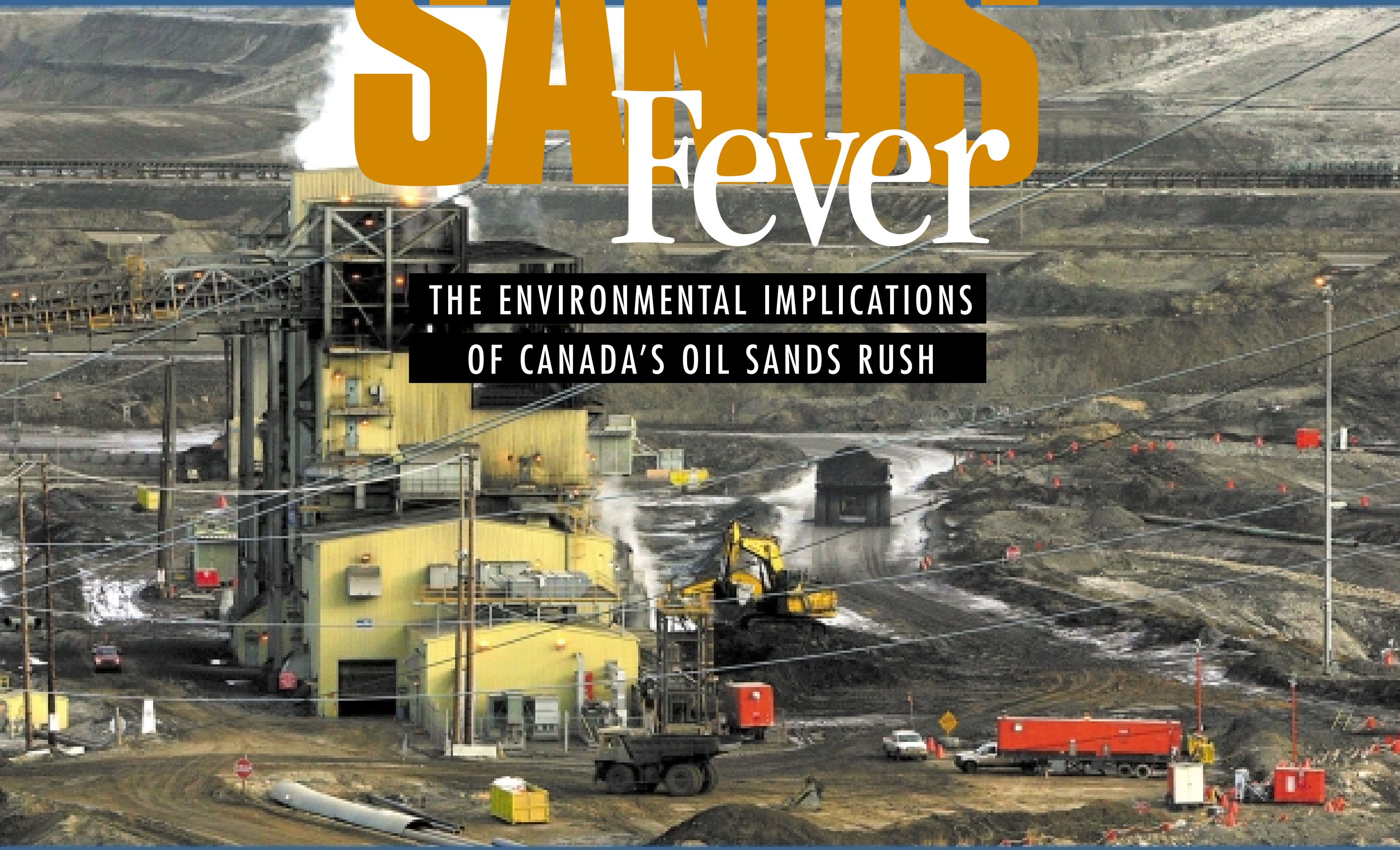
Oil SANDS Fever

THE ENVIRONMENTAL IMPLICATIONS OF CANADA'S OIL SANDS RUSH



BY DAN WOYNILLOWICZ

CHRIS SEVERSON-BAKER • MARLO RAYNOLDS

November 2005

the PEMBINA institute

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The Pembina Institute creates sustainable energy solutions through research, education, advocacy and consulting. 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 **www.pembina.org** or by contacting **info@pembina.org.**

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PHOTOS: DAVID DODGE, THE PEMBINA INSTITUTE

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Until recently the oil sands were a vast but largely inaccessible resource. In the last 15 years this has changed dramatically. After advancements in technology significantly improved the economics of oil sands production, government and industry implemented an ambitious strategy in 1995 to increase production. Central to this strategy were commitments by both federal and provincial governments to significantly reduce royalties and taxes to spur investment.

Ambitions of producing one million barrels per day of oil from the oil sands by 2020 have been greatly exceeded: this goal was surpassed in 2004. This intense rate of development is being driven by a steadily rising market price for crude oil, growing uncertainty about the global supply of oil and rapidly growing demand from the United States and Asia. Canada's so-called "black gold," now regarded as an abundant, secure and affordable source of crude oil, is the focus of international attention. With international attention, comes international responsibility. A feverish rush of oil sands investment and development, not unlike the gold rush that swept through North America in the 19th century, is underway. This new wealth comes at a cost.

Managing the environmental impacts arising from this pace and scale of development is a considerable challenge that must be urgently addressed, particularly in light of the new goal of producing five million barrels per day by 2030. As Alberta's northern boreal forest is torn up for oil sands development, the environmental impacts to air, land and water in Alberta are increasing rapidly. Not surprisingly, Alberta is now Canada's pollution capital for industrial air pollutants. And the oil sands are the single largest contributor to greenhouse gas emissions growth in Canada.

A more positive future is possible.

Until now the story of Canada's oil sands has only been partially told. Tales about the vast economic potential of development have been told and re-told by the oil industry, government, energy analysts and the media, but there has been a dearth of information about the environmental consequences. *Oil Sands Fever: The environmental implications of Canada's oil sands rush* fills a critical gap by providing a comprehensive overview of the impacts and making recommendations regarding their management.

