# Energy Development in British Columbia

## A Discussion Paper for the British Columbia First Nations Energy Summit

**Alison Jamison • Ellen Francis • Karen Campbell • Matt Horne • Josha McNab • Katie Laufenberg • Ian Picketts**

**March 2007**

the PEMBINA institute

Sustainable Energy Solutions

*Energy Development in British Columbia: A Discussion Paper for the First Nations Energy Summit*
1st Edition, published March 2007
Printed in Canada

Editor: Jane Kalbfleisch
Layout: Anya Knechtel



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## About the Pembina Institute

The Pembina Institute creates sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy and environmental governance. More information about the Pembina Institute is available at http://www.pembina.org or by contacting info@pembina.org.

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## Acknowledgements

This discussion paper was written by the Pembina Institute for First Nations attending the BC First Nations Energy Summit, in partnership with the Canadian Boreal Initiative and the Carrier Sekani Tribal Council. The opinions expressed in this report are those of the Pembina Institute and do not necessarily represent the views of the supporters. Any errors and omissions are those of the authors.

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# Energy Development in British Columbia

## A Discussion Paper for the British Columbia First Nations Energy Summit

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# Executive Summary

First Nations across British Columbia deal with a staggering number of resource challenges, including mining, forestry, agriculture and other industrial development. Many First Nations communities are now feeling the impacts of climate change, particularly through the mountain pine beetle epidemic. Adding energy development proposals against this backdrop will intensify the environmental challenges that communities already face. At the same time, however, energy development proposals present communities with economic opportunity and increased employment prospects.

This discussion paper offers information to First Nations in British Columbia about the way energy development can affect traditional territories. It addresses the environmental issues associated with different energy developments, including fossil fuels such as oil, gas or coalbed methane, and renewable sources such as wind or run-of-river hydro power.

Because the impacts of oil and gas development can be extensive, much of this paper is focused on oil and gas development and its effects on land, air and water. There are ways to limit the impacts of oil and gas development. Some of these are outlined in Appendix A, Mitigating Impacts of Oil and Gas, which recommends responsible practices for oil and gas exploration that do not unnecessarily harm the environment

Renewable energy, such as wind, run-of-river hydro, and biomass, are supplied by sources that will not dry up or run out. Opportunities to harness renewable resources and improve energy efficiency are abundant in British Columbia. They make it possible to meet energy needs with lower environmental impacts. Renewable energy projects offer a way for us to rely less on conventional energy sources and to advance a positive vision of the future.

This discussion paper is intended to provide leaders and community members with the background and technical information they need to make decisions about future energy development — decisions that encourage healthy ecosystems for generations to come. British Columbia can support energy projects that provide economic benefit to its communities while also respecting the land.

# Introduction

British Columbia (B.C.) has no shortage of energy opportunities — among them, wind, solar, geothermal, tidal, oil, gas and coal. While most of the power generated for electricity in the province comes from renewable sources such as hydropower, the B.C. government is increasingly looking to oil and gas development as a means to generate revenue. The oil and gas industry operates extensively in northeastern B.C., and the recent 2007 B.C. Energy Plan has made it clear that the provincial government intends to expand the oil and gas industry to new basins, particularly the Nechako Basin in the interior.

Although B.C. is a net importer of petroleum products such as gasoline, it is a net exporter of natural gas. Over 65% of natural gas produced in B.C. in 2004 was exported, primarily to the United States. As population grows and development increases, B.C. is under pressure to develop new energy sources and greater energy efficiency.

While fossil fuels such as oil and gas have been reliable energy sources for more than a century, concerns are emerging about our continued dependence on them to meet present and future energy needs. The environmental impacts of oil and gas development on land, water and air are extensive. In addition, the burning of fossil fuels is the primary cause of global warming, the impacts of which are increasingly felt throughout the world as well as here at home in B.C. through the mountain pine beetle epidemic. However, oil and gas will continue to be developed in the near future, and as such, we have included a section on how to minimize the impacts of its development.

Many opportunities exist in the province to use less energy (i.e., increase energy efficiency) and to develop low-impact renewable energy sources. There are alternatives that can produce the energy B.C. needs, provide communities with long-term employment and economical opportunity, and at the same time, reduce environmental impacts.

This discussion paper is intended for those who want to better understand where our energy comes from and what impacts are associated with its development. It consists of four sections and one appendix:

- Section 1 provides a summary of energy in B.C. today. It describes the major energy sources in the province, provides an overview of some proposed fossil fuel developments, and introduces some of the central themes in the provincial government's 2007 Energy Plan.
- Section 2 offers an overview of oil and gas, explaining the process of conventional oil and gas development. It also explores a number of unconventional oil and gas methods: namely, coalbed methane, tight gas and shale gas, and tar sands.
- Section 3 offers an overview of the environmental impacts of the various stages of oil and gas development for land, air and water, including fish and wildlife populations. It also addresses the challenge of cumulative impacts, the potential impacts from pipelines, and the marine impacts of oil and gas development off B.C.'s coast.
- Section 4 provides an overview of the opportunities, benefits, challenges and potential impacts of some of the most promising renewable energy and energy efficiency options in B.C.
- Appendix A: Mitigating Impacts of Oil and Gas, outlines least damaging practices for oil and gas development to ensure that where it is developed, it is done so responsibly.

This paper does not address the issues associated with oil and gas use by consumers (e.g., electricity generation and transportation uses). It also does not consider the impacts associated with major energy sources other than oil and gas. For example, the impacts associated with coal mining and large-scale hydropower, though significant in B.C., are beyond the scope of this paper.

We hope that the information presented in these pages will assist leaders and community members with the decisions they make about future energy development. The decisions we make today will shape the land and future generations throughout the province and globally.

# 1. Energy in British Columbia: The Big Picture

This section offers a snapshot of the current state of energy in British Columbia today. It highlights the primary energy sources in the province, provides an overview of some proposed major fossil fuel developments, and introduces some of the central themes and key policies in the provincial government's 2007 Energy Plan.

## 1.1 Primary Energy Sources in British Columbia

### 1.1.1 Oil and Gas

British Columbia has some large oil and gas basins, with significant exploration and development in the northeastern part of the province. Coalbed methane development, a newer form of natural gas development, is triggering exploration and development in previously undisturbed areas such as the East Kootenays, the Smithers/Telkwa region, the Klappan region near Iskut, and Vancouver Island. Oil and gas pipeline infrastructure linking Alberta's hydrocarbon resources to sea ports is currently being proposed. If approved, this infrastructure could spur on the development of oil and gas in across northern B.C.

### 1.1.2 Coal

Coal is the second most important export commodity in British Columbia, and there are many coal mines throughout the province.[1] B.C. mines over 25 million tonnes of coal each year, most of which is exported. Proposals for coal-fired power generation are new to B.C. and represent a new threat to its land, air, and communities. In February 2007, the B.C. government announced that any proposals for coal-fired power would be required to capture carbon before it is released into the air, in an effort to minimize dangerous greenhouse gas emissions. As a result, two recently proposed coal-fired power plants likely will not proceed unless the companies can safely capture and store the carbon emissions.

### 1.1.3 Large-scale Hydropower

Large-scale hydroelectric power currently accounts for approximately 90% of B.C.'s electricity supply, primarily from a series of dams on the Peace and Columbia river systems.[2] While often touted as clean energy because of its low emissions throughout the operational period, environmental impacts from large-scale hydro include the initial flooding of huge areas of productive and pristine land, irreversibly turning riverbeds into lakes, and the resulting impacts on wildlife and fish.

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[1] Ministry of Energy, Mines and Petroleum Resources, Government of British Columbia, http://www.em.gov.bc.ca/Mining/Geolsurv/coal/coalinbc/coal_bc96.htm

[2] B.C. Hydro, corporate website, http://www.bchydro.com/info/system/system15240.html (accessed February 27, 2007).

### 1.1.4 Smaller Scale Renewable Energy

B.C. also has many renewable energy opportunities, including wind, run-of-river hydro, biomass, tidal power and geothermal. Although there has been limited development of low-impact renewable energy sources in B.C. to date, there are many economic and environmental reasons to support greater development in these areas. Renewable energy and energy efficiency are discussed in some detail in the final section of this paper.

## 1.2 Major Fossil Fuel Potential in British Columbia

In the past few years, many new energy and pipeline projects have been proposed for B.C., particularly in the north. While each project may not seem significant in its own right, together these developments could significantly transform the landscape. Some of these potential developments include:

- *Expansion of oil and gas activity in B.C.'s northeast.* The number of wells being drilled in B.C. has doubled from 643 in 2002 to 1,279 in 2004. Over 1,400 wells were drilled in 2006.[3] Yet although more wells are now being drilled in the northeast, actual gas production is beginning to decline. Also, new wells are more likely to be drilled closer to homes and communities than in the past.
- *Continued large sales of oil and gas tenures in northeastern B.C.* The sales of the oil and gas tenures that companies must purchase before they can begin exploration in an area were at their second highest in history in 2006. 2006 would have had the highest sales except that one company, EnCana, spent $400 million in acquiring the rights to the Cutbank area of the South Peace in 2005.[4]
- *Coalbed methane development is being actively promoted throughout B.C.* Exploratory coalbed methane drilling programs have started up throughout B.C., particularly near Hudson's Hope in the northeast, Fernie in the southeast, Princeton, Vancouver Island and Klappan Mountain, near Iskut. More than 50 wells have been drilled throughout the province. The B.C. government tried to sell the tenure for coalbed methane development near Telkwa, but the sale has been met with opposition by First Nations and others.
- *Pipelines linking Alberta to the coast.* A number of pipelines have been proposed that would cross the province from east to west, linking the ports on the coast to oil and gas fields in Alberta and northeastern British Columbia:
    - The Pembina Pipeline Corporation proposal (no connection to the Pembina Institute) to build a 665-kilometre, 100,000 barrel per day condensate pipeline from Kitimat to Summit Lake, near Prince George, B.C.
    - Kinder Morgan's TransMountain pipeline project (often referred to as TMX), which would twin an existing pipeline between northern Alberta, through south central British Columbia to the Washington border, and include an extension from Valemount to Kitimat via Prince George.
    - The Kitimat LNG and Pacific Northern Gas proposal to build The Pacific Trails Pipeline, a 500-kilometre, 30–36 inch natural gas pipeline between Summit Lake and Kitimat.

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[3] "Good Year Coming but Challenges Remain," *Northeast News,* January 3, 2007.

[4] Ibid.

- The Enbridge Gateway proposal (postponed in late 2006) to build parallel 1,150 kilometre oil and condensate pipelines from Edmonton to Kitimat.

If these projects go ahead, they will open up access to B.C.'s interior basins, making it easier for oil and gas companies to begin to explore in the Nechako and Bowser Basins.

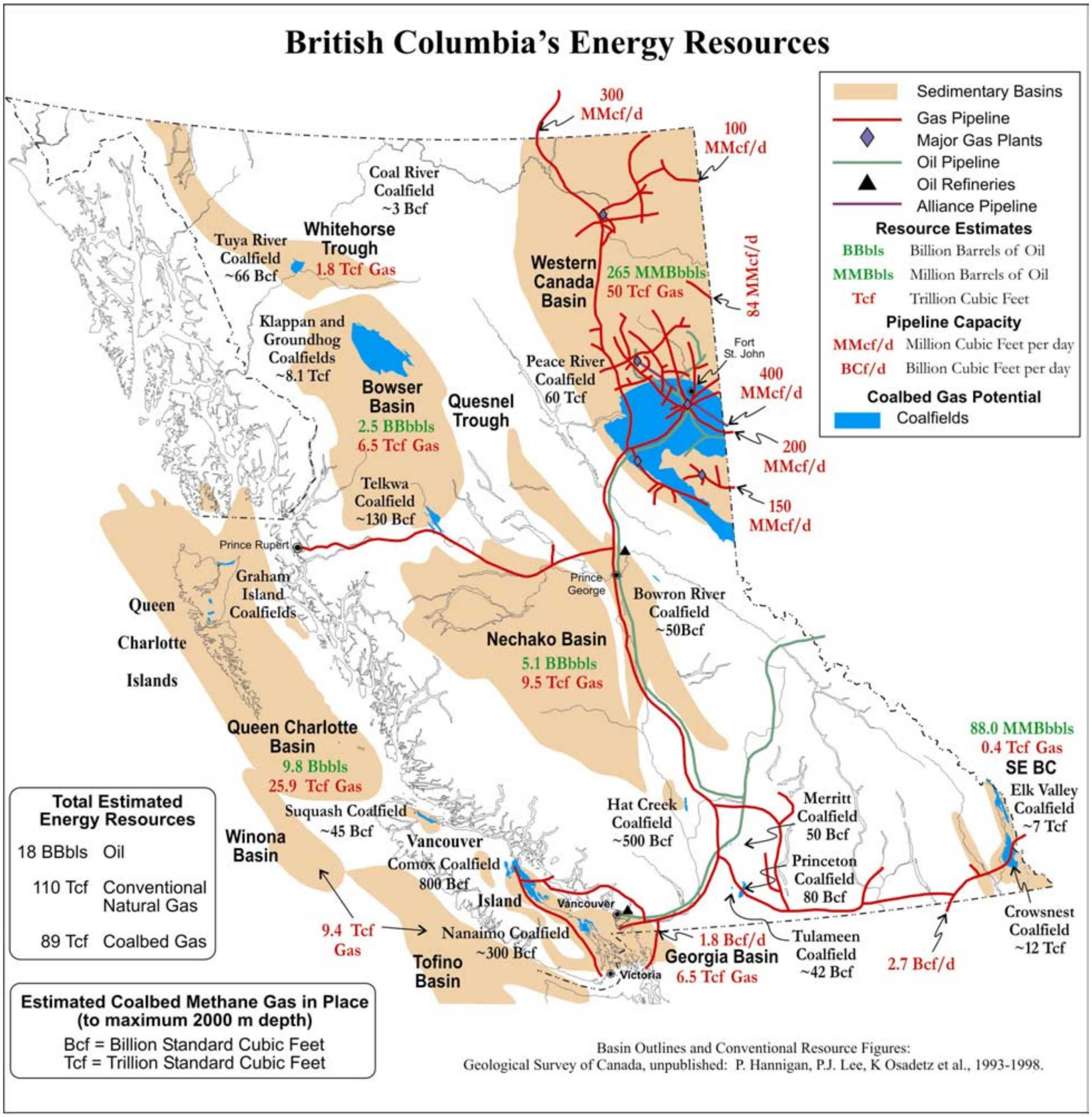


**Figure 1.1 British Columbia's oil and gas resources**

Ministry of Energy, Mines and Petroleum Resources, 2004. Courtesy of Treaty 8 Tribal Council.

