by on-site gas turbine engines, which are a cleaner source of power than diesel internal combustion engines.

Selection, Handling and Storage of Materials

Proper Fuel Management

In upland areas crews must keep fuels and other materials a safe distance away from water bodies and above high water zones:

- Drilling sites, fuel and other materials should be stored on stable ground more than 100 metres above the normal high-water mark of any water body. Workers should not refuel equipment within the active floodplain of any water body. Of course, in areas such as the Mackenzie River Delta, where most activity occurs below the high water mark, these types of measures do not apply.
- Companies can use double-walled tanks to store fuels in order to provide secondary containment in the case of a leak.
- At fixed camps, workers should construct "berms" of mounded soil or clay or low walls of concrete or other materials that surround fuel-supply sites to contain fuel to the area around the base of the tank in the case of a serious leak or spill.

Crews should use oil drip pans on major equipment such as generators, trucks and other vehicles to avoid impacts associated with ongoing small leaks and spills. Workers can also limit soil impacts by refuelling and servicing equipment in dedicated areas that are equipped with spill capture and containment devices.

30 North East National Petroleum Reserve-Alaska Integrated Activity Plan/Environmental Impact Statement - EA for 1999-2000 Winter Exploration Drilling Program Record of Decision, U.S. Department of the Interior Bureau of Land Management, December 1998.
31 Environmental Performance on Alaska's North Slope, BP Exploration (Alaska) Inc., External Affairs Department, February 1998.

Companies should develop fuel spill contingency plans for fuel storage and refuelling sites. To minimize environmental impacts and hazards to workers, all crews should be aware of what to do in the event of a spill.

Composting (Bio-treatment) of Drilling Waste

In some cases, companies can use composting to treat invert muds (toxic, oil-based drilling muds) and other hydrocarbon-contaminated drilling mud waste. This method is likely only to be viable in the southern parts of the Northwest and Yukon Territories. Even then the summers may be too short to break down the waste, except for those that are easily biodegradable. Decomposition takes 12 to 18 months under southern Alberta climatic conditions.[32]

When composting, crews combine hydrocarbon-contaminated solids with wood chips and sawdust. This binds the hydrocarbons and liquids to the wood particles, and makes them more stable. Workers then pile this mixture into an area surrounded by "berms" of mounded soil or clay. The crew then turns the pile occasionally to introduce oxygen into it and keep a healthy environment for micro-organisms to grow. These micro-organisms digest and break down the mixture into an environmentally safe substance. Workers may add sawdust and/or wood chips, water, and nitrogen-phosphorus fertilizer during the mixing process as needed to keep a suitable environment for the micro-organisms to live and decompose the hydrocarbon waste.

When workers compost waste instead of using other bio-treatment methods, such as land-spreading of drilling waste, they reduce the risk that wastes will enter surface or subsurface soil and water by containing the treatment area until the process is complete. Like other forms of bio-treatment, however, composting only addresses the hydrocarbon fraction of drilling wastes. Any salt or heavy metal compounds in the drilling waste will remain in the compost. For this reason, the security of the ultimate disposal location of the compost material will depend on the overall chemical composition of the waste.

More studies are needed to determine if composting of hydrocarbon contaminated drilling wastes will work in the cold arctic regions of Canada.

Reuse and Recycling of Drilling Fluids and Drill Cuttings

Drilling fluid can be reused in drilling multiple wells before being disposed. By filtering and reusing fluids, companies can significantly reduce the quantities of drilling mud liquids and solids to be handled and disposed.

Fluids can be filtered with conventional "shale shakers" that remove large fragments. Crews can use de-sanders and de-silters to remove smaller particles, and centrifuges to remove

32 Review of Newpark's Wood Waste Composting Process for Degradation of Hydrocarbon Contaminated Wastes, Ron Lincz, Brad Chapman, Sean Parenteau, Newpark Environmental Services, April 1999.

very small suspended particles. Mud cleaners can be used to break up oil and water emulsions and remove dissolved components. These methods can reduce the moisture content of the solid waste stream and improve the reusability of the drilling mud.[33]