The natural resources of our country are ours to decide how best to manage. This report should compel Canadians to demand that the governments of Alberta and Canada ensure that sound environmental management and protection accompany the economic opportunities arising from oil sands development. Furthermore, the intensity of energy requirements and environmental impacts of development are clear indications that we need to fundamentally re-evaluate how we produce and consume transportation fuels. Now is the time to focus our resources on implementing energy systems that allow us to restore our environment and build healthy and resilient communities.

The rapid and unconstrained oil sands expansion now before us risks squandering a publicly owned resource and creating a legacy of environmental degradation and long-term environmental liabilities. To combat these challenges and further the positive legacy desired by the public, politicians and industry, we have put forward recommendations to improve the environmental management of the oil sands while calling for an accelerated transition towards sustainable energy in Canada.

Dr. Marlo Raynolds, Executive Director
Calgary, November 2005

▲ SOURCE: PHOTO BY MELINA MARA. © 2005, THE WASHINGTON POST. REPRINTED WITH PERMISSION

1 Canada's Oil Sands Rush

1.1 Location and Scale

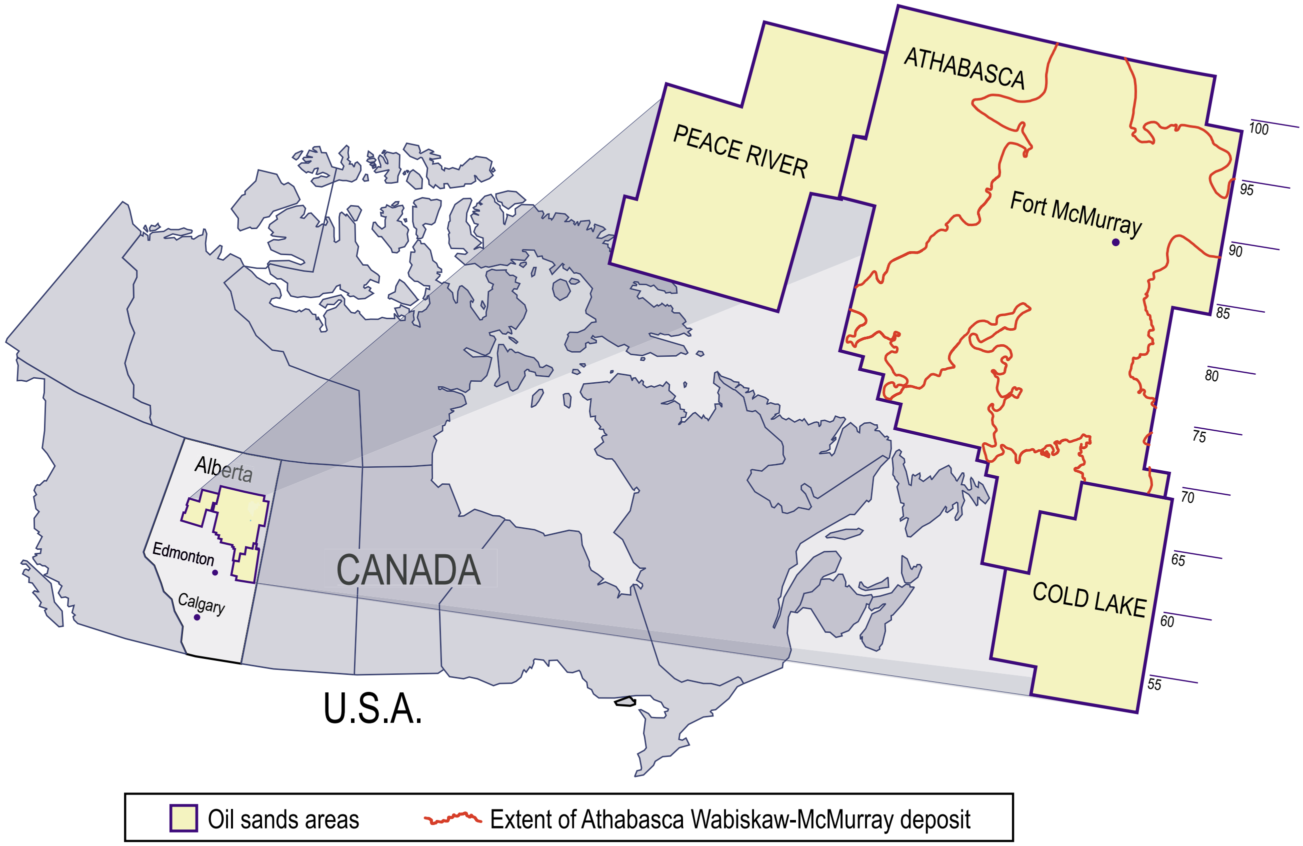

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FIGURE 1: Alberta's oil sands deposits

SOURCE: © 2005 ALBERTA ENERGY AND UTILITIES BOARD

The vast majority of Canada's oil sands are located in Alberta and underlie an area larger than Florida. Oil sands are found in three deposits: Peace River, Cold Lake and Athabasca (Figure 1, Table 1). Collectively these deposits underlie approximately 149,000 square kilometres of Alberta's northeastern boreal forest – roughly 23% of the province.[1,2] The Regional Municipality of Wood Buffalo, more specifically the city of Fort McMurray (population 61,000), serves as the regional hub for oil sands development.[3]

This report will focus on the largest and most heavily developed Athabasca oil sands deposit, which includes all the deposits that can be surface mined and extensive in situ (in place) reserves.

The Alberta Energy and Utilities Board (EUB) estimates that approximately 1.7 trillion barrels of crude bitumen (the technical term for the fossil fuel extracted from the oil sands) are in the oil sands but predicts that only 19% of this total (315 billion barrels), will ultimately be recovered. A smaller amount, 174 billion barrels, could be recovered using today's technology and under current and anticipated economic conditions. This amount is counted as established oil reserves.[4,5]

Deposit	Initial volume of crude bitumen in place (barrels)	Land area (square kilometres)
Athabasca (in situ + surface mineable)	1.37 trillion (110 billion is surface mineable)	102,610 (2,800 is surface mineable)
Cold Lake	201 billion	29,560
Peace River	129 billion	17,250
Total Oil Sands	**1.7 trillion**	**149,420**

▲ *TABLE 1: Area and bitumen resource of Alberta's oil sands deposits*[7]

1.2 A Brief History

TAR SANDS: A FUNDAMENTALLY DIFFERENT TYPE OF OIL

"It's the single largest hydrocarbon deposit on the Earth, and it's next door to the biggest market for oil products, the United States. What's wrong with it? It's crap oil.... You've got to use a lot of energy and a lot of pots and pans to extract it from the sand, and you have low-quality oil. It's a high-cost business and a lot of capital and a lot of operating costs."