A number of fossil fuel processing and shipping facilities are also in various stages of the approval process. If these facilities are developed, they would support additional fossil fuel development in B.C. and Alberta:

- Kitimat LNG plans to build a liquefied natural gas (LNG) terminal near Kitimat, B.C., which will require LNG tanker traffic to Kitimat.
- WestPac Terminals plans to build a second LNG storage and reshipment facility, the Prince Rupert LNG Terminal.

## 1.3 British Columbia's 2007 Energy Plan

The B.C. government released an updated Energy Plan in February 2007.[5] It contains commitments to support the development of clean and renewable electricity generation while also heavily focusing on policies to encourage further oil and gas exploration and production.

### 1.3.1 Renewable Energy Commitments

The Energy Plan commits B.C. Hydro to generating 90% "clean or renewable energy" in the province by 2016. This commitment includes large-scale hydroelectric generation and means that the government is considering developing the Site C Hydro project in the northeast.

The Energy Plan also establishes a target to meet B.C. Hydro's incremental electricity needs with 50% energy efficiency and conservation measures by 2020. This target signals that renewable energy and energy efficiency technologies are a growing and viable alternative to fossil-fuel-based projects.

Finally, the Energy Plan also includes a commitment to streamline the process for clean electricity projects of less than ten megawatts to produce power onto the grid, which should help encourage the development of small renewable energy projects.

### 1.3.2 Non-Renewable Energy Commitments

The Energy Plan commits B.C. to zero net greenhouse gas emissions from coal-fired electricity generation. Any coal-fired power project in B.C. must capture carbon emissions. To do so, a company would have to separate the carbon dioxide and inject it into an underground reservoir.

The Energy Plan also contains a number of policies and commitments to promote oil and gas development in B.C., with an emphasis on coalbed methane, offshore oil development and the opening up of new basins in the Interior, particularly the Nechako basin. The Energy Plan emphasizes that B.C. wants to be a competitive oil and gas jurisdiction. It contains a number of policies that are dedicated to promoting oil and gas development, including support for new technologies, a commitment to address labour and transportation issues, and notably, commitments to work with First Nations in considering benefit sharing. It is likely that there will be additional infrastructure investments, incentives and subsidies to support oil and gas exploration and development.

[5] *The BC Energy Plan: A Vision for Clean Energy Leadership*, Victoria, February 2007.

# 2. Overview of Oil and Gas

This section provides an overview of oil and gas: what it is, how it is found, and how it is produced. It explains the process for conventional oil and gas development — from seismic exploration to drilling and completions to production and pipeline transport. This section also explores a number of unconventional oil and gas methods: coalbed methane, tight gas and shale gas, and tar sands. The final pages of this section address offshore oil and gas development.

In the last century, oil and natural gas have become a leading source of energy worldwide. Although they differ in appearance — oil is a liquid, while natural gas is gaseous and would escape into the atmosphere if it was not stored in proper containers — both oil and gas are hydrocarbons. Hydrocarbons are made of hydrogen and carbon atoms. They hold energy potential that is released when they are burned (or combusted). Oil and gas are used to supply people with energy for their cars and heat for their homes and to produce electricity. Derivatives from oil and gas are also used for thousands of other purposes, such as fertilizers, plastics, dyes, detergents, pesticides and medical drugs.

In Canada, there are many different types of oil and gas resources that are produced and sold to markets around the world. The differences between the types of oil and gas reserves we hear about are normally due to the quality of the resource and the type of formation in which it is found.

**Conventional** oil and gas reserves are stored in rock formations deep underground and have been produced for decades. The oil or gas is found in tiny spaces between rock, similar to the way water is held in a sponge.

**Unconventional** oil and gas reserves — such as tar sands, shale gas and coalbed methane — are found in formations that are more difficult to access. Newer, less established methods of oil and gas production have been developed to produce unconventional reserves in sands, shale and coal formations. They are called unconventional because they require new technologies to extract them. These technologies often require more energy or more complex approaches than those used for conventional oil and gas. Figure 1.1 reveals the areas in British Columbia where oil and gas are found.

Oil and gas production follows a typical pattern almost everywhere it is produced. Once a company puts adequate infrastructure such as roads and pipelines in place, it becomes economically attractive for other companies to operate in the same region. More infrastructure, more discoveries, and more workers make a region even more economically attractive and so development continues to increase. After oil and gas production reaches a peak, new or different types of reserves may still be discovered, but the rate of production typically declines.

In the decline phase, it is common for even more development activity to occur — more seismic exploration will take place to search for untapped reserves. Although more wells are drilled, they usually produce far less oil or gas than the initial wells in the region because the highest-producing wells are drilled first, and the reservoirs become depleted. To imagine this depletion, picture more and more straws in a glass sucking out what is left of your drink. More wells producing less oil and gas are typical in the decline phase. Some of the world's largest oil fields in Saudi Arabia, Kuwait, China and Mexico have all passed their peak oil production and are now in this decline phase. The decline in Alaska's oil production for more than a decade has contributed to the pressure to open up the Arctic National Wildlife Refuge for oil development.[6]

Once a region has exhausted its oil and gas supply, it enters a shutdown or consolidation phase, where old wells are abandoned and reclaimed, exploration ceases and no new wells are drilled.

## 2.1 Conventional Oil and Gas

**Figure 2.1 A well pad in British Columbia**

Photo: Wayne Sawchuk

People have been producing conventional oil and gas reservoirs for about 150 years. Many think that drilling is the first step in finding oil and gas, but there are activities that must take place before the land is ever drilled. The process begins when a company obtains rights from the Government (referred to as a tenure) to perform field observations in a defined area and then conduct seismic exploration.

### 2.1.1 Seismic Exploration

Companies start examining the land to look for features that indicate that oil and gas may lie beneath it. They base their examination on other areas where oil and gas have been found. For example, certain types of exposed rock and even oil seepage can suggest that an area has oil and gas deposits. If a company thinks there may be oil or gas in an area, they will apply for and usually obtain the rights to conduct seismic exploration.

Seismic exploration, as illustrated in Figure 2.2, involves using sound waves on the surface of the ground to determine what might be found below. Specialized machines that thump the surface or small explosives set off just below the surface create sound waves causing a vibration on the ground that travels downwards, as depicted in Figure 2.2, number 1.

[6] Roger Blanchard, "Will Technology Delay Peak Oil?" *EV World,* 2006, http://www.evworld.com/view.cfm?section=article&storyid=968

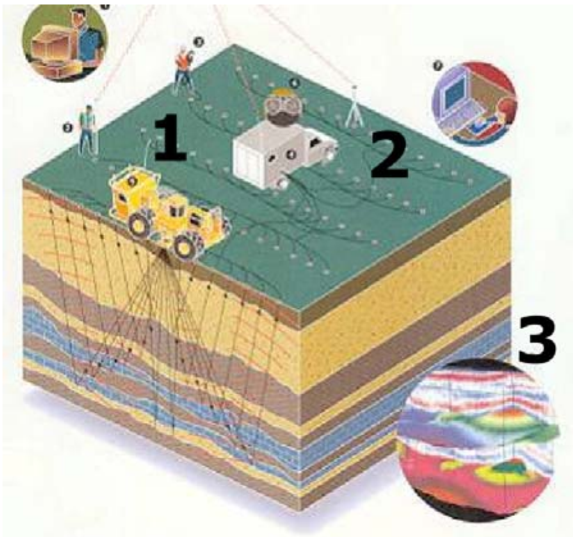


**Figure 2.2 Seismic exploration**

The sound waves travel beneath the earth's surface and are reflected back by the various rock layers. The reflected sound waves travel at different speeds depending on the type of rock formation that they must pass through. Sound waves are intercepted (or received) by geophones, which are placed on the ground in a grid-like pattern, as shown in Figure 2.2, number 2. Geophysicists interpret the information collected by the geophones to locate underground rock formations that may contain profitable deposits of oil or gas, as seen in Figure 2.2, number 3. Underground maps are then created to indicate where oil and gas deposits are most likely to be found.

### 2.1.2 Drilling and Completions

After a company analyzes the seismic data and identifies rock formations that seem likely to contain oil or gas reserves, test hole drilling (also known as wildcat drilling) takes place. Test holes can be drilled kilometres below the surface to determine whether there are in fact oil or gas deposits in a specific location. If a test hole hits an oil or gas reserve, it could be turned into a producing or wet well. If a test hole does not hit an oil or gas play, it is considered a dry well and must be abandoned and reclaimed.

**What is a Dry Well?**

In 1946, 133 dry wells were drilled before the first successful producing well was drilled in Leduc, Alberta.[1] Although seismic technology has advanced significantly over the years, dry wells are still drilled today. In 2004, the success rate for producing wells in Alberta was just over 11%, resulting in the creation of 15,503 dry wells.[2]

[1] Alberta's Petroleum Heritage Edukit, www.edukits.ca/petroleum/students_faq.htm (accessed November 8, 2006).

[2] Alberta Department of Energy, Oil Statistics, www.energy.gov.ab.ca/803.asp (accessed November 20, 2006).

Before a well can be drilled, a road must be built to access the site. In addition, camps or trailers need to be put in place to house rig workers.

Drilling takes place on a well pad which is cleared of vegetation and topsoil. A well pad is typically about a hectare in size (100 square metres). In some cases, companies will drill several wells from a single well pad.

**Figure 2.3 Coalbed methane drilling rig**
**Photo: Alison Jamison, The Pembina Institute**

A drilling rig is a tall structure that a team of workers uses to drill a well (Figure 2.3). Drilling typically occurs by rotating a drill bit at the bottom of a pipe and exerting a downward force. Drilling fluids, also called drilling muds, must be circulated through the drill bit to keep it cool and lubricated, remove rock cuttings and control the pressure inside the well hole. After a well has been drilled, these drilling muds must be disposed of.

Drilling operations vary greatly depending on many conditions such as the depth of the resource, the possible presence of dangerous hydrogen sulfide ($H_2S$, also known as sour gas) and the pressure of gas within rock formations. Some wells take months to drill, while others can be completed in less than a day. Wells can be drilled as shallow as 150 meters and as deep as 10 kilometres. Drilling can also be performed directionally, which means that the hole can be drilled at angles and even horizontally to access different resources or minimize surface impacts.

After a wet well is drilled, it is tested. Well testing can involve long periods of flaring, which involves burning off oil or gas into the atmosphere to determine the pressure, quality and flow rates associated with the well. Once a well has been tested, a decision will be made to either abandon it or complete it.

Completing a well involves putting steel piping (called production casing) down the entire well, cementing it in place and installing production tubing through which the oil or gas can flow. In addition, the cement lining in the well must be perforated (or opened up) at the depth where the oil or gas is located so that it can flow into the production tubing. For safety reasons, a permanent well head is installed at the top of the well to control the flow. When a well is successfully completed, it is ready for production.

**Figure 2.4 Gas flare at a compressor station in Drayton Valley**
Photo: Dave Mussell

### 2.1.3 Production and Pipeline Transport

When oil or gas comes to the surface, dehydrators remove water at the well site to prevent problems of freezing. The oil or gas is transported, usually by pipeline, to a processing plant and then sent to customers in a usable form.