Companies operating in Alaska's North Slope region are required to dispose of all drilling waste and hydrocarbon-contaminated waste at a central "grind and inject" facility. It is possible to wash most of the cuttings generated to acceptable contaminant levels so that they can be used as construction gravel for roads and pads. The remaining cuttings are ground into a fine slurry and injected into deep wells along with waste drilling muds.[34]

The Mackenzie Delta

SOURCE: ENVIRONMENT CANADA

"Zero Drip" While Drilling and Servicing

"Zero drip" is a pollution prevention practice that companies use to minimize the discharge of drilling mud and hydrocarbon liquids during well drilling and servicing. Companies must plan carefully and make use of simple secondary containment devices. These devices are called "secondary" because they contain leaks coming from places that are not supposed to leak.

Here are some examples of secondary containment devices:[35]

- Kelly Kan — a patented product that fits around the drill pipe above the drill floor to capture fluids that may be sprayed from connections during well drilling or servicing, and to then redirect them to a mud can or a Katch Kan.
- Katch Kan —a patented product installed below the drill floor to catch all drill floor fluids.

33 U.S. EPA Sector Notebook Project, Oil and Gas Extraction, October 1999
34 Environmental Performance on Alaska's North Slope, BP Exploration (Alaska) Inc., External Affairs Department, February 1998.
35 Drilling Rig Zero Spill System, Katch Kan Enterprises Ltd., www.katchkan.com (June 2003).

- Drip Trays — specially designed drip trays to catch drips from leaky connections and to collect fluids from temporary pipeline connections.

Liquid Storage

Companies must store fuel, chemicals and hydrocarbon liquids in tanks. They must keep these tanks in an area that has a liner and is surrounded by a berm of mounded soil or clay or a low wall of concrete or other material that is large enough to hold 110% of the stored volume. The liner material should be compatible with the stored product and stay leak-proof during typical weather extremes expected throughout the storage period. Companies can use double-walled tanks to store fuels and other hazardous materials to provide secondary containment in the case of a leak.

Alternative Drilling Fluids and Additives

Instead of diesel oil, companies can choose less toxic alternatives for invert drilling muds. They can also use canola oil or mineral oil instead of saltwater as part of the drilling mud combination.

Drilling fluid additives can be toxic. There are alternatives to some of the most toxic drilling fluid additives:[36]

- Replace chrome lignosulphonate dispersants with chrome-free lignosulphonates and polysaccharide polymers. Dispersants break up solid clusters into small particles so that the drilling fluid can carry them.
- Use amines to kill bacteria that produce hydrogen sulphide gas instead of penta-chlorophenols, paraformaldehyde and biocides.
- Use lead-free pipe dope to prevent the accumulation of lead in drilling wastes. Pipe dope is a compound used in drill string connections. Some types of pipe dope contain very large concentrations of lead that can contaminate drilling mud waste.

When companies use less toxic drilling fluid additives they reduce the risks associated with accidental spills and leaks of drilling fluid. They also reduce the impacts associated with the disposal of drilling waste, particularly if they use surface and sub-soil disposal methods.

Thermal Desorption and Destruction

Various "mobile thermal desorption" technologies are available to treat hydro-carbon-contaminated waste. Basically, waste is fed by conveyer belt into a rotary drum "desorber" — a device that uses heat to remove particles from a surface by turning them into vapour. In the case of hydrocarbon-contaminated waste, the hydrocarbon compounds that are attached to the clay particles of the drilling mud and the rock drill cuttings are turned into vapour. The vapour is then directed into an "oxidizer" — a device that breaks down the vapour compounds by exposing them to very high heat and air. Nelson Environmental Remediation Ltd. has developed a mobile unit that effectively treats hydrocarbon-contaminated drilling waste.[37]

36 US EPA Sector Notebook Project, Oil and Gas Extraction, October 1999
37 Nelson Environmental Remediation Ltd., www.ner.ab.ca (June 2003).

Katch Kan Device on a drilling rig.