Neil Camarta, former Senior Vice President, Oil Sands, Shell Canada[6]

In 1944, the Alberta government partnered with a company called Oil Sands Limited to build a pilot oil sands extraction plant at Bitumount, a site north of Fort McMurray where much early experimentation had occurred. When the costs for the construction of the plant doubled to $500,000 in 1948, Oil Sands Limited pulled out, and the government of Alberta took over sole control of the plant. After successfully demonstrating extraction of bitumen from the oil sands in 1949, the government then sold the Bitumount complex at a loss for $180,000.[8]

Commercial development did not begin until 1967 when the Great Canadian Oil Sands Company (now Suncor) started the first open pit surface mines in the Athabasca deposit.[9] In 1973, the Alberta government invested in the oil sands again by forming the Alberta Energy Company (AEC), a 50/50 partnership between the government of Alberta and its citizens. The AEC became a direct equity investor in Syncrude's original operations through an 80% ownership of the pipeline carrying oil from Syncrude to Edmonton, a 50% ownership in Syncrude's power facility and a 50% ownership in the Syncrude plant.[10] By 1978 Syncrude was also producing oil from the oil sands.[11]

For several decades, Suncor and Syncrude faced numerous challenges such as breakdowns, freeze ups, fires and high costs. But by 1986 advancements in technology had reduced the operating costs of producing synthetic crude oil from Cdn$35 to Cdn$13 per barrel.[12]

1.3 Tar Sands Makeover

Until the mid-1990s, development of the tar sands, the original name for oil sands, was still considered risky and unprofitable. Then in 1993, the Alberta Chamber of Resources convened the National Oil Sands Task Force (the Task Force), a collective of oil industry and government representatives, to draft a framework for making the oil sands an economically attractive resource. In its 1995 report entitled *The Oil Sands: A New Energy Vision for Canada*, the Task Force laid out a 25-year strategy that envisioned tar sands production doubling or tripling to reach between 800,000 and 1.2 million barrels per day by 2020.[13] The strategy also called for efforts to improve public perception of the dirty sounding "tar sands." The term "oil sands" was selected as the new brand name for tar sands, and they were framed as "a national prize."[14]

In 1997, the governments of Alberta and Canada implemented a key recommendation of the Task Force by introducing a generous royalty regime and federal tax breaks for oil sands development. The Alberta government's Generic Oil Sands Regime collects only 1% of total revenue until all capital costs (for new projects and expansions) are recovered, at which time 25% of total revenue is collected. This creates strong motivation for rapid re-investment and expansion. Similarly, the tax breaks introduced by the federal government

"The Task Force has identified a clear vision for growth and answered – affirmatively – the fundamental question: Should oil sands development proceed?"

"To attract investment, the Task Force has embarked on a carefully calculated, new course for development."

"The industry must develop an active and on-going program to change outdated perceptions of the oil sands and create an informed, supportive public that understands the value and potential of the oil sands."

National Oil Sands Task Force, The Oil Sands: A New Energy Vision for Canada (1995)[15]

▲ *Raw oil sands. The tar-like bitumen found in these sands becomes oil only after an expensive and intensive feat of engineering succeeds in washing the bitumen from the sand and converting it into a synthetic crude oil.* SOURCE: SUNCOR have made the oil sands industry the envy of Canada's industrial sector.

Only five years after the release of the Task Force's recommendations, the necessary conditions for an oil sands boom were in place. Further reductions in operating costs and rising crude oil prices also heightened industry interest. Numerous expansion plans and new projects were launched. A wave of significant new expansion began to unfold. The scale of this new development greatly exceeded expectations. Fuelled by strong growth in demand for transportation fuels, particularly in the United States, and a favourable fiscal regime, oil sands production more than doubled to approximately 1.1 million barrels per day between 1995 and 2004 – 16 years ahead of the anticipated timeline.[16]

1.4 Global Attention

BILLIONS INVESTED

To date, four of the five largest publicly traded oil companies in the world – Royal Dutch/Shell, ExxonMobil, ChevronTexaco and TotalFina[17] – have invested or committed to invest billions of dollars in oil sands development.

In the first half of 2005, Chinese oil companies signed three deals to tap into Canada's oil sands reserves by purchasing stakes in two start-up oil sands companies and a proposed pipeline to transport synthetic crude oil from the oil sands to the Pacific coast for shipping to China.[18]

Alberta's oil sands have become a frequent destination for foreign politicians, bureaucrats and energy executives seeking to see firsthand the scale of the resource.

The United States' Energy Information Administration (EIA) and the *Oil and Gas Journal* took notice and formally recognized Canada's oil sands as an economically viable resource in 2003, vaulting Canada's oil reserves from 21st position in the world to 2nd (Figure 2). The oil sands, lavishly described as "black gold," "resources beyond belief" and "the eighth wonder of the world,"[19,20,21] were seen as an abundant, accessible and affordable source of crude oil.