**Figure 2.5 Pipeline construction**

There must be a significant amount of oil and gas in an area before a company will consider spending the money to build the necessary infrastructure, such as pipelines and compressor stations, to transport it (Figure 2.5 and Figure 2.6). There is a huge underground network of pipelines in Canada which includes pipelines that move oil and gas from wells to processing facilities (the gathering system), long distance transmission pipelines to deliver gas to market centers, and a network of distribution pipelines which deliver oil and gas to customers across Canada and into the United States.

Oil and gas processing facilities (also known as gas plants) are required to separate the different hydrocarbons found in reserves, such as ethanes, propanes and butanes. Processing varies depending on the type and grade of oil or gas produced.

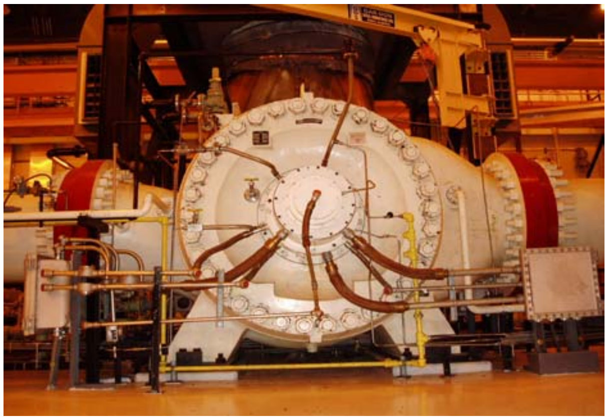

**Figure 2.6 Gas compressor in a processing plant**

When oil or gas is transported in pipelines from well sites or processing facilities, it requires enough pressure to get it to the next destination. Compressor or pumping stations are built along pipeline routes to maintain the pressure and temperature that is needed for the oil or gas to continue to flow through the pipe. Figure 2.7 illustrates the infrastructure and steps required to produce gas from a well head and deliver it to consumers.

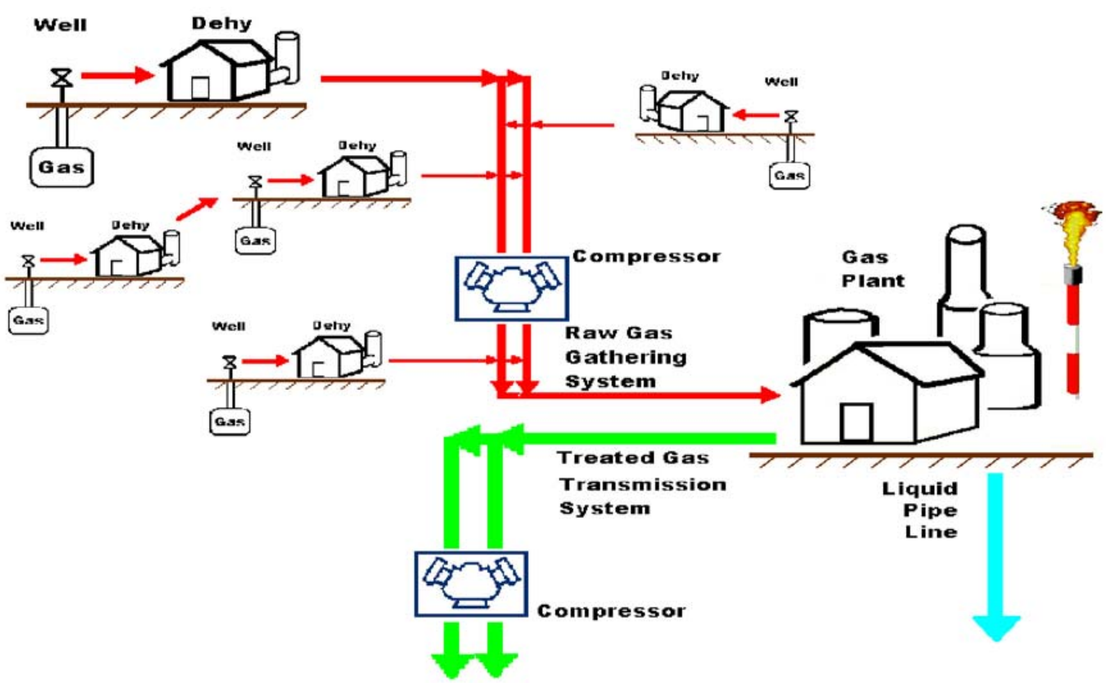


**Figure 2.7 Overview of steps required to produce gas from a well to transport to consumers**

## 2.2 Unconventional Oil and Gas

Unconventional oil and gas such as coalbed methane, tar sands and shale gas are newer and more complex methods of oil and gas development.

### 2.2.1 Coalbed Methane

Coalbed methane is a form of unconventional gas that is being promoted in British Columbia. The B.C. government offers various subsidies and tax credits to encourage coalbed methane production,[7] although there is no commercial production underway yet.

Coalbed methane is natural gas generated and stored in underground coal seams. The production of methane gas from coal seams creates different challenges than the production of natural gas from conventional rock formations. Methane gas is attached to the coal and can only flow through its natural fractures (known as cleats). The coal must also be extensively fractured to improve the gas flow to the well.

Coalbed methane development differs from conventional gas development in two primary ways: First, coal seams often contain water. If so, the coal seam must have the water drained off (or dewatered) to reduce the pressure in the coals and allow the gas to flow. When coal is dewatered, the produced water may be contaminated with salts that are detrimental to land or waterways. In 2007, the B.C. government committed to requiring zero surface discharge of produced water from coalbed methane. That means that any produced water must be reinjected well below fresh water aquifers so that it will not interfere with surface ecosystems or shallow groundwater. While this regulation should reduce surface water contamination risks, produced water does occasionally leak from pipelines and spills may occur.

Second, coalbed methane wells produce gas at lower pressure than conventional gas wells. As a result, to access gas, they require more wells per area than conventional gas. Alberta's experience with coalbed methane development may suggest how development will play out for British Columbia. In 2000, Alberta had about 20 coalbed methane wells. By the end of 2006, over 10,000 wells had been drilled, and within the next ten years or so, another 50,000 wells are expected.

### 2.2.2 Tight Gas and Shale Gas

Regions of northeastern B.C have both tight gas and shale gas, and tight gas is expected to hold the highest potential for recoverable supply.[8]

Tight gas is a natural gas very similar to conventional gas except that it is found in fine-grained (known as tight) rock formations. Tight gas cannot be produced economically without extensively fracturing (or fraccing) the underground formations so that the gas can flow more readily into the well. Shale gas is simply tight gas that is found specifically in shale formations. Shale is a tight rock formed by the deposition and compression of clay, silt and sand.

Because it is so much harder to get these gases to flow, tight and shale gas wells typically do not produce nearly as much as conventional wells do. Consequently, as with coalbed methane, these gases require more wells per area than conventional gas. Because of the large number of wells and also the potential damage to groundwater that underground fraccing may cause, the potential environmental impacts of tight and shale gas development are more significant than conventional gas.

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[7] Ministry of Provincial Revenue, Government of British Columbia, Coalbed Methane Royalty Program, http://www.sbr.gov.bc.ca/mog/oil_gas/information_letters/2004/2004-02.pdf (accessed March 10, 2007).

[8] Ministry of Energy, Mines and Petroleum Resources, *Oil and Gas Production and Activity in British Columbia* (Vancouver, B.C.: Government of British Columbia, 2004).

### 2.2.3 Tar Sands

Oil and gas exploration and production is very different in the tar sands, also known as the oil sands. Tar sands projects exist exclusively in Alberta, but they are summarized here because their impacts are far reaching.

Tar sands developments are currently the largest growing source of greenhouse gas emissions in Canada. They threaten fresh water, land, air and wildlife beyond Alberta's borders. In addition, tar sands depend on significant amounts of other energy sources for their extraction. Given these environmental impacts, they need to be taken into account in any consideration of the use of energy resources in Canada.

There are two ways to extract tar sands:

- *Mining* — Bitumen is the heavy tar-like substance that gives tar sands their name. It is often found very close to the surface, making it possible to extract it using huge trucks and shovels and massive open pit mines. Once the tar is extracted, the bitumen is removed from the sand using heat.
- *In situ (in place)* — Bitumen can also be extracted from the subsurface using wells. However, because bitumen does not flow like conventional oil, it needs to be heated underground before it will move up the well. This process is known as in-situ operations. Steam is commonly injected via pipe into an underground formation to heat up the bitumen, which then flows to the surface through a second pipe. This process requires large quantities of water and energy.

Oil sands operations in northern Alberta currently consume approximately 6% of all of the natural gas produced in Canada. They are licensed to use 349 million cubic metres of water per year from the Athabasca River.[9] 349 million cubic metres is approximately twice the volume of water that was used in 2003 by the city of Calgary, a city of almost one million people.[10] The area being developed in Alberta covers 140,000 square kilometres, roughly the same land mass as Florida. Although the Alberta government has yet to put any cumulative management plans in place, there are already 43,000 square kilometres (or 30% of the region) leased for tar sands developments.

Condensate is a chemical and petroleum mixture used to thin the tar extracted from the Alberta tar sands so it can more easily flow through pipelines. There is currently a proposal to ship condensate by tanker from Asia to Kitimat, B.C. and then by pipeline to the tar sands in Alberta. The proposed Kitimat to Summit Lake Condensate Pipeline project is expected to transport about 100,000 barrels (or 16,000 cubic metres) of condensate per day. With increasing production from Alberta's tar sands and its heavy oil regions, demand for condensate has outstripped supply.[11]

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[9] Golder Associates Ltd., *A Compilation of Information and Data on Water Supply and Demand in the Lower Athabasca River Reach* (Calgary, AB: Golder Associates Ltd., 2005).

[10] Sustainable Calgary, *2004 State of Our City Report* (Calgary, AB: Sustainable Calgary, 2004), 48. Calgary's municipal water requirement for 2003 was 174 million cubic metres.

[11] Pembina Pipeline Corporation, "Proposed Kitimat to Summit Lake Condensate Pipeline Project" (project description, 2006).

### 2.2.4 Offshore Oil and Gas

Since 1972, B.C. has had a moratorium on offshore oil and gas drilling, banning activity and crude oil tankers from Hecate Strait, Queen Charlotte Sound and Dixon Entrance, according to federal government documents.[12] The B.C. government has recently reiterated its desire to see an offshore oil and gas industry developed within the next two to three years.[13] In the 2007 Energy Plan, the provincial government reaffirmed its commitment to lift the B.C. moratorium by seeking to get the federal moratorium lifted.[14]

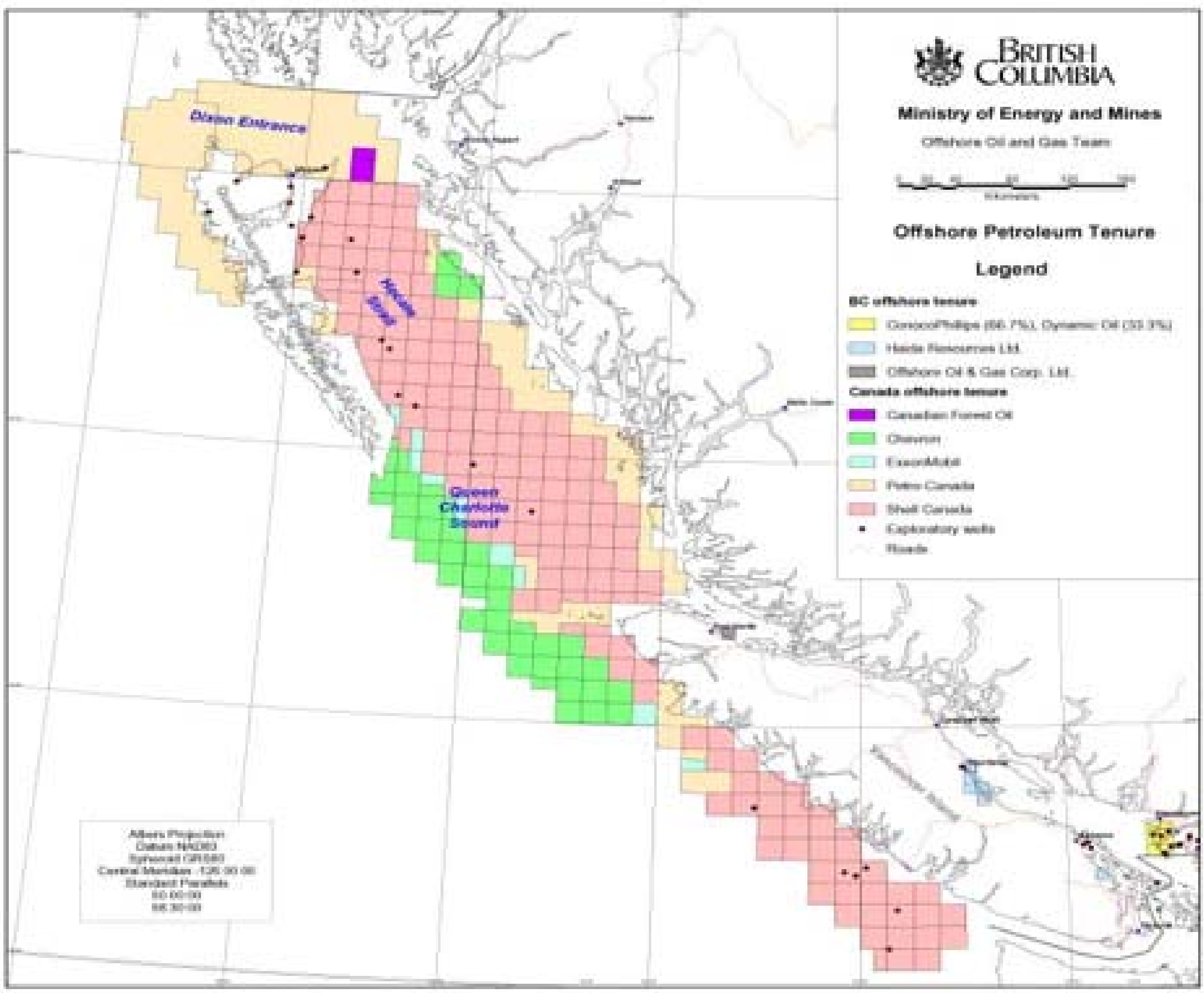


**Figure 2.8 Offshore oil and gas leases**
Source: Ministry of Energy and Mines

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[12] Natural Resources Canada, *Terms of Reference: Public Review of the British Columbia Offshore Oil and Gas Moratorium* (Ottawa, ON: Natural Resources Canada, 2003).