SOURCE: KATCH KAN LIMITED

Alternatives to Flaring

In the drilling phase of oil and gas development, production testing of gas wells by flaring creates the most air emissions. If a pipeline that is gathering gas from a producing well is nearby, the well could be connected to the gas gathering system for an in-line test, rather than a flaring test. Usually workers connect the well to the existing gathering pipeline with a temporary surface pipeline. When the test is being carried out the flowing gas travels down the pipeline to a gas plant rather than being burned by a flare. In-line testing as opposed to flare testing substantially reduces local air pollutants and greenhouse gas emissions by directing production test gas to a gas plant where it is processed and shipped to market.

In areas of Alberta where flare test emissions could harm the health of humans and livestock, more and more companies are using large-volume mobile incineration units that can handle the volumes of gas associated with well test flaring. Incinerators work by burning gas in a high temperature chamber through which large volumes of air are continuously circulated. The combination of high temperatures and exposure to circulated air results in almost complete breakdown of the gas. While flares come close to fully breaking down hazardous pollutants, they do not do so completely. Incinerators, then, are preferable to flares because they fully destroy many of the hazardous air pollutants in gases.

The emissions associated with the testing phase for gas wells can be reduced by limiting the duration of the test to a maximum of three to four days.

Monitoring and Enforcement

Enforceable Standards versus Self-monitoring

It is important that regulatory agencies use environmental regulations and standards to manage oil and gas that match their capacity to monitor industry compliance and enforce the rules if necessary. A number of on-site oil-field waste treatment and disposal practices permitted in Alberta are a de facto system of industry self-monitoring and voluntary compliance because companies are required to carry out little or no reporting and regulators are unable to effectively inspect the large number of sites with its limited enforcement resources. The experience of Environment Canada's Pacific and Yukon Region indicates that significant non-compliance results when regulators rely on industry voluntary compliance.[38]

Waste Tracking and Monitoring

Regulatory agencies should use oilfield waste "manifests" — waste management systems to track waste from the time it leaves the generator facility where it is produced, to the time it reaches its final destination where it will be stored, treated or disposed. These systems allow the waste generator to verify that its waste has been properly delivered, and that no waste has been lost or unaccounted for in the process. Manifests also provide detailed information that first responders can use in the event of an accident. Waste manifest systems normally require that companies, transporters and receivers fill out forms that document the type and quantity of waste being transported, instructions for handling the waste, and the names of the companies involved.

Since 1996, Alberta has required that all dangerous oilfield waste transported on public roads in Alberta be manifested.[39] Companies operating in Alaska's North Slope region are required to implement a hazardous materials tracking system to ensure [40]

38 Enforcement vs. Voluntary Compliance: An Examination of the Strategic Enforcement Initiatives Implemented by the Pacific and Yukon Regional Office of Environment Canada 1983 to 1998, Peter K. Krahn, Inspections Division, Environment Canada, Pacific and Yukon Region, March 9, 1998.

39 Guide 58, Oilfield Waste Management Requirements of the Upstream Petroleum Industry, Alberta Energy and Utilities Board, November 1996.

40 Appendix B Stipulations, Record of Decision, Northeast National Petroleum Reserve – Alaska, Final Integrated Activity Plan/Environmental Impact Statement, October 1998.

Area of Concern	
PLANNING	
Construction of new access roads	• Use existing access as much as possible.
Construction of all-season access roads	• Use winter access, snow or ice roads for exploratory-only wells. • Give consideration to the use of winter-only access for production wells. • Maximize the use of heli-operation to minimize surface disturbances.
Use of exploration drilling	• Use exploration drilling only above high-water mark.
Clearing land for airstrips	• Put in place a water withdrawal plan that minimizes potential impact on over-wintering fish and habitat. Consider cumulative withdrawals.
Withdrawal of water for construction of ice roads on land	• Put in place a water withdrawal plan that minimizes potential impact on over-wintering fish and habitat. Consider cumulative withdrawals. caribou and other animals.
Drilling activity scheduled during wildlife migration or mating periods	• Schedule activities to minimize impact on wildlife migration and mating cycles. • Plan to shut down or scale back activity during crucial times for caribou and other animals.
Emergencies	• Have an Emergency Response Plan (ERP) for both safety and environmental emergency response, including spill response.
Waste generation exceeds treatment and disposal facility capacity	• Prepare regional waste management plans and ensure adequate capacity to address all phases of exploration and development.