Not surprisingly, the world has also taken notice. Major powers are positioning themselves to ensure their access to the oil sands, which have been described by the U.S. Energy Policy Development Group as "a pillar of sustained North American energy and economic security."[22]

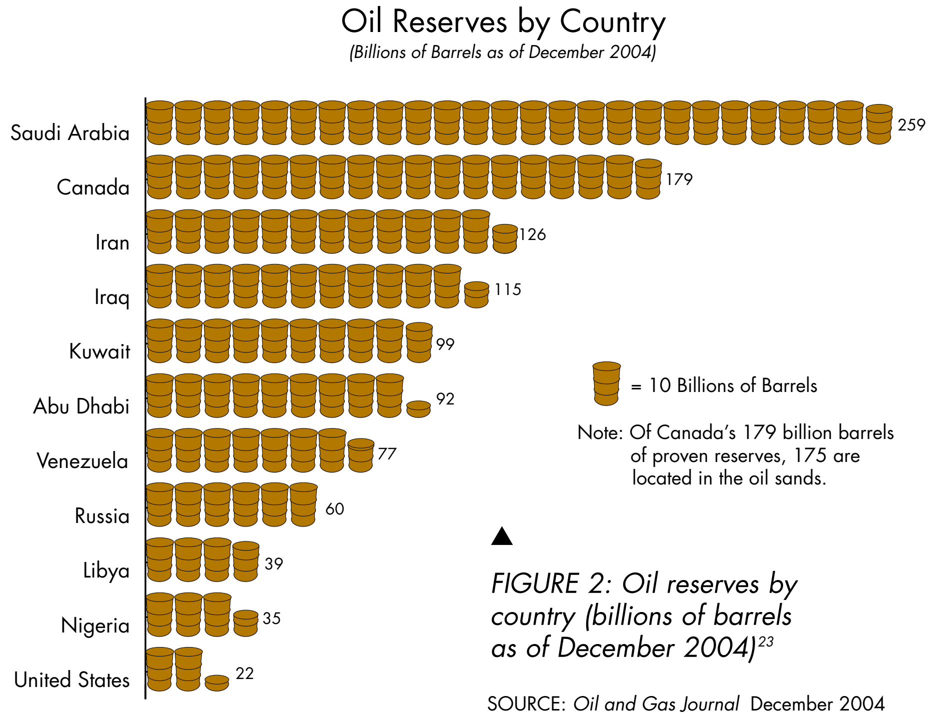


FIGURE 2: Oil reserves by country (billions of barrels as of December 2004)[23]

SOURCE: *Oil and Gas Journal* December 2004

1.5 New Goals and Speculation

From 1999 through 2004, Suncor and Syncrude both expanded their surface mining operations. Four new surface mines and seven new in situ operations were also approved in the Athabasca oil sands region.[24] This wave of development is projected to increase production to more than two million barrels per day by 2010-2012.[25]

With increasing confidence that oil prices are likely to remain high, wild speculation abounds regarding potential production. The Canadian Association of Petroleum Producers (CAPP) has projected that production could reach 2.7 million barrels per day by 2015.[26] In 2004, the Alberta Chamber of Resources put forward a vision of producing five million barrels per day by 2030 (Figure 3).[27] More recently, the government of Canada has envisioned producing six million barrels per day of production by 2030, and some energy analysts have projected production as high as eleven million barrels per day by 2047.[28,29] For the purpose of this report, we will assume the more conservative projection of five million barrels per day by 2030.

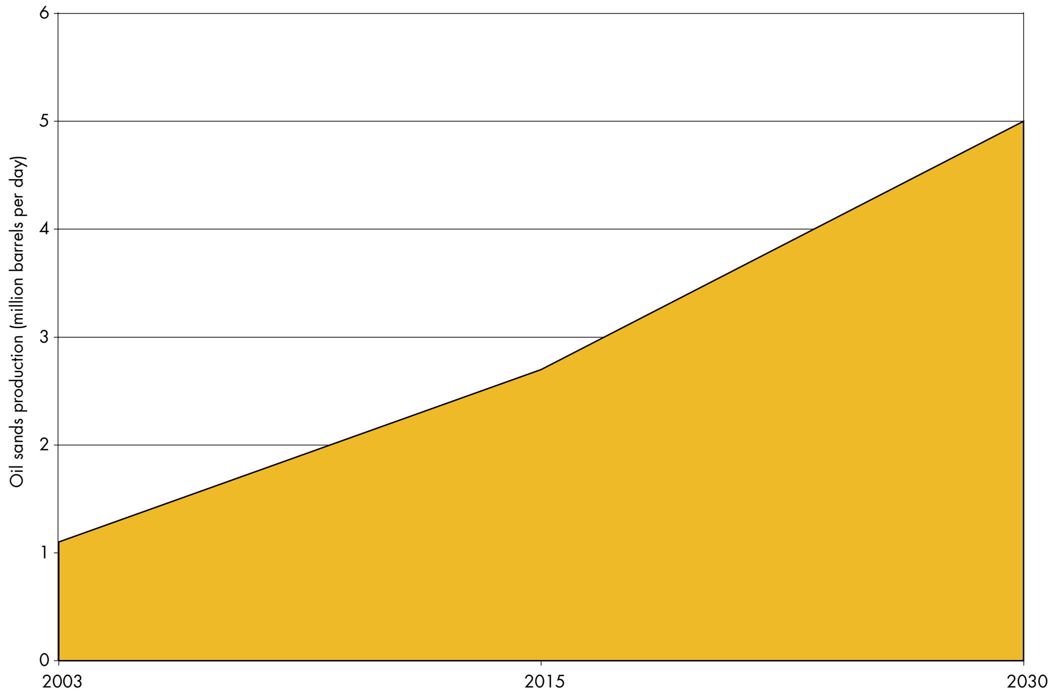
1.5.1 Oil Sands Domination

In 2001, crude bitumen production exceeded conventional crude production in Alberta for the first time.[30] This trend is predicted to continue (Figure 4). By 2003 oil sands represented 54% of Alberta's total oil production and one-third of Canada's total oil production.[31] In 2005, oil sands production will represent about half of Canada's total production of crude oil.[32] The Canadian Association of Petroleum Producers (CAPP) predicts that by 2015, three out of four barrels of oil produced in Canada will be from the oil sands.[33]