[13] S. Simpson. and M. Cernetig, “Offshore oil, gas drilling may be 2 to 3 years away, premier says,” *Vancouver Sun,* November 23, 2006.

[14] Government of British Columbia, *The B.C. Energy Plan: Oil and Gas Policies* (Vancouver, B.C.: Government of British Columbia, February 2007).

Offshore oil and gas development is proposed primarily in and around Hecate Strait. Prior to the enactment of the moratorium in 1972, leases were granted to companies to explore offshore. These leases have remained inactive since that time. Figure 2.8 illustrates the leases held for development in this area.

Offshore oil and gas development involves marine seismic testing. Once potential deposits have been located, companies drill for oil and gas beneath the surface of the ocean from platforms that float on the water's surface or are fixed to the ocean floor. Development of offshore oil and gas resources typically occurs in four phases that are similar to those of conventional oil and gas mining: exploration, development, production and decommissioning.

Exploration involves surveying with seismic, sonar and other geophysical technologies to gather information on sea depth and seabed character to assess the suitability of an area for exploratory drilling. Seismic and sonar surveying generate very high levels of underwater noise. Sonar surveying uses high frequency sound pulses, while seismic surveying involves the detonation of airguns underwater to bounce sound waves through underlying geologic strata so the returning waves can be analyzed. Once a potential deposit of oil or gas is located, exploratory drilling begins. Exploratory drilling has a success rate of one producing well for every nine wells drilled.[15]

During the development phase, developers construct marine and onshore infrastructure — including drilling rigs and platforms, inshore supply ports and submarine pipelines. Preparing the marine and onshore sites usually involves pile driving, dredging and construction. Pipeline construction may be required, and further surveying and well drilling may be conducted. Onshore development may involve construction of supply bases, roads, helicopter landing pads, pipelines, processing plants, employee housing and other infrastructure.[16]

Once the development phase is complete, production begins. The number of wells drilled in the production phase depends on the size of the reserve and the developer's production strategy. The oil and gas produced from the wells is transported either to the shore via pipelines or to other ports via tankers.[17]

When the reserves have been exhausted, the infrastructure used during production needs to be removed and decommissioned. One of the largest challenges of the decommissioning phase is to clean up sites that have been contaminated and impacted from years of drilling. The eventual decommissioning of a drilling operation can also have significant impacts on the socio-economic well-being of local communities. [18]

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[15] D. Hertzog, *Oil and Water Don't Mix* (Vancouver, B.C.: David Suzuki Foundation, 2003). Available at http://www.davidsuzuki.org/Publications/Climate_Change_Reports

[16] Offshore Oil and Gas Research Group, *A Review of Offshore Oil and Gas Development in British Columbia*, (Vancouver, B.C.: Simon Fraser University, 2004), http://www.rem.sfu.ca/sustainableplanning/OOGRG.html

[17] Ibid.

[18] Hertzog,

# 3. Environmental Impacts of Oil and Gas Development

Each stage of oil and gas development has many impacts on the natural environment. Impacts on the land, air and water, including wildlife and fish populations, can be significant especially when we consider the cumulative impacts to a region — that is, the effects of the individually minor but collectively significant actions that take place over time.

Developers and regulators can leave a smaller footprint on the land through careful planning and the use of least damaging technologies and practices such as those outlined in Appendix A. However, even with the best technologies currently available, oil and gas development inevitably has environmental and social impacts.

Because regions vary in their land, air, water and wildlife characteristics, oil and gas development does not always result in the same environmental impacts. This section provides an overview of the varied impacts to land, freshwater, air, wildlife and fish from all stages of oil and gas development, including exploration, production and transportation. This section also addresses the challenge of cumulative impacts, the potential impacts from pipelines, and the marine impacts of offshore development.

## 3.1 Land

Seismic testing involves the construction of access roads, camps, and in certain locations, airstrips or helicopter pads. All of these activities require the removal of vegetation and soil compression, which can change the landscape in ways that are difficult to repair.

**Figure 3.1 Seismic Lines crisscross the landscape in Alberta**

Photo: David Dodge, The Pembina Institute

Cutlines, as shown in Figure 3.1, are required for seismic surveys. Typically separated by distances of 100 to 1000 metres, they can range in width from two to eight metres and require the removal of vegetation. Heavy equipment can compress the soil making it more difficult for vegetation to regenerate after seismic testing is complete.

Oil and gas companies tend to cause impacts in an area more than once, as the same company will often return to get additional data, or different companies will explore the same area to collect their own seismic data. For example, in Alaska's North Slope, vegetation has been contaminated by diesel fuel, oil and saltwater and also damaged by seismic activities.[19]

Drilling operations have two primary impacts on land. First, drilling requires the creation of roads and well pads, which requires the removal of vegetation and topsoil. The use of heavy drilling equipment also compacts the land and makes it difficult to restore.

Second, the drilling muds used to remove cuttings (or rock chips) from the hole as well as to lubricate and cool the drill bit can contaminate soil, subsoil, surface waters and groundwater when it is disposed of.[20] Either freshwater, saltwater or oil-based, and usually made up of many different compounds, drilling mud mixtures vary for each application and may contain toxic products. Sumps, or disposal methods such as "mix, bury, cover" whereby the muds are mixed with soil and then buried, can lead to surface contamination. When drilling muds are shipped to an off-site facility for disposal, accidental spills can occur and also result in surface contamination.

**A Legacy of Waste**

Treaty 8 First Nations in northeastern British Columbia estimate there are over 1,800 sites on their territory that have not been rehabilitated by oil and gas activity. An estimated 90% of these sites remain contaminated and in desperate need of cleanup.[1] In Alberta, there are hundreds of abandoned well sites called "orphan wells" that no company is legally responsible to clean up and rehabilitate.[2] The provincial government has not taken steps to address them.

[1]Treaty 8 Tribal Association, "Wildlife and Well-Site Contamination in Treaty 8 Territory Declaration" (Treaty 8 Tribal Association, September 13, 2004).

[2]Alberta Oil and Gas Orphan Abandonment and Reclamation Association. http://www.orphanwell.ca

Once a well is producing, the primary land impacts come from permanent access to the site. While a well is producing, it cannot be reclaimed, and any roads or well pads that were originally built for drilling remain in place. When a well has stopped producing, the normal procedure for sites is reclamation — the process of attempting to return the site to its natural condition.

Coalbed methane is particularly land intensive since it usually requires more wells to produce the same amount of gas as conventional methods Figure 3.2. Since smaller amounts of gas are extracted from coalbed methane wells, up to eight wells can be required per section (640 acres or 258 hectares of land) for coalbed methane development to be profitable. Conventional gas, on the other hand, typically requires only one well per section.[21] B.C. currently places no limits on the number of coalbed methane wells that can be drilled in an area.

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[19] Board on Environmental Studies and Toxicology (BEST) and Polar Research Board (PRB), "Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope" (Washington, DC: The National Academies, 2003), http://www.nap.edu/books/0309087376/html/3.html

[20] Niki Wilson and Chris Severson-Baker, "Exploration and Production Drilling," in *Environment and Energy in the North* (Calgary, AB: The Pembina Institute, 2004) 15.

[21] Andrew Nikiforuk, "Life Inside a Science Project," Globe and Mail, April 29, 2005.

**Figure 3.2 Densely spaced coalbed methane wells in Colorado with access roads, drill sites and containment ponds**
Photo: Rebecca Claren

## 3.2 Freshwater

When seismic lines are cut close to water bodies, they can damage nearby river or lake banks. These areas are sensitive to disturbances, and the removal of vegetation can lead to erosion and sedimentation, where run-off of sand and soil from the land builds up in rivers and lakes. In addition, seismic lines and cutlines often cross waterways, which can change the characteristics of the water body.

The explosive charges used in seismic testing can also cause damage to nearby water wells. Also, if the shot holes (the holes that the charges are put in) are not sealed properly, groundwater is susceptible to surface contamination.[22]

As discussed in Section 3.1 above, drilling muds must be disposed of after use. Disposal either on or below the earth's surface can lead to surface or groundwater contamination.[23] Accidental leaks and spills or improper disposal can lead to water contamination due to the toxicity of some of the compounds within the muds. In B.C., these muds are often disposed of on-site, adjacent to the well, in pits that are called sumps.

A producing well also runs the risk of surface and groundwater contamination. Accidental leaks of oil and gas from wells or pipelines, or spills of other on-site fluids during maintenance activities, can lead to contamination of nearby water bodies and groundwater. Contamination can also occur when vehicles and equipment on-site are cleaned and chemicals enter the natural environment. Groundwater can also be contaminated if a well is not properly abandoned once production is completed.

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[22] See Oil and Gas Accountability Project. *Oil and Gas at Your Door? A Landowner's Guide to Oil and Gas Development*, (Durango, Colorado: Oil and Gas Accountability Project, 2004 ), I-6, I-7, IV-27.

[23] Wilson and Severson-Baker, 15.

Water is sometimes used during the production phase to increase oil and gas recovery. It is injected into the ground to increase the pressure in the formation (downhole pressure) so that the oil or gas continues to flow to the surface. In such cases, the freshwater cannot be recovered for other uses such as drinking water or irrigation, and most is left underground in the formation.[24] For example, Alberta allocated 604 million cubic metres of surface water and 106 million cubic metres of groundwater to oil and gas extraction and processing in 2004.[25] This is approximately four times the volume of water consumed by the entire city of Calgary in 2003.[26]

Coalbed methane wells have unique water issues, as coal seams may contain fresh or salt water. Although some Alberta coal seams are dry, the seams that have been drilled in B.C. produce water. The coal seam must first be dewatered — water must be pumped out of the coal seam to reduce the pressure so that gas will flow — before production can begin. The quantity and quality of water that must be removed for the gas to flow will differ from basin to basin. Soil and water contamination can result when produced water containing salt or heavy metals is discharged into the environment.

In addition, after a coalbed methane well has been drilled, a combination of chemicals is injected to fracture the coal seam and allow the gas to flow to the surface. Sand is then pumped into these fractures so that they do not close back up. In the U.S., these frac fluids have been known to migrate along the coal seams and into local drinking water. They can contaminate both water and soil during their underground movement.[27]

## 3.3 Air

Once a well has been drilled and is producing, the oil and gas company will test it to determine the quality and quantity of the oil or gas, typically by flaring the oil or gas as it comes to the surface. Flaring is a significant source of air emissions: a flare test of a productive gas well can release "more pollutants in four days' time than would a gas plant over the course of a month."[28] Companies will also flare wells from time to time throughout the production life of a well if there are any problems with the well or associated pipelines, and for periodic well maintenance. Extensive flaring is common in B.C., but the government's 2007 Energy Plan commits to phasing out flaring from oil and gas activities by 2016.

Another concern is that some wells contain $H_2S$ or poisonous sour gas. Sour gas can be released into the environment and is deadly to humans and animals at certain concentrations (see text box, above).

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[24] Government of Alberta, *Water and Oil: An Overview of the Use of Water for Enhanced Oil Recovery in Alberta* (Calgary, AB: Government of Alberta, March 2004).

[25] Calculated from Alberta Environment data for 2004, providing total allocated amounts of surface and groundwater, and percentages allocated to oil and gas activities.

[26] Sustainable Calgary, 48.

[27] Earthworks, "Fracking Fact Sheet (Washington, D.C.: Oil and Gas Accountability Project, January 17, 2006), http://www.earthworksaction.org/publications.cfm?pubID=145 (accessed March 10, 2007). See also the Oil and Gas Accountability Project publication, *Our Drinking Water at Risk: What EPA and the Oil and Gas Industry Don't Want You to Know About Oil and Gas Fracturing* (Durango, Colorado: Oil and Gas Accountability Project, 2005).