Area of Concern	
LOW GROUND COMPACTION TECHNIQUES	
Use of wheeled vehicles	• Use low pressure vehicles such as Nodwells (tracked), Rolligons (balloon tires), etc.
Use of large equipment to skid together trains of camp buildings	• Skid individual camp units using small Cats (D5 or smaller) instead of one large Cat to skid in all camp units at once.
Creation of windrows	• Avoid creating windrows to minimize impact on wildlife movement and fire hazards.
LOW IMPACT DRILLING TECHNIQUES	
Use of multiple drill sites	• Use directional drilling technology to drill multiple wells with only one surface location.
Spills and leaks	• Use "zero drip" technology. • Maintain tanks in lined storage areas surrounded by containment berms. • Use double-walled tanks to store fuels and other hazardous materials to provide secondary containment in the case of a leak.
SELECTION, HANDLING AND STORAGE OF MATERIALS	
Spills and leaks	• Use "zero drip" technology. • Maintain tanks in lined storage areas surrounded by containment berms. • Use double-walled tanks to store fuels and other hazardous materials to provide secondary containment in the case of a leak.
Use of sumps to store drilling wastes	Use closed-loop drilling technology.

Area of Concern	
SELECTION, HANDLING AND STORAGE OF MATERIALS	
Use of potentially toxic drilling additives	• Use only non-toxic or less toxic drilling-mud additives.
Use of invert muds (diesel)	• Use small drilling units mounted on low-ground-pressure ATVs or tracked vehicles. • Use heli-portable drilling units. • Use vibroseis equipment where clearing is not needed and in other open areas. Avoid use of vibroseis equipment in treed areas because of the large rights-of-way needed.
Use of on-site burial as the primary disposal method of drilling waste	• Use deep-well disposal using "grind and inject" technology for solid wastes. • Employ composting or thermal desorption in select cases.
MONITORING AND ENFORCEMENT	
Waste tracking	• Conduct full waste manifesting.
Non-existent or self-monitoring/ enforcement of environmental performance	• Ensure effective monitoring and enforcement by government or a third party.
Production testing to flare	• Seek alternatives to flare testing. If a suitable flow line exists nearby, connect the well to the flow line for the test. Use high-efficiency portable incinerators instead of conventional flares.
Wildlife disturbance	• Employ the services of a local expert as a wildlife and environment monitor.

Citizens' Rights

If you are concerned about an exploration or production drilling project and think that you may want to take part in the regulatory approval process, this section gives you information and advice on how to go about it.

It explains how you can get information and summarizes the key issues associated with an exploration or production drilling project. It also gives advice on how to have a say in the government's decision-making process when approving such a project.

To conduct oil and gas exploration, companies have to get a permit or licence from the government that will allow them to do the work. The way companies get these rights and permits and licences varies between the NWT and the Yukon, and from region to region within each territory. The rules about public consultation and public intervention opportunities can also vary. You can find more details about the laws and procedures for each region of the Yukon and NWT in Citizens' Rights and Oil and Gas Development: Northwest Territories and Citizens' Rights and Oil and Gas Development Yukon Territory respectively.

Here are some steps to follow if you wish to review and comment on a proposed exploration or production drilling project:

Find out about Proposed Projects

The first thing you need to do is make sure you know what proposals there are for companies to carry out exploration or production drilling projects.

Companies send copies of drilling proposals and licence applications to government agencies, Aboriginal Nations or Groups, and interested parties. Companies may also arrange for copies to be available for public viewing at libraries and government offices.

You can register yourself as an "interested party" by contacting the primary government agency responsible for oil and gas development in your region. You will receive notice of new exploration or production drilling proposals and information about timelines for public comment on the regulatory approvals process. Another way to get information about a proposed exploration or production drilling project is to contact the company directly and ask for a copy of detailed proposals or licence applications, as well as information about future development plans.

A company planning to conduct exploration or production drilling (the proponent) must give public notice of their plans before they receive regulatory approval. Notice requirements vary from region to region. Sometimes companies will post notices in local newspapers or other media to announce proposed projects; other times you may have to be more active to ensure you are aware of new proposals.