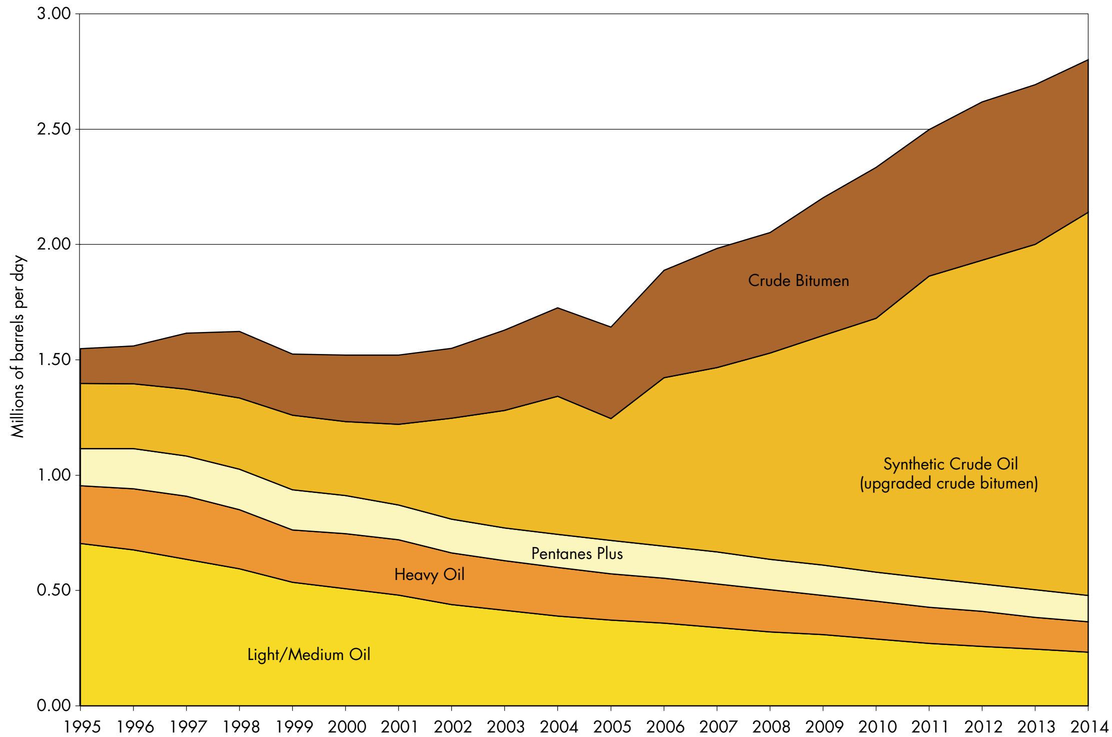
New growth in oil production is being driven by global demand for oil, with domestic demand in Alberta representing only a small fraction of total production (Figure 5). In the short term, growing demand for

"We appreciate the fact that Canada's tar sands are now becoming economical, and we're glad to be able to get the access toward [sic] a million barrels a day, headed toward two million barrels a day."

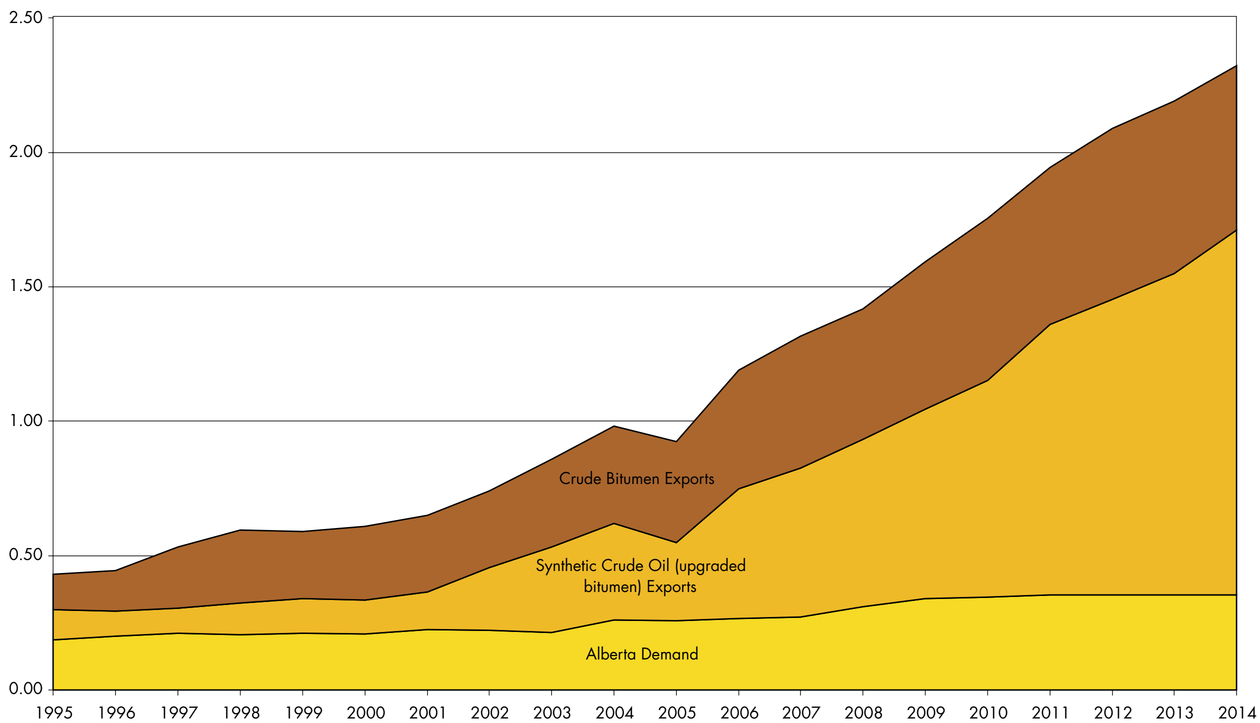
U.S. President George W. Bush, March 23, 2005[34]