[28] Wilson and Severson-Baker, 157.

**Sour Gas or Sweet Gas?**

If hydrogen sulfide ($H_2S$) or high amounts of carbon dioxide are found in a gas well, the gas is called *sour gas.* If there is no $H_2S$ or carbon dioxide, it is called *sweet gas.* $H_2S$ gas is toxic. It releases a smell like rotten eggs and is commonly found in conventional natural gas deposits. At low concentrations, it can cause eye problems and disturb the respiratory tract; at high concentrations, even one breath can cause death as $H_2S$ impairs cellular respiration. People who work around $H_2S$ gas are required to carry monitors to ensure they are not being exposed to high levels of the gas. They are also trained to be prepared for $H_2S$ gas emergencies.

Oil and gas operations also use engines when operating the drilling rig and pumps on-site, for pipeline construction and electricity generation, and at compressor and pumping stations. Byproducts from these engines contribute to air pollution and greenhouse gas emissions. The operation of pumps and compressors also results in the release of other air contaminants such as nitrous oxides and sulphur dioxide, both of which cause negative impacts to human health and the surrounding environment. Finally, the dust generated by construction activities can also have negative impacts on air quality.

## 3.4 Wildlife

### 3.4.1 Impacts from Seismic Testing and Linear Disturbances

Seismic testing can require the cutting of long corridors two to eight metres wide that are separated by distances of 100–1,000 metres. Similar to seismic testing, pipelines require long straight cutlines of up to 30 metres wide, known as right-of-ways.

These cutlines fragment the landscape by creating many linear (or straight line) disturbances that can cause significant changes in wildlife behavior. For example, wolves have been observed using the long corridors for quick access from one area to another, increasing predation. Cleared areas create habitat that may attract moose, which results in reduced habitat for other species and a change in predator-prey relationships as the moose become more accessible to their predators in cleared areas.[29] Caribou will avoid cutlines and roads by 250 metres.[30]

### 3.4.2 Impacts from Wells and Well Infrastructure

The infrastructure required for a producing well — such as a well pad, roads and compressor stations — also creates habitat disturbances. Pumps, compressors and other sources generate enough noise to disturb species such as caribou and lead to their avoidance of affected areas. The noise generated at different stages of oil and gas development, such as during drilling operations, can last from a couple of days to a month. Compressor stations that are used to maintain pressure and flow in pipelines, for example, provide a continuous source of noise pollution. A recent study revealed that compressor station noise mutes male bird songs, which results in significantly less breeding.[31] Noise can also be an annoyance for local residents, even when it is below regulated levels.

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[29] Bob Wyne, "Boreal Caribou Research Program: Alberta's Boreal Caribou and Oil and Gas Development" (paper presented at CPAWS Oil and Gas Workshop, Edmonton, AB, May 26, 2002).

[30] Simon Dyer, "Movement and Distribution of Woodland Caribou in Response to Industrial Development in Northeastern Alberta" (Masters thesis, University of Alberta, 1999).

[31] Lucas Habib et al, "Chronic Industrial Noise Affects Pairing Success and Age Structure of Ovenbirds, *Seiurus aurocapilla,"* *Journal of Applied Ecology* 44 (2007): 176-84.

Continued exposure to oil and gas operations on the landscape may cause some animals to experience stress over long periods of time, ultimately affecting the entire population and resulting in the extinction of local species. Stressed animals may not rest, eat properly or pay attention to predators. Caribou have been known to move around more when there is a lot of noise, thereby using up energy usually dedicated to finding food and avoiding predators.[32] Similarly, scientists in Alberta are concerned that long-term stress from oil and gas activities is having negative effects on grizzly bear health.[33] These effects include a decreased ability to fight disease, lower reproductive rates, low birth weights and decreased growth.

### 3.4.3 Impacts from Toxic Contamination

**Figure 3.3 Moose drinking from sump well site in northeastern British Columbia**
Photo: Saulteau and West Moberly First Nations

Another hazard for wildlife is the drilling muds, contaminated water and other toxic materials left at well sites that can potentially be ingested. For example, the Saulteau and West Moberly First Nations found sick moose in the Del Rio area near Chetwynd.[34] There, as captured in Figure 14, moose and deer were visiting well sites and drinking and eating contaminated water and soil that had not been fenced off. Bears, wolves and coyotes that were drawn to the site to hunt deer and moose also drank and ate the contaminated water and soil.

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[32] C.J. Bradshaw et al, "Effects of Petroleum Exploration of Woodland Caribou in Northeastern Alberta," *Journal of Wildlife Management* 61, no. 4 (1997): 1127–33.

[33] G.B. Stenhouse and K.Graham, Eds., *Foothills Model Forest Grizzly Bear Research Program 2005 Annual Repo*rt (Calgary, AB: Foothills Modest Forest, 2006).

[34] Wildland Resources, *Petroleum Contaminants Community Research Project Final Report* (prepared for Health Canada, Saulteau First Nation and West Moberly First Nation, 2004).

In Alberta and northeastern B.C., the web of oil and gas development has had harmful effects on many wildlife species. Impacts range from loss of habitat to poisoning to a reduction in herd size and home range. Species in decline because of industrial development in Alberta include caribou, lynx, martin, fisher, wolverine and several birds.[35]

Finally, with more roads, seismic lines and cleared areas, more people can access the land for work and recreation. Areas once too difficult to travel through become accessible by snowmobile, quads and trucks. This new access means possible collisions with wildlife and an increase in hunting and fishing. Some studies estimate that poachers kill as many fish and wildlife as are taken legally.[36] There is a general concern in Canada that unlimited access to recreational fisheries could be causing the collapse of some populations.[37] The combined effect of various land uses, such as off-road vehicle use, snowmobiling, hunting, fishing and camping, can result in significant cumulative effects in areas that were once pristine.

## 3.5 Fish

### 3.5.1 Impacts from Seismic Testing

The detonation of explosives used in seismic testing in or near water is known to damage fish livers, kidneys, spleens and swim bladders (the organ that keeps the fish afloat).[38] Explosions can also change fish behavior and result in chemical and physical changes to their habitat similar to the changes caused from increased sediments.[39] Byproducts from explosives can include ammonia and similar compounds that can be toxic to fish and other aquatic life.

**Seismic Cutlines Can Travel Far**

In 2003 alone, an estimated 21,700 kilometres of seismic lines (20% of the total) were cut in British Columbia, bringing the estimated total length of seismic lines in the province to 110,400 kilometres, the equivalent of crossing Canada more than 20 times.[1]

[1] Forest Ecosystem Management Assessment Team, *Forest Ecosystem Management Assessment Team Report* (sponsored by USDA Forest Service, U.S. Environmental Protection Agency, USDOI Bureau of Land Management, National Park Service), (Portland, Oregon: FEMAT, 1993).

[2] West Coast Environmental Law et al, *Oil and Gas In British Columbia: 10 Steps to Responsible Development* (Vancouver. B.C.: West Coast Environmental Law et al, 2004), 15.

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[35] The Pembina Institute and the Canadian Parks and Wilderness Society, *Death by a Thousand Cuts: Impacts of In Situ Oil Sands Development on Alberta's Boreal Forest* (Edmonton, AB: The Pembina Institute, 2006), 50.

[36] B.C. Ministry of the Environment, September 15, 2006, http://www.env.gov.bc.ca/cos/rapp/costs.html

[37] J.R. Post et al, "Canada's Recreational Fisheries: The Invisible Collapse?" *Fisheries* 22 no.1 (2002): 6-17.

[38] D.G. Wright and G.E. Hopky, "Guidelines For the Use of Explosives In or Near Canadian Fisheries Waters," *Canadian Technical Report Fisheries and Aquatic Sciences* 2107 (1998), iv+ 34p.

[39] Ibid,

### 3.5.2 Impacts from Roads and Well Infrastructure

**Figure 3.4 Hanging culverts prevent fish movement upstream**
Photo: Ward Hughson, Parks Canada

Building roads over streams and rivers requires the building of culverts, the large pipes installed where roads cross smaller waterways so surface water can flow through them, underneath the road. Over time, water can wash away the gravel from the downstream side of a culvert, leaving it hanging above the streambed as seen in Figure 15. This uneven surface coupled with fast moving water in the culvert can impede fish movement. There are thousands of culverts in B.C., and many more will be installed as new roads are built for industrial operations. The proper installation and design of culverts is critical to protect the habitat and diversity of fish populations.

**Figure 3.5 Road washing out into streambed in northeast British Columbia**
Photo: Wayne Sawchuk

Sediment — stream bed and shore dirt and gravel — is released into streams and rivers from road building and road washouts (see Figure 3.5). It is also released in trench excavation and backfilling used in open-cut water crossings during pipeline building.[40] Although streams and rivers can naturally experience sediment increases, risks to fish increase when sediment levels are higher than normal. Certain concentrations of sediment will kill fish directly, and in lower concentrations, it increases the amount of stress that fish experience, disrupting their feeding, growth, social behavior and susceptibility to disease.[41] Sediment can also settle over streambeds, clog the spaces between pebbles covering fish eggs and affect the survival of young fish. It also makes water cloudy, reducing the amount of light that gets through. Less light may result in less plant growth, decreasing food and habitat for the insects that fish depend on for survival.

### 3.5.3 Leaks and Spills

Leaks and spills during oil and gas production can end up in waterways, creating a major source of contamination for both the water and the fish within it. Oil contains chemicals that can dissolve in water, resulting in the death or disease of fish and aquatic insects. In Alberta, the oil and gas industry averaged 674 pipeline failures per year from 1980–1997.[42] Pipelines can directly expose streams, rivers and lakes to oil and the toxic byproducts of oil and gas operations.

## 3.6 Cumulative Impacts

Over time, the effects of multiple projects in an area can result in serious long-term changes for people, wildlife and the land. Cumulative effects result from individually minor but collectively significant actions that take place over time.[43] One gas well may not result in serious environmental consequences; however, hundreds of gas wells can result in significant air pollution, threats to fresh water sources, destruction of local wildlife populations, and much more.

### 3.6.1 How Cumulative Impacts Happen

When one company builds roads and facilities, it becomes more affordable for others to develop areas that are nearby. The infrastructure built for one project can encourage other companies to explore or develop in a region. For example, an established pipeline may provide an incentive to companies to develop oil, gas or coalbed methane in the region because the pipeline provides an easy way to ship these products to market.

The cumulative impacts in a region are not limited to the oil and gas industry. Once roads appear, forestry and mining companies may use them to log forests and conduct mining exploration in areas that were previously inaccessible.

Declining reserves also contribute to cumulative impacts. As oil and gas reserves decline, companies look to extract other types of fuels such as coalbed methane, tight gas and shale gas

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[40] S.M. Reid and P.G. Anderson, "Effects of Sediment Released During Open-Cut Pipeline Water Crossings," *Canadian Water Resources Journal* 24, no. 3 (1999): 235–51.

[41] I.K. Birtwell, *Effects of Sediment on Fish and Their Habitat* (Pacific Scientific Advice Review Committee – PSARC – research document HAB 99-1), (Ottawa, ON: Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat, 1999).

[42] Alberta Energy and Utilities Board, *Pipeline Performance in Alberta 1980–1997* (report 98-G), (Calgary, AB: Alberta Energy and Utilities Board, December 1998).

[43] Forest Ecosystem Management Assessment Team, *Forest Ecosystem Management Assessment Team Report* (sponsored by USDA Forest Service, U.S. Environmental Protection Agency, USDOI Bureau of Land Management, National Park Service), (Portland, Oregon: FEMAT, 1993).

(all found in northern British Columbia). The result is a spider web of development on the land and increased pressures offshore: thousands of kilometres of roads, seismic lines and pipelines; cleared land to house equipment; and increased vehicular and tanker traffic for all phases of development — from construction of infrastructure to delivery of products to market.

## 3.7 Potential Impacts from Pipelines

To install a pipeline, plants and trees are cleared in a wide corridor, or right-of-way, of 10–30 metres. In some cases, roads must be created along the length of the corridor to allow crews to install and service the pipeline. This corridor must remain clear as long as the pipeline is operating.

During pipeline construction, as vegetation is removed and soil is disturbed, the land is fragmented, which can result in erosion and the sedimentation of nearby water bodies. Sedimentation can cause negative impacts such as higher water levels (flooding and habitat damage) and increased nutrient levels. Sedimentation can also cover critical habitat for fish and insects.[44] Pipelines may also have to cross waterways. For example, Enbridge's proposed Gateway Pipeline across northern B.C. is expected, if it proceeds, to cross at least 870 streams and rivers. Depending on the design of these crossings, they may damage sensitive shoreline areas, increase sedimentation and change water flow patterns.