Learn about Public Consultation Rules

Next, you need to find out the rules for public consultation in your area.

Contact the primary government agency responsible for oil and gas development in your region and get answers to the following questions:

- ❑ What does the company have to do to give notice of their proposed project? Who do they have to consult? What form does the consultation have to take (meetings, open houses, etc.)?
- ❑ What does the company have to do with the public comments they receive?
- ❑ What is the deadline for public comments?
- ❑ To what government agency approving bodies does the company have to send public comments?
- ❑ What do government agencies do with the public comments and concerns they receive?
- ❑ What happens if the public objects to or wants conditions attached to the approval, licence or permit?
- ❑ What is the process for deciding whether and how the project will proceed?
- ❑ Is it possible to call for a public hearing, if needed?
- ❑ How can the public find out whether the government has granted a drilling approval, licence or permit?
- ❑ How can the public get a copy of a drilling approvals, licences or permits?
- ❑ Can the public appeal an approval, licence or permit? If so, how?

Review the Exploration or Production Drilling Application

Once you've received a copy of a company's proposal for exploration, and have learned about the rules for public consultation, you'll next want to review the project application.

When you review the application you may find that you are satisfied with the information presented or you may have questions or concerns about the project.

If you have questions or concerns, make of list of these and call a meeting with the company and/or proper government agency to discuss them (see box on page 43: *How to Negotiate with Companies*).

If you can't resolve your concerns about the project directly with the company or government agency you may wish to call for a public hearing (see section on page 42: *Participate in Decision Making*) if such a legal avenue is available.

Key questions to ask when reviewing an exploration or production drilling application (note that this is a general list and only a subset will be applicable to specific licence and permit applications):

- ❑ In what season will the company be drilling?
- ❑ Is the developer proposing exploration-only wells, or conventional wells that would be converted to production wells if drilling is successful?
- ❑ How many exploratory or production wells is the developer proposing?
- ❑ What methods will crews use to build roads and camps, and where will these be located?
- ❑ How big is the well pad? How many wells will be drilled from the well pad?
- ❑ What type of vehicles will crews use?
- ❑ Will crews have to cross water bodies? Where and how will they do this?
- ❑ How will crews protect the soil and vegetative mat?
- ❑ What erosion mitigation measures will crews use?
- ❑ What permafrost protection measures will crews use?
- ❑ What reclamation practices will crews use? Will they follow-up to make sure the reclamation is successful?
- ❑ What sources of fresh water will they use? How much water will they need?
- ❑ What type of drilling mud will the developer use? What does it contain?
- ❑ How will crews manage and dispose of drilling waste?
- ❑ How will crews manage and dispose of solid and human waste?
- ❑ What is the company's spill prevention and response plan?
- ❑ How will the crew manage and dispose of surface water and produced water?
- ❑ Is there any chance the workers will encounter hydrogen sulphide?
- ❑ Does the developer have an Emergency Response Plan?
- ❑ What setbacks will the developer use? Why are the setbacks needed? How big is the evacuation zone?
- ❑ Will crews use flaring to test wells? What alternative testing methods can they use?
- ❑ Did the company collect baseline environmental data?
- ❑ Has the developer assessed the area for sensitive ecosystems?
- ❑ Did the company conduct baseline groundwater quality testing?
- ❑ Will the project have a wildlife and environment monitor?
- ❑ Has the company clearly outlined measures to avoid disturbing wildlife? Does the company have policies to ensure workers know how to minimize impacts on wildlife?

❑ Has the developer assessed socio-economic benefits (e.g., employment of local residents) and impacts associated with the proposed project?

❑ Has the company outlined a future development scenario if exploration drilling is successful, including needs for a gathering system pipeline and production facilities?

❑ Has the developer considered ways they will reduce their impact on other land uses, such as hunting and trapping?

❑ How will the company manage any newly created recreational access to the area?

❑ What are the developer's plans for reclaiming roads and well sites?

Participate in Decision Making

If you meet with the company and government agencies directly and find you can't resolve your concerns about the project, you may wish to call for a public hearing.