▲ *FIGURE 3: Projected growth in oil sands production to 2030*



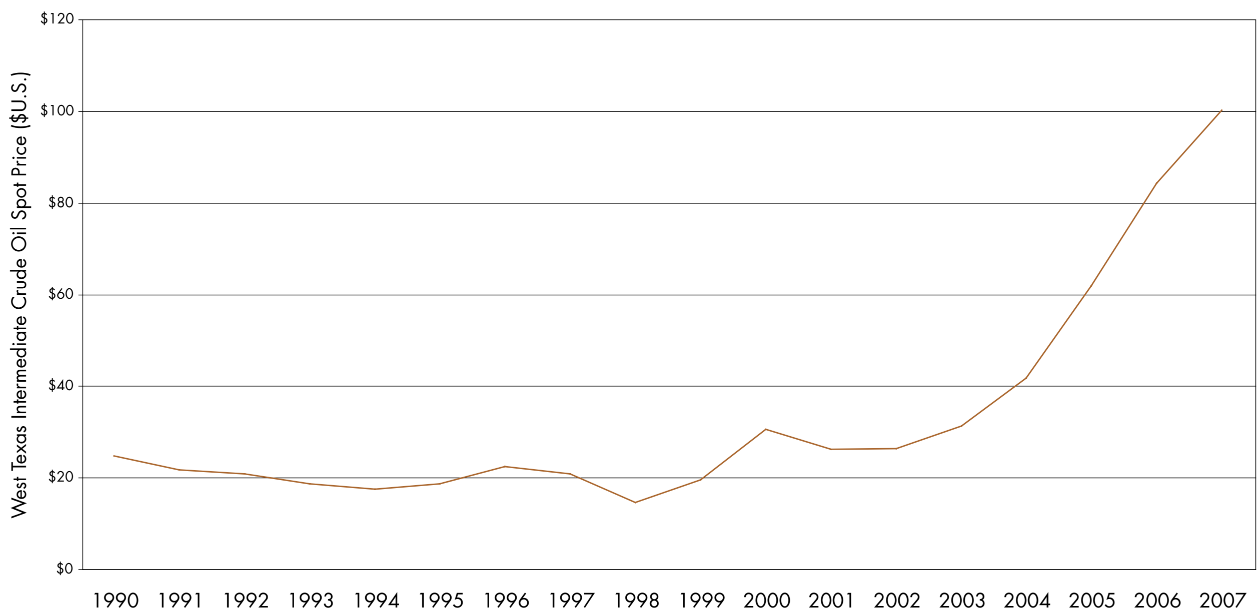
▲ *FIGURE 4: Crude oil production in Alberta 1995–2014*[35]



▲ *FIGURE 5: Alberta demand and export of crude bitumen and synthetic crude oil (upgraded bitumen) 1995–2014*[36] synthetic crude oil is projected to come from existing markets in the American Midwest and Rocky Mountain regions but may also expand to potential markets on the U.S. East and West coasts and the Far East.[37] The Canadian National Energy Board predicts that by 2015 there will be a 90% increase to 2.8 million barrels per day of Canadian crude oil exports to the United States, with about 70% coming from the oil sands.[38]

1.5.2 Rising oil prices

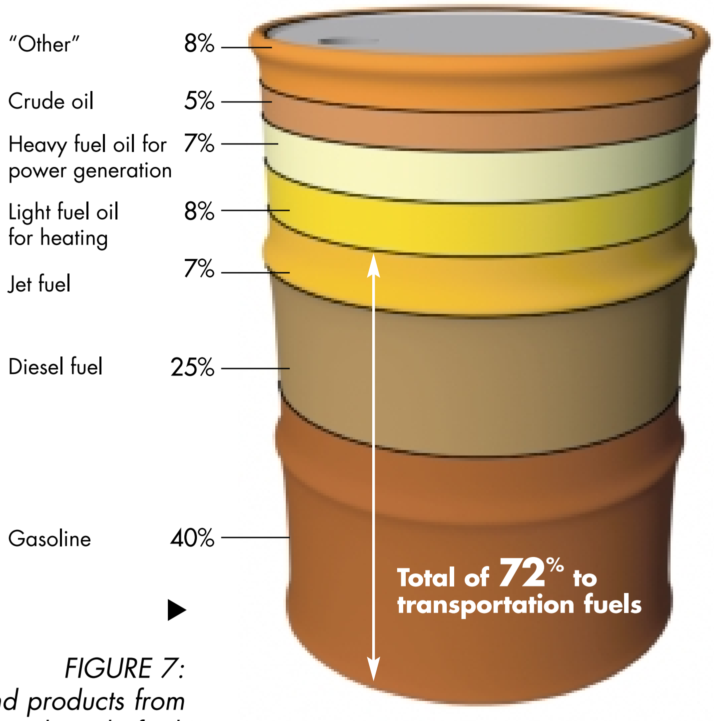
Neither the Task Force nor the governments of Alberta and Canada predicted that geopolitical instability in the Middle East and surging global demand for oil would drastically increase oil prices (Figure 6) – a trend many energy and financial analysts suggest will continue.[39] In September 2005, the Canadian Imperial Bank of Commerce reported that the price for oil might average US$84 per barrel in 2006 and US$100 by the fourth quarter of 2007.[40] Even the Toronto Dominion Bank, which projected that slowing economic growth in the United States would lead oil prices to drop to $US45 in early 2007, has acknowledged that the world has entered a new era of sustained higher crude prices.[41] With estimates that the oil sands will be profitable as long as the price of oil stays above $US25, there is little doubt that producing synthetic crude oil from the oil sands will remain a highly profitable venture.[42] This prediction is confirmed by the commitment of billions of dollars of investment by the world's most powerful oil companies.



▲ *FIGURE 6: Spot prices for West Texas Intermediate crude oil 1990–2007*[43]

1.6 The Impacts of Irresponsible Demand

▲ *Growing demand for transportation fuels is being driven by inefficient use in gas guzzling vehicles. Approximately 65% of a barrel of synthetic crude oil goes to making gasoline and diesel fuel.* SOURCE: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE



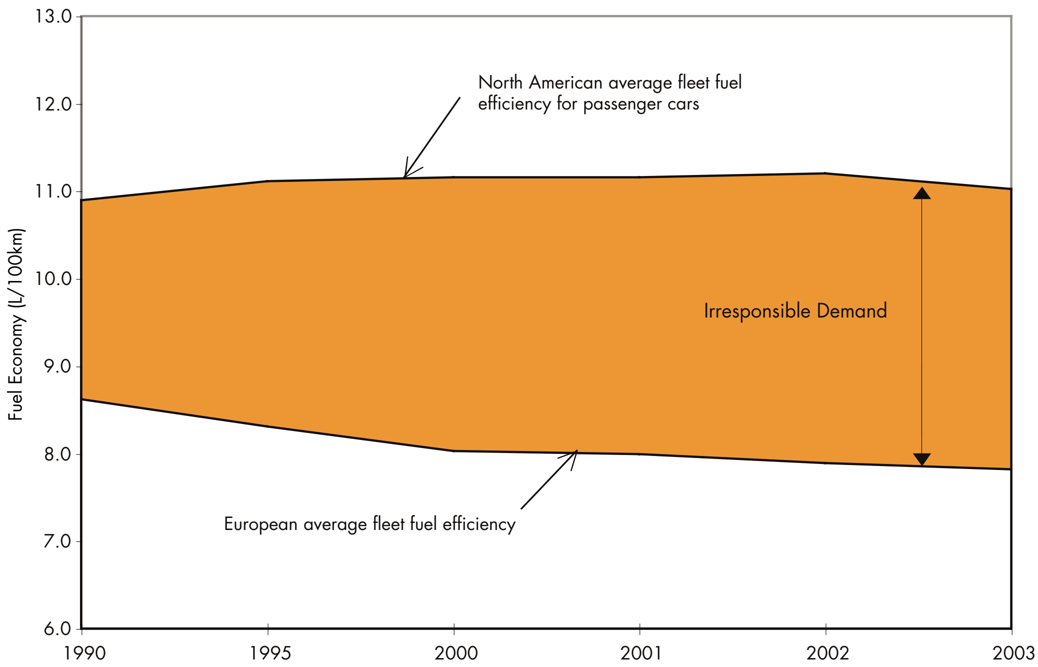
▶ *FIGURE 7: End products from a barrel of oil* [44]

North Americans are starting to see the oil sands as a source of cheap and locally available oil that will meet their demand for transportation fuels. As illustrated in Figure 7, most of the synthetic crude oil from the oil sands goes to producing transportation fuels.

As we struggle with the concept that the era of abundant oil may be drawing to a close, a dangerous mythology is emerging about the role of oil sands in perpetuating highly inefficient transportation fuel consumption.

CAPP's predicted oil sands production of 2.7 million barrels per day in 2015 would only meet 11% of the United States' projected demand.[45] Looking to 2030, the five million barrels per day of projected oil sands production projected would only fulfill 16% of North American demand in 2030, or less than 5% of global demand.[46,47] Global transportation fuel consumption is rising so quickly that even feverish oil sands development will not be able to keep pace. The oil sands are not, as some may suggest, the proverbial silver bullet that will allow our affection for inefficient personal vehicles to persist. Globally, we face a significant energy challenge, in part because of our fleet of inefficient vehicles.

The average fleet fuel efficiency of North America's personal vehicles in 2005 is 11.2 liters per 100km.[48] The peak average fuel efficiency in North America, 10.7 litres per 100 km, occurred in 1986 before automakers began selling large volumes of sport utility vehicles (SUVs). Today, the



▲ *FIGURE 8: Irresponsible demand for private-vehicle fuel in North America (L/100 km)*

average fleet fuel efficiency is the same as it was in 1981. The difference between North America's average fleet efficiency and the European average is 3.4 litres per 100 kilometres, which is a conservative estimate of the amount of wasted fuel.[49] This wasted energy is what we refer to as irresponsible demand. The irresponsible demand for fuel between 1990 and 2003 is shown in Figure 8.

Given the magnitude of impacts associated with producing fuel from the oil sands, Canadians should be concerned with this inefficient use of their natural resource. As an emerging global energy supplier, Canada should take responsibility and show leadership by providing incentives for responsible consumption. Canada could set an example by adopting its own best available technology fleet fuel efficiency standard.

"These Canadian oil sands will help keep American SUVs running in the years to come."

Knight Ridder Newspapers, October 2005[50]

"In the long run, rich countries and emerging countries are going to have to be much more discriminating about what we use oil and coal for."

Former U.S. President Bill Clinton, October 2005[51]

1.7 The Untold Story

In 1995, the Task Force gave relatively little heed to the question of how to mitigate the environmental impacts of producing one million barrels per day from the oil sands. Perhaps they assumed that they would have 25 years to address this question. They did not.

Production exceeded this target in less than a decade. With a new goal of producing five million barrels per day by 2030, the question of how to manage the associated environmental impacts becomes even more urgent.

1 Canada's Oil Sands Rush

Oil Sands Fever documents the environmental and climate change challenges arising from the oil sands development that occurred between 1996 and 2004 and describes the even greater consequences of the immense development now contemplated. The regulatory agencies responsible for ensuring development that is "fair, responsible, and in the public interest" are overwhelmed by the sheer pace of development. These agencies must be empowered to effectively and proactively manage the growth. To do so the government must shift its efforts and priorities to ensuring that irreversible environmental harm is prevented through proactive management.

In 1995, the Task Force deemed the principal risk for the oil sands to be "that the full economic and social potential of the resource will not be realized in public and private wealth creation."[52] In our opinion, a decade later it is clear that the greatest risk associated with the oil sands is the long-term environmental and climate implications arising from the current pace and approach to exploiting this resource.

"Higher oil prices are merely one of a long number of warning signs, natural, social and economic, all telling us that our addiction to fossil fuels is ecologically harmful, technologically backward, economically costly, and practically unnecessary.... The point is not whether the price rises but, rather, how we perceive that fact. What we face is not a threat so much as an opportunity, if not an epochal challenge. And when opportunity knocks it is time to open the door. As the oil system door closes we need to open a different door, one that opens the way to clean efficient energy."

Vincent di Norcia, Editor, Corporate Ethics Monitor[53]

"Notwithstanding our commercial interests, Canadians stand to be harmed by a world that is polluted and depleted of energy resources. Thus, we must join policy makers everywhere to promote conservation and efficiency measures, as well as investment in alternative energy sources. Despite the fact that we in Canada have an abundance of oil, gas, uranium and hydroelectric power, our vast resources will not last forever."

David Kilgour, MP Edmonton – Millwoods / Beaumont, June 15, 2005[54]

2 From Tar to Tank

2.1 Making Oil from Tar

▲ *It takes two tonnes of oil sands ore to yield one barrel of oil.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Carrying 400 tonnes per load, oil sands mining companies use the biggest trucks in the world.