**Figure 3.6 Aerial photo of oil spill in the Pine River, August 2000**
Photo: West Moberly First Nations

Once a pipeline has been constructed, it is checked for leaks and stability by hydrostatic testing: water is injected into a pipe at a higher pressure than the required operating pressure for which the pipeline is designed. After a pipeline has been tested, all of the water is removed before any hydrocarbons are piped through it. A source for the test water must be identified. Drawing on a water source that supports fish (especially over winter, a common season for pipeline construction and testing) or other important habitats should be avoided but often is not. When water has flowed through a pipe, it is contaminated with different dusts, paints and other compounds found in a newly installed pipe. If a pipe ruptures under a hydrostatic test, there can be impacts to the surrounding vegetation or water bodies. The temperature of the water used, as

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[44] Wilson and Severson-Baker, 18.

well as the pressure at which it is released, can contribute to soil erosion, and water body contamination.

When hydrostatic testing is used to check older pipelines, water may require treatment before being released into water bodies. It may also require more extensive sampling than water used to test new pipelines.[45]

Once a pipeline is built, leaks can be a significant source of water contamination. Small leaks can go undetected for a long time since they do not change the pressure in the pipeline enough to be detected. Even small leaks can result in surface and groundwater contamination.

Back in August 2000, an oil pipeline of the Pembina Pipeline Corporation (no connection to the Pembina Institute) ruptured near Chetwynd, B.C (see Figure 3.6). The spill released about one million litres of crude oil into the Pine River, killing thousands of fish and eliminating aquatic insects (an important food for fish) from the area. Fish populations 20 kilometres downstream of the rupture point also suffered major impacts. Fishery biologists from the Ministry of Environment estimated that tens of thousands of fish died as a result of this incident. It took two years for the spill to be cleaned to provincial standards and for fish stocks to return to normal levels.[46]

## 3.8 Marine Impacts from Offshore Oil and Gas Development

The environmental impacts of oil and gas development on marine ecosystems are primarily caused by seismic testing, drilling platforms, and the shipment of oil and gas products by tanker ships.

### 3.8.1 Impacts from Seismic Testing

Seismic testing would be the first step in the establishment of an offshore oil and gas industry off the B.C. coast. This process involves an array of air guns (as many as 35) blasting high pressure air at the seabed. This high pressure air releases sound waves at extremely intense levels, and could be fired as frequently as every 10 seconds, 24 hours a day. The pressure waves bounce off the rock below the seabed and indicate the most likely location of oil and gas reserves.

Concern exists about the effect of seismic testing in the marine environment. The International Whaling Commission (IWC) has expressed concern about the consequences of seismic testing on large whales[47] and the Department of Fisheries and Oceans (DFO) also recognizes the potential for detrimental consequences.[48] DFO reports the potential impacts of seismic testing to include: decreased catch rates, interference with fish spawning, space conflicts with existing fishing

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[45] TERA Environmental Consultants (Alta.) Ltd. and CH2M Gore and Storrie Ltd., "Hydrostatic Test Water Management Guidelines" (report prepared for Canadian Association of Petroleum Producers and Canadian Energy Pipeline Association, September 1996), http://www.capp.ca/raw.asp?x=1&dt=PDF&dn=25023

[46] Presentation by Ministry of Water, Land and Air Protection official at an Insight Conference on Environmental Law, Vancouver, Fall 2001.

[47] IWC Agreement on Ocean Noise, Science Committee, 2004.

[48] DFO, 2004. Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004.002.

activities, mortalities in a number of species and a number of life stages; and possibly change in marine mammal movements.[49]

The noise generated by seismic surveys is among the loudest in the marine environment, and can be detected hundreds of kilometres away. In addition to the fish impacts mentioned in section 3.5, potential impacts from coastal seismic testing include:

- Damage to the internal organs and limbs of snow crabs, as well as changes in behaviour. [50]
- Damage to fish hearing, with no evidence of repair up to 58 days after air gun exposure.[51]
- Decrease in fish catch rates during seismic testing by as much as 50 to 70%; the duration of the decrease in catch rates is unknown. [52]
- Behavioural changes in marine mammals. In one study, orca and baleen whales stayed away from the seismic vessel, fin and sei whales fed less and surfaced more frequently during seismic testing.[53] Evidence suggests that high-intensity sound from sonar and airguns leads to strandings and subsequent mortality of beaked whales. [54]

### 3.8.2 Impacts from Drilling Platforms

Discharges from well drilling are another serious impact of offshore development. Cuttings from the drilling process form the largest part of the discharges and often contain drilling muds, heavy metals, and even naturally occurring radioactive materials dug up from the ocean floor. Drilling wastes are disposed of directly into the sea, back into wells or onshore. These cuttings affect the local environment by burying the sea floor, smothering small aquatic species, reducing light penetration and increasing turbidity (stirring up particles in the water).[55] Other discharges include those from hydrocarbon extraction, miscellaneous routine activities, and spills. In an analysis of the Cook Inlet in Alaska, small oil spills associated with offshore development — spills of less than 1,000 barrels — are expected to total 484 over 25 years.[56]

Blowouts can also result in significant impacts. Blowouts occur when the pressure inside the well during drilling exceeds the capacity of the safety device, releasing oil and gas into the marine environment. Blowouts are most likely to occur during the exploration phase.[57]

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[49] Boudreau et al. 1999. Maritime Region, 1999. The Possible Environmental Impacts of Petroleum Exploration Activities on the Georges Bank Ecosystem. Can. Tech. Rep. Fish. Aquat. Sci. 2259, p. 56

[50] DFO, 2004. Potential Impacts of Seismic Energy on Snow Crab. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004/003.

[51] R.D. McCauley et al. 2003. High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America 113: 638-642.

[52] A. Engas, Lokkeborg, S., Ona, E. and Vold Soldal. 1996. Effects of seismic shooting on local abundance and catch rates of cod and haddock. CJFAS 53:2238-2249.

[53] C. Stone, 2003. The Effects of Seismic Activity on marine mammals in UK waters, 1998-2000, JNCC Report No 323.

[54] Hildebrand, J. Marine Mammals and Sound, Prepared for the Marine Mammal Commission, 2003.

[55] Ibid**.**

[56] Ibid.

[57] Hertzog

Offshore development also contributes significant amounts of air pollution. Emissions from engines, well fluid burning, flaring and venting all contribute nitrogen oxides, sulphur oxides, carbon monoxide, carbon dioxide, particulate matter, unburned hydrocarbons, volatile organic compounds and hydrogen sulfide to the atmosphere.[58]

### 3.8.3 Impacts from Tankers and Shipping

Many of the new energy projects planned for northern B.C. require tankers to pass through provincial waters. With an increase in tanker traffic, oil spills will be inevitable, affecting fish, marine mammals, seabirds and other marine life.

According to Environment Canada, 100 small, 10 moderate and one major spill is predicted every year based on current levels of tanker traffic in Canada. A catastrophic spill — a spill of over 72,000 barrels — is predicted once every 15 years.[59] Even with modern technology, recovering 15% of the oil spilled from major tanker accidents is considered successful.[60]

Internationally, between 1974 and 1999, there were 278 oil tanker spills greater than, or equal to, 1,000 barrels of crude oil. During the same time period, 46 tanker spills of at least 1,000 barrels of crude oil occurred in U.S. waters, including 11 spills associated with crude oil transportation from the Alaskan North Slope.[61]

With increased tanker traffic, oil spills are the most significant environmental concern, the devastating impacts of which are known. A familiar example is the *Exxon Valdez* spill of 1989 that spilled over 11 million gallons (over 40 million litres) of crude oil into Alaskan waters. An estimated 2,800 sea otters, 250,000 birds, 1.9 million salmon and 12.9 billion herring were killed. A 2003 study found lingering effects on local marine life in the area, even 14 years after the spill.[62]

If plans to import condensate, a petroleum product used in tar sands production, proceed as discussed in Section 2.2 of this paper, condensate will travel by tanker to Kitimat, B.C. Condensate is toxic to marine life. It kills organisms immediately but evaporates more quickly than oil.[63] The impacts of a condensate spill on marine life have not been well researched.

Other threats from increased tanker traffic include air pollution and the introduction of non-native marine species from the discharge of the large amounts of water (known as ballast water) that stabilize the ship and are carried from other ocean regions.[64]

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[58] Offshore Oil and Gas Research Group.

[59] Environment Canada, *2003 Facts and Figures — Oil, Water and Chocolate Mousse* (Ottawa, ON: Environment Canada, 2004), http://www.ec.gc.ca/ee-ue/pub/chocolate_e/toc.asp

[60] L. Clarke, "Oil Spill Fantasies," *The Atlantic Monthly*, Nov. 1990, 65–77. See also *The International Tanker Owners Pollution Federation Handbook 2003/2004* (London, England: International Tanker Owners Pollution Federation, 2004), 14.

[61] T. Gunton et al, *Managing Impacts of Major Projects: An Analysis of the Enbridge Gateway Pipeline Project* (Vancouver, B.C.: Simon Fraser University School of Resource Management, 2005).

[62] C. Peterson et al, "Long-Term Ecosystem Response to the Exxon Valdez Oil Spill," *Science* 302 (2003): 2082–86.

[63] Merv Fingas, Chief, Emergencies Science Technology, Environment Canada, personal communication, September 2006.

[64] Global Ballast Water Management Programme.

# 4. Renewable Energy and Energy Efficiency in British Columbia

Energy projects can unfold in ways that respect the land and respect communities. Renewable energy, such as wind, run-of-river hydro and biomass, are supplied by sources that will not dry up or run out. Energy efficiency is not linked to a specific energy source, but rather an approach that allows communities to heat homes and power lights and appliances with less energy. Opportunities to harness renewable resources and improve energy efficiency are abundant in B.C., and they can sufficiently meet our energy needs with low environmental impacts. These opportunities do not exist only in B.C.: as illustrated in Figure 4.1, the development of renewable energy projects has been accelerating exponentially on a global scale.

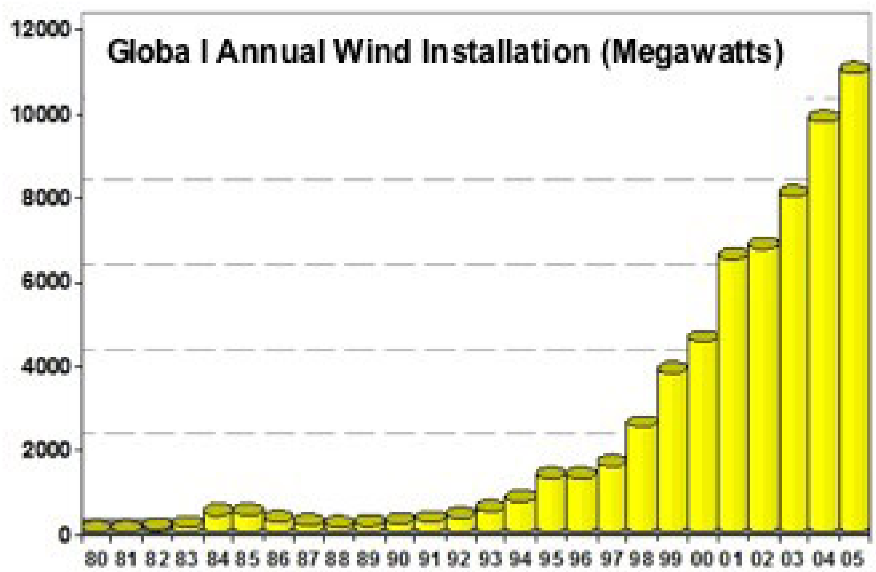


**Figure 4.1 Increase in the global development of wind energy from 1980–2005**

Renewable energy projects can be implemented on a large scale where energy is sold to B.C. Hydro or other communities. They can also be implemented on a much smaller scale by reducing or eliminating a small community's need for diesel generators. Regardless of the scale, these projects can produce real economic and environmental advantages for communities that can replace or reduce their dependence on oil and gas resources. For many community leaders, renewable energy projects offer an opportunity to advance a positive vision of the future, and a means to ensure the protection of traditional territories.

This section provides an overview of the opportunities, benefits, challenges and potential impacts of some of the most promising renewable energy and energy efficiency options in B.C.

## 4.1 The Opportunities

The opportunities for renewable energy and energy efficiency in B.C. are diverse and abundant, and they range from emerging technologies to those that are market-ready (i.e., already competitive with conventional energy). This section explores the opportunities that are most viable today and that have the broadest applicability across the province: that is, electricity generated from wind, run-of-river hydro and biomass resources as well as energy efficiency.

The opportunities beyond the scope of this paper include electricity generated from the sun, the tides and the earth's heat; heat generated from the sun, the earth or biomass; and fuels produced from forestry or agricultural wastes. Although these are economically viable options, they do not have the widespread potential of wind, run-of-river hydro, biomass, or energy efficiency. In the right conditions, they could become attractive to communities. For example, geothermal electricity projects, which generate electricity from heat in the earth, are proving to be very promising in some areas of B.C., as the Meagher Creek project north of Pemberton has illustrated. Heat and electricity generated from the sun is another one of the less prominent renewable resources that deserves mention. While these technologies are not suited to large-scale developments in B.C., in an individual household, small solar systems can help meet heat and electricity needs at a reasonably low cost.