Public hearings are meetings held to get comments from the general public, businesses, special interest groups, and local officials about proposed regulations, permits, or other changes that could affect the public.

You'll need to find out the rules for holding public hearings in your region, whether such a legal avenue is available for commenting on drilling projects and what the terms are. You can find more details about public participation in regulatory decision making in Citizens' Rights and Oil and Gas Development: Northwest Territories and Citizens' Rights and Oil and Gas Development: Yukon Territory. These guides include government agency contacts that you can call to get more information about how governments conduct hearings and the specific rules for members of the public to call for and participate in hearings.

You'll want to find out

❑ When are the deadlines for letters calling for hearings and for written and oral submissions?

❑ Who has intervener status—that is, the legal right to call for a hearing?

❑ Is there funding available for interveners to hire experts, including lawyers?

❑ What are the hearing procedures?

❑ Are there any appeal mechanisms?

HOW TO NEGOTIATE WITH COMPANIES

Most companies have experience dealing directly with members of the public who have questions and concerns about oil and gas projects. They usually welcome opportunities to meet with interested parties, to provide information and to try to resolve issues outside of formal regulatory decision-making forums.

When involved in discussions with a company, make sure you

- ❑ *Get everything in writing. If you have an oral agreement or telephone conversation with a company representative, ask him or her to confirm it in writing and to send copies to the proper government agencies.*
- ❑ *Ask the company to explain anything you do not understand. If some of the written information the company has provided is ambiguous, ask for clarification in writing.*
- ❑ *Tell the company any concerns you have about the project. Suggest ways they could change the project to address your concerns. Be persistent if the company does not adequately resolve your concerns right away.*
- ❑ *Don't make a deal with the company wherein they only agree to deal with your issues of concern if you agree to not take part in a hearing. Sometimes it is not possible for you and the company to resolve all of the issues. But, if a public hearing is held, it will be shorter and more focused if you have resolved as many of the issues as possible. A shorter, more focused hearing is to the benefit of all parties involved.*
- ❑ *Recognize that some "give and take" may be necessary. For successful negotiation, both parties must be able to reach their final objectives and be willing to agree with the other.*
- ❑ *Negotiations can take a long time. Often members need a lot of time to both review and write documents. Therefore, it is important to research opportunities for intervener funding. It may be reasonable to ask the company for funding to make sure that members of the public can be more effectively engaged in the consultation.*

WORKING WITH THE MEDIA

Using the media to raise public awareness about an issue is not always appropriate. Under some circumstances, however, it can be an important tool:

- ❑ *It can make other members of the public aware of the proposed project and your concerns. This can help build support for your activities and increase your chances of success in negotiating with the company.*
- ❑ *It can encourage a company to negotiate. Many companies worry about their public image and would like to avoid negative publicity. Real or potential media attention on an issue may be an incentive for a company to try to resolve issues.*
- ❑ *It may ensure the government agencies are aware of and involved in your issue.*

Media include:

- ❑ *local, regional and national newspapers*
- ❑ *local and regional radio stations*
- ❑ *community and regional television stations*

If you have a message to get out, sending out a news release can be helpful. It does not have to be long, but you need to consider the following:

- ❑ *Decide on your main message and state this clearly in the first sentence.*
- ❑ *Include a brief outline of your key concerns and the outcome you want.*
- ❑ *Include one or more contact names and numbers.*
- ❑ *Put a short title at the top of the release — something eye-catching. Put the date at the top as well.*
- ❑ *Keep the release short — less than a page. You may want to include quotes and position statements.*
- ❑ *Consider including a separate "backgrounder piece." A backgrounder gives only factual information on the subject, rather than opinions.*
- ❑ *Make sure you are aware of the deadline for making submissions to the media.*
- ❑ *When your news release is ready, you should fax or deliver it to your local and regional newspapers, radio and television stations. Follow up with phone calls to select media contacts.*
- ❑ *Send a copy of your news release to both the company and the proper government agency. This will allow them to be better prepared to respond to the media if they know in advance what you are saying.*

For More Information

For information on government agencies, industry associations, and further reading on this issue, please consult the companion publication entitled: **Resources and Contacts**.

Pembina Institute
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