**Measuring Electricity**

**1 Gigawatt = 1,000 Megawatts = 1,000,000 Kilowatts**

- These are all measures of how much electricity is being generated or consumed at a single time. For example, since it takes 20 watts of electricity to turn on a typical compact fluorescent light bulb, a one Megawatt wind turbine could turn on 50,000 bulbs.

**1 Gigawatt-hour = 1,000 Megawatt-hours = 1,000,000 Kilowatt-hours**

- These are all measures of how much electricity is being generated or consumed over a period of time. Although there is significant variation from home to home, a typical home will use 10,000 kilowatt-hours per year. B.C. Hydro supplied almost 58,000 gigawatt-hours in 2006, enough for 5.8 million homes.

Focusing on wind, run-of-river hydro, biomass, and energy efficiency, B.C. has already developed, or is in the process of developing, enough renewable energy resources to meet the needs of hundreds of thousands of homes in the province. Many more projects are already under development, and as Figure 4.2 illustrates, these resources are abundant when compared to the amount of new electricity B.C. Hydro expects to need over the next ten years. Some observers believe the potential for renewable energy in the province is even greater. For example, the B.C. Sustainable Energy Association claims that renewable electricity projects in B.C. could generate 84,000 gigawatt hours per year, which is almost one and half times more than B.C.'s current total electricity use.

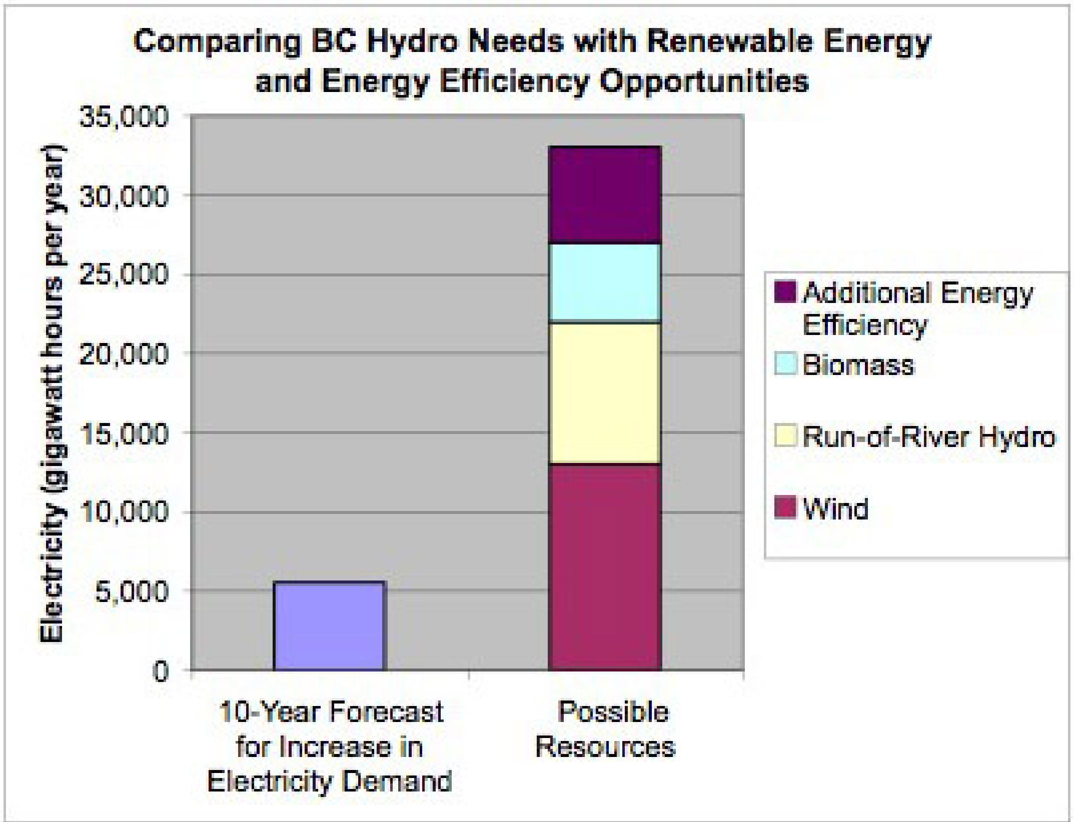


**Figure 4.2 A comparison of B.C. Hydro's expected increase in electricity demand with renewable energy and energy efficiency opportunities**[65]

### 4.1.1 Wind

**Figure 4.3 Wind power is an abundant source of renewable energy**
Photo: Matane

Wind projects rely on wind to turn large turbines (of up to 100 metres tall) that generate electricity when they spin. In sites with strong and consistent winds, they can be important components of electricity supply. B.C. Hydro estimates that wind projects on the North Coast

[65] This ten-year forecast already includes the expected savings from B.C. Hydro's energy efficiency activities as outlined in their 2005 integrated electricity plan.

could generate over 8,000 gigawatt hours per year, and that an additional 5,000 gigawatt hours per year could be generated by projects in the Peace region. These amounts could generate enough power to supply 1,300,000 homes — or the number of homes in Greater Vancouver and Vancouver Island.

### 4.1.2 Run-of-river Hydro

**Figure 4.4 China Creek run-of-river hydro project**
Photo: Hucapasath First Nation

Run-of-river hydro projects divert water from a river through a generator to produce electricity. They do not require a dam or reservoir, and the amount of water diverted does not compromise the health of the river. Because these projects are limited to times when water flows are naturally high, they do not provide power on-demand in the way a large hydro project can. B.C. Hydro estimates that there is an additional 9,000 gigawatt hours per year of small hydro potential in B.C., the majority of it located in mountainous coastal areas. Tapping this potential could produce enough energy to power almost 900,000 homes.

### 4.1.3 Biomass


**Figure 4.5 A wood chipper processes biomass**
Photo: Peterson Pacific Corp

Biomass electricity projects burn wastes from forestry and agriculture operations to convert water to steam, which in turn powers a turbine to produce electricity. Burning wood waste from forestry operations is the most abundant biomass resource in the province. B.C. now has over 750 megawatts of production in place, primarily at sawmills throughout the province. B.C. Hydro estimates that there are over 1.6 million tonnes of wood residues that could potentially be used in biomass generation projects, resulting in up to 5,000 gigawatt hours per year, or enough energy to power almost 500,000 homes.

### 4.1.4 Energy Efficiency

Energy efficiency involves reducing the need for energy instead of increasing the supply. It requires a broad approach that involves small reductions across many different energy uses. Although energy efficiency is challenging, it is critical to any discussion of the future of energy because the total potential for energy savings is significant, and it can often be pursued at less cost and with less impacts than renewable energy projects. For example, according to B.C. Hydro's review of conservation potential, B.C. could reduce energy consumption by an additional 6,000 gigawatt hours per year for less than it costs to provide new supply.

Because they are above and beyond what B.C. Hydro is already pursuing, these improvements are not necessarily easy to achieve, but they would free up enough of our existing supply to meet the needs of 600,000 homes. From a community perspective, energy efficiency does not usually represent a significant economic development opportunity, but it can help residents and businesses reduce their energy costs and environmental impacts, and reduce their exposure to fluctuating energy prices.

**Figure 4.6 Installing new windows in a home is one means of improving energy efficiency**

## 4.2 The Benefits of Low-Impact Renewable Energy

Low-impact renewable energy projects provide a number of economic and environmental benefits: new employment opportunities, new revenue for a community, protection of local air quality, and protection against the impact of global warming.

### 4.2.1 New Employment Opportunities

Because of the skilled labour required to plan, develop and maintain a renewable energy project, these projects often create new employment opportunities. As renewable energy is further developed in B.C., it can be expected to create many new short-term and long-term jobs for the province. Table 4.1 estimates the number of construction and operating jobs that three different renewable energy projects could generate over a construction period of one year.

In other words, a 100-megawatt wind project consisting of 75 turbines would employ 98 people during the year it takes to build the project; then it would require 10 full time workers to operate and maintain it on an on-going basis. A 100-megawatt project is comparable in size to many of the developments being pursued in B.C. today.

| Renewable Electricity Type | Development & Construction (Jobs per 100 megawatts)* | Operation & Maintenance (Jobs per 100 megawatts) |
|---|---|---|
| Wind | 98 | 10 |
| Run-of-river hydro | 108 | 22 |
| Biomass | 200 | 95 |

**Table 4.1 Employment Potential of Different Renewable Energy Projects**
*Assuming a one-year construction time[66]

### 4.2.2 New Revenue for a Community

The value of the energy produced and its associated environmental benefits can generate revenue for a community. In terms of electricity sales, B.C. Hydro recently signed contracts for 36 renewable energy projects. Once they are operational, they will cost B.C. Hydro approximately $400 million per year — an average of more than $11 million per year for each project. A local community could directly collect a portion of a project's revenue, or it could work in partnership with an independent power producer and collect a royalty on electricity sales. The Squamish-Lillooet Regional District, for example, requires all power projects to share approximately 2–4% of their revenue with the district.[67]

In addition to the value of the electricity, companies and individuals are beginning to place value on the environmental benefits of green energy. For example, based on data from a survey of green power programs, green power certificates are being sold for $20 to $30 per megawatt hour to companies and individuals that want to reduce their greenhouse gas emissions.[68] This represents more than a 25% premium on the value of the power.[69]

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[66] The Pembina Institute, "Renewable and Alternative Energy Options for British Columbia" (Resource Development in the North fact sheet), (Calgary, AB: The Pembina Institute, October 2006).
[67] Squamish Lillooet Regional District, "Independent Power Project Development in the Regional District" (Squamish Lillooet Regional District Policy, July 2003).

[68] Green Power Certificates represent a certified reduction in greenhouse gas emissions that result from the supply of renewable energy (such as energy generated from wind, solar or biomass) to the electricity grid instead of polluting energy sources such as natural gas or coal. You can demonstrate your preference for green power by purchasing Green Power Certificates, which support the production of renewable energy.

[69] M. Bramley and J. Whitmore, *Survey of Green Power Programs* (Calgary, AB: The Pembina Institute, 2004).

### 4.2.3 Protection of Local Air Quality

Renewable power generation can protect local air quality because there are fewer emissions of toxic contaminants such as nitrogen oxides, sulphur dioxide, particulate matter and mercury than there are with natural gas or coal-fired electricity generation. Energy efficiency, wind and run-of-river hydro projects have negligible impact on local air quality. Biomass projects, however, do have the potential for local air emissions, making location and pollution-control technologies an important consideration when developing biomass projects.

### 4.2.4 Protection Against the Impacts of Global Warming

By eliminating the need for electricity projects that produce large amounts of greenhouse gas emissions, such as oil, gas or coal-fired power projects, renewable energy projects help protect against the impacts of global warming. Many renewable energy opportunities, such as wind and hydro, have no harmful greenhouse gas emissions. Although burning wood waste does produce greenhouse gas emissions, their impacts overall are less than those associated with oil and gas development. Renewable electricity projects in B.C. cannot solve the global warming problem, but they can be part of the solution.

## 4.3 The Challenges

Since renewable energy projects are relatively new to B.C., and especially those that are developed by communities, there are still challenges involved in putting project ideas into practice. The key challenges — a lack of access to the transmission grid, high capital costs and intermittent supply — are already being overcome in many communities.

### 4.3.1 Lack of Access to the Transmission Grid

Many of the best renewable energy sites (windy areas, for example) are not close to the existing electricity transmission grid, and the costs of making that connection can be high. Given B.C.'s geography, this challenge will not disappear, but spreading the cost of transmission across a cluster of projects that share a single transmission line can help make it manageable. For example, a community could spread the costs across a number of shared facilities or projects in order to overcome this barrier and make access to the transmission grid more affordable. While a project may not be able to proceed on its own because of the cost, a number of small projects clustered together can make the economics of the project much more manageable.

### 4.3.2 High Capital Costs

The cost of developing a green energy project is typically dominated by capital costs — the costs required to get the project up and running. Once the project is built, there are no significant fuel or operating costs. Despite high start-up costs, securing financing is not seen as a significant barrier to most project developers. The market for green energy projects is strong and getting stronger, and most projects are able to obtain financing once they have secured a long-term agreement with B.C. Hydro. For example, B.C. Hydro recently signed agreements to purchase power from 36 new hydro, biomass and wind projects that will provide upwards of 1,200 megawatts of capacity when completed. With agreements in place, all of these projects were able to secure the financing they need.[70]

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[70] B.C. Hydro, B.C. Hydro Resource Options Report (Vancouver, B.C.: B.C. Hydro, 2005).

### 4.3.3 Intermittent Supply

Most renewable energy projects only produce electricity when the resource is available (when the wind is blowing or when the sun is shining, for example); consequently, unlike conventional electricity, renewable energy projects are only available intermittently. An intermittent supply presents a challenge because the times we need electricity do not necessarily match up with the times that it is available from natural sources.

B.C. has an extensive network of existing large hydro dams that can be used to generate electricity when renewable resources are not available and to store it when they are. In addition to using existing dams to complement renewable options, other types of storage solutions, such as batteries, are becoming more and more cost-effective. Intermittent resources can also be combined with renewable resources that are not intermittent — biomass, for example. With this range of potential solutions, the intermittency of some renewable resources does not present an insurmountable challenge to meeting provincial electricity demands.

As communities continue to express more interest in renewable energy, the better B.C. will become at understanding and managing these challenges, and the sooner renewable energy will be a common source of electricity for all of us. For communities that are taking steps towards low-impact renewable energy projects, there are many lessons to be learned from the communities that have already begun to develop their resources.

## 4.4 The Impacts

No energy project is impact free, and renewable energy projects are no exception. All renewable energy projects require land for a generating facility and transmission lines. Negative environmental impacts can result from construction and the shipment of materials and parts. On their own, these impacts are typically minor, but as discussed earlier, cumulative impacts are an important consideration, and renewable energy is no exception. For example, the Squamish-Lillooet Regional District has expressed its concern over the scale and pace of run-of-river development on streams in the district.

A well-planned renewable energy project will offer more benefits than oil or gas projects, and result in far fewer impacts. The following impacts need to be considered when investigating potential renewable energy projects.

### 4.4.1 Impacts of Wind Projects

The shadows and noise generated by turbines can be disturbing to people living near wind projects. Best practices can ensure that projects are not situated in areas where these impacts are noticeable. Some wind projects have resulted in impacts on bird and bat populations due to the animals colliding with the towers or blades. Although these impacts have been minor in the vast majority of projects, prior to proceeding with any project, a community should understand how birds and bats currently use an area and how they might be affected by the project. Finally, the appearance of wind turbines is unattractive to some. This can be a challenging issue for communities and is best addressed through open discussion about a proposed project.

### 4.4.2 Impacts of Biomass Projects

Biomass projects do result in local air emissions that can negatively affect human health and the environment. These impacts can be mitigated through proper siting and using the best available emissions controls, but in the end, some areas will not be suited to biomass development.

Although the footprint of a biomass facility is typically quite small, the land base needed to support a project can be a concern. When considering a possible biomass project, a community needs to actively explore the source of the biomass, know and accept the impacts on the forest, and ensure that trees will be replanted responsibly.

### 4.4.3 Impacts of Run-of-River Hydro Projects

Although run-of-river hydro projects do not require a dam, they do divert water from the stream for a short distance to generate electricity. The stream can experience impacts up to the point where the water is returned, and it is important for communities to understand how reduced water levels will impact the resident species. Many projects deal with these challenges by ensuring that water is returned to the stream above natural impediments to fish — large waterfalls, for example — so that the overall negative effects are minimized.

# Appendix A: Mitigating Impacts of Oil and Gas

Although no oil and gas development takes place without creating some negative impacts, certain technologies and practices can be used to reduce impacts below business-as-usual practices. While not exhaustive, the twelve practices discussed in this Appendix can provide companies with a good starting point for more responsible oil and gas development:

1. Develop land use plans and ecosystem stewardship plans.
2. Establish thresholds.
3. Map out protected areas.
4. Address land reclamation.
5. Minimize land use.
6. Opt for low-impact seismic exploration.
7. Manage waste disposal.
8. Reduce risk of groundwater contamination.
9. Reduce surface water impacts.
10. Reduce air impacts.
11. Reduce hazards from sour gas.
12. Limit noise.

It is important for stakeholders to be aware that these practices exist and to suggest them to companies who, otherwise, may not volunteer to use them. The series of questions listed for each practice is suggested to guide you in determining and evaluating what is being proposed in a certain area.

## 1. Develop Land Use Plans and Ecosystem Stewardship Plans

Although not mandatory, companies seeking natural resources in an area should be encouraged or legislated to collaborate on long-term development plans to help reduce the number of facilities and the scale of infrastructure. The sharing of facilities and infrastructure can help to reduce and minimize land impacts.

First Nations were not involved in the original design of provincial land use planning processes. Through the New Relationship in 2005, First Nations and the Province committed to developing new, shared approaches to land planning and management. Generally speaking, First Nations and the Province view land use and planning, or ecosystem stewardship, from different world views. Consequently, they often use different concepts and terminology to articulate their interests and perspectives.

Many First Nations are seeking to undertake their own unique planning processes, and some use the phrase “ecosystem stewardship planning” to differentiate their efforts from those of the B.C. government. Ecosystem stewardship planning refers to planning and management decision-making that is culturally relevant to First Nations and that reflects their unique connection with land and resources and their inherent responsibility to care for the interconnectedness of the land, water, air, people, animals and fish in a manner consistent with their spiritual beliefs and values.[71]

To ensure that new development meets First Nations concerns and interests, it is important to have an ecosystem stewardship plan in place prior to development.

**Questions to Ask**

- Is there a land use plan in place? If so, does it contain limits to development?
- Have First Nations provided their free, prior and informed consent to the land use plan? If not, are they engaged in a process to reconcile differences with the Province?
- Are companies coordinating with each other to minimize the total amount of area disturbed and infrastructure required?

## 2. Establish Thresholds

A threshold is the maximum amount of development that a natural environment can sustain while still maintaining healthy ecosystems. Thresholds should be determined using both scientific and traditional ecological knowledge and should then be approved by stakeholders and integrated into land use plans.

Cumulative effects assessments need to be done *before* development occurs. These assessments help communities weigh the cost and benefits of development and decide what level of impact is acceptable. Monitoring programs are critical to understanding the changes on the land that result from development.

To ensure that important environmental and social conditions are maintained or improved in a region:

- Set simple, meaningful thresholds based on existing data. Do not waste time determining exact numbers. Instead, determine what is an acceptable trade-off.
- Ensure responsible authorities have access to resources to enforce thresholds and that they are legally binding.
- Do not approve developments in the absence of thresholds.
- Use thresholds to facilitate development by providing certainty of access.

**Questions to Ask**

- Have suitable thresholds been developed for the entire region to properly assess potential impacts?
- What thresholds is the company using?
- What monitoring programs are being proposed? What plans or laws are in place to deal with the exceedance of a given threshold?

[71] First Nations Leadership Council briefing note, February 2007.

## 3. Map Out Protected Areas

Map out protected areas in a region prior to beginning any new development. This includes areas with traditional-use areas, burial grounds, ancient artifacts, ecological sensitivity, prime wildlife habitat, waterways or rare plants. Sensitive areas such as floodplains, river banks, lakeshores, wetlands and areas subject to severe erosion can be avoided.

**Questions to Ask**

- Is the development going to be located near waterways? How far away are the nearest waterways?
- What measures will be taken to minimize impacts on waterways from the proposed developments?
- What is being done to avoid sensitive areas? For any sensitive areas that are not avoided, what are the setbacks from these areas?
- How were these setbacks determined? Is there evidence from development elsewhere that this project will not result in unacceptable negative impacts?

## 4. Address Land Reclamation

The life of an oil or gas project can be anywhere from 10–40 years. The reclamation procedures that follow the completion of a project are not consistent, nor are they undertaken in a timely fashion. If topsoil is appropriately stored after it is removed, land can be reclaimed closer to its natural state after operations are complete. In some cases, reclamation regulations require a site to be returned to a natural state but not to its original state. For example, seismic lines through forested areas may be returned to grass rather than planted with native tree species.

**Questions to Ask**

- When and how will the site be reclaimed?
- Will topsoil be stored? How and for how long?
- What will the site be reclaimed to? What species will be planted compared to what existed before?

## 5. Minimize Land Use

Wherever possible, current roadways, pipelines and seismic lines or previously disturbed areas should be used before new areas are disturbed. To minimize the total amount of land disturbed, multiple wells should be drilled from the same well pad wherever possible. It is especially important to reduce well pad density for coalbed methane operations.

**Questions to Ask**

- How many wells will be drilled?
- Is the company using existing infrastructure and previously disturbed areas?
- Can directional drilling be used to avoid sensitive areas and to drill multiple wells from one pad? If not, why not?

## 6. Opt for Low-impact Seismic Exploration

To decrease the impact of seismic exploration on wildlife and prevent surface erosion, crews can use hand tools or small mulchers to create meandering rather than straight cutlines that are less than two metres wide. They can leave chips and brush on-site to prevent surface run-off. This approach can help reduce the negative impacts to wildlife associated with linear disturbances. It can also reduce the human use of an area.

**Questions to Ask**

- What are the widths of the proposed seismic testing cutlines?
- What equipment will be used to perform the seismic testing?
- Will any vegetation be cleared for seismic lines? If so, how will the seismic lines be cut?
- What are the predicted impacts for wildlife? What measures are being taken to minimize the effect on local wildlife?

The detonation of seismic charges to create sound waves can injure fish. To protect fish, suitable setbacks (safe distances) from fish-bearing streams and lakes should be agreed upon.

**Questions to Ask**

- Will explosive charges be used for seismic testing?
- If so, at what setback will they be from waterways?
- How were these setbacks determined?

## 7. Manage Waste Disposal

Drilling waste and other contaminants that are not stored properly can be a source of leaks or spills. The risk of soil contamination from drilling muds can be reduced by temporarily storing drilling waste on-site using tanks or bins before trucking it to an approved landfill.

**Questions to Ask**

- What is your company’s record of leaks and spills? What have you done to reduce the risk of spills and leaks?
- How will drilling wastes be disposed of?
- If drilling wastes are to be stored on-site, how will they be stored?

When wildlife can freely access an oil or gas well site, they will eat and drink unnatural substances and contaminated water. Wildlife can be protected by effectively fencing off and isolating areas that have been contaminated and those that contain dangerous compounds; and by keeping well sites clean and removing, or effectively containing, dangerous compounds.

**Questions to Ask**

- How will local wildlife populations be protected from coming in contact with toxic substances?
- If fencing is put up, who is in charge of maintaining it? How often will its intactness be checked?
- When will dangerous compounds be removed from the area?

## 8. Reduce Risk of Groundwater Contamination

Nearby water wells can be tested before, during and after operations. Surface casing should be set below the base of groundwater protection and cemented to the surface.

**Questions to Ask**

- Will water wells be tested before drilling operations begin?
- What measures are being taken to protect groundwater?

## 9. Reduce Surface Water Impacts

Produced water and drilling wastes can contain salts that are toxic to vegetation and severely compromising for soil integrity. Produced water can be disposed of using deep well injection or by transporting it off-site.

**Questions to Ask**

- How will the local vegetation and soils be protected?
- Is produced water expected from this well? If so, is it expected to be salt or freshwater? How will it be disposed of?
- Do the drilling muds contain salts?

To decrease impacts to waterways and fish habitat, stream crossings should be at 90 degrees (i.e., perpendicular) to the stream. They should not decrease the width of the channel, and they should leave the banks intact. Customized practices should be developed to benefit each individual river crossing. In some cases, the best option is to build pipelines underneath streams or rivers. In other cases, an above-ground option may result in the least impacts.

**Questions to Ask**

- What rivers and streams will be crossed by roads or pipelines?
- What efforts are being made to minimize stream crossings?
- What measures are being taken to minimize their impact on the environment?

## 10. Reduce Air Impacts

Flaring and running equipment are two main sources of air pollution. Flaring can be minimized whenever possible by diverting small quantities of gases into tanks or pipelines. Flare times can be reduced to the minimum amount of time needed to assess the reservoir potential — often this can be narrowed down to hours rather than days.

**Questions to Ask**

- Will flaring be conducted for this well?
- Can the well be tested in-line? (i.e., by connecting the well into existing pipelines)
- How long will flaring be required in order to establish flow characteristics?
- Who will the company notify before flaring takes place? How long before?

The use of engines that run on natural gas instead of diesel can reduce the emissions associated with on-site engines.

**Questions to Ask**

- What equipment will be permanently on-site? (pumps, compressors, etc.)
- What measures are being taken to minimize air emissions from these sources?
- What measures are being taken to minimize vehicular traffic? What measures are being taken to minimize dust production from these vehicles? (e.g., spraying roads with water)
- Will greenhouse gas emission credits be purchased to offset the emissions produced by this development?

## 11. Reduce Hazards from Sour Gas

Special operating procedures are required for sour wells to reduce the hazards of hydrogen sulfide gas ($H_2S$). However, because regulations are often set on a per well basis, wind direction and many wells can lead to a disproportionate amount of $H_2S$ in one area.

**Questions to Ask**

- Is this well a sour well?
- What is the concentration of H2S that will be released from this site?
- How many H2S wells are already in the area? How many more are likely in the future?
- What measures are being taken to minimize the risk of local releases of H2S?

## 12. Limit Noise

To limit noise disturbance to wildlife or nearby residents, noise from compressors and pumps can be minimized with sound-reducing enclosures or engine silencers.

**Questions to Ask**

- What sources of noise will be present during construction and during production?
- How is noise being minimized so as not to impact local wildlife populations?
- Are sensitive life stages for local wildlife being taken into consideration? (breeding seasons, birthing seasons, etc..