PHOTO: SUNCOR ENERGY

▼

▲ *Millennium mine conveyors from air.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Oil sands deposits are composed of sand, silt, clay, water and about 10%-12% bitumen.[55] They have a dark color and a strong hydrocarbon smell. The technical term for the oil extracted from oil sands is crude bitumen, which is defined as a viscous (thick), heavy oil that will not flow to a well in its natural state.[56]

Depending on the depth of the reserves, oil sands are either surface mined (also known as strip mining) from open pits or heated so the bitumen can flow to a well and be pumped to the surface (in situ extraction). To be surface mined, the deposit must be less than 100 metres from the surface (Box 1, Figure 9).[57] The EUB has defined an area of 2,800 square kilometers as the surface mineable zone within the Athabasca deposit.[58] Crude bitumen is extracted from the mined oil sands through a process that essentially mixes the oil sands with hot water to wash the bitumen from the sand.

In situ recovery is used to access deeper deposits. The Alberta government estimates that approximately 93% of Alberta's oil sands can only be developed using in situ recovery.[59] But unlike

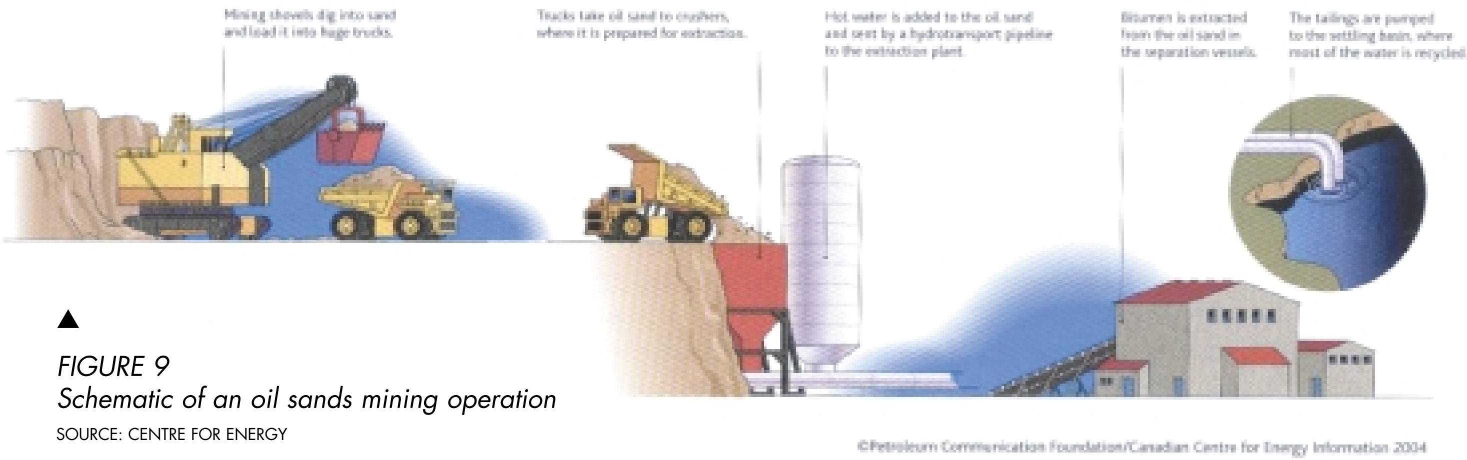


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FIGURE 9
Schematic of an oil sands mining operation
SOURCE: CENTRE FOR ENERGY

OIL SANDS SURFACE MINING

To mine the oil sands, wetlands need to be drained, rivers diverted, and all trees and vegetation stripped from the surface.

Approximately four tonnes of material (two tonnes of soil and rock above the deposit and two tonnes of oil sands) must be mined to produce one barrel (159 litres) of synthetic crude oil.[60] *The hydraulic shovels used in the oil sands are the largest in the world – each scoop of the shovel moves over 40 cubic metres of material.*[61]

Every two days, mining operations move enough oil sands to fill Toronto's Skydome or New York's Yankee Stadium.[62]

Oil sands mining trucks are 15 metres long by 7 metres tall, have 4-metre tall tires and are 40% heavier than a Boeing 747 airplane.[63,64]

Extracting a barrel of bitumen using surface mining requires

- *Two to five barrels of fresh water*[65] *(a barrel can hold 159 litres, a little more than an average bathtub)*
- *250 cubic feet of natural gas,*[66] *enough to heat a Canadian home for almost 1.5 days.*
- *The mining and extraction process recovers about 90% of the bitumen found in the deposit.*[67]

conventional crude oil, the thick, viscous bitumen cannot be recovered using conventional well drilling techniques. Special recovery methods, most commonly the injection of high-pressure steam, are needed to separate the tar-like substance from the sand. Heating the bitumen reduces its thickness so that it can flow to a well and be pumped to the surface. The predominant in situ technology is called steam assisted gravity drainage (SAGD) (Box 2, Figure 10).

▼ *Oil sand is mined from 100-metre deep pits and then fed into an extraction facility where hot water is used to wash the bitumen from the sand and clay.* PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

After being separated from the sand, the bitumen must be upgraded before it can be refined into gasoline, diesel, jet fuel and other hydrocarbon products (Box 3, Figure 11). The upgrading process converts the bitumen from thick, molasses-like oil, through the addition of hydrogen, into a lighter, higher quality synthetic crude oil that can be sent to refineries.

IN SITU OIL SANDS PRODUCTION

The predominant in situ technology is Steam Assisted Gravity Drainage (SAGD).

Well pads ranging in size from one to seven hectares are cleared of all vegetation, and multiple pairs of horizontal wells are drilled into the bitumen-containing formation: an injector well and a producer well.

Well pads generally have between 4 and 10 well pairs (8 to 20 wells).

A large SAGD project can have up to 25 well pads spread over a 150-square-kilometre parcel of land crisscrossed by above-ground pipelines.[68]

A central facility produces high-pressure steam that is carried by above-ground pipelines to the well pads where it is injected into the formation to reduce the viscosity of the bitumen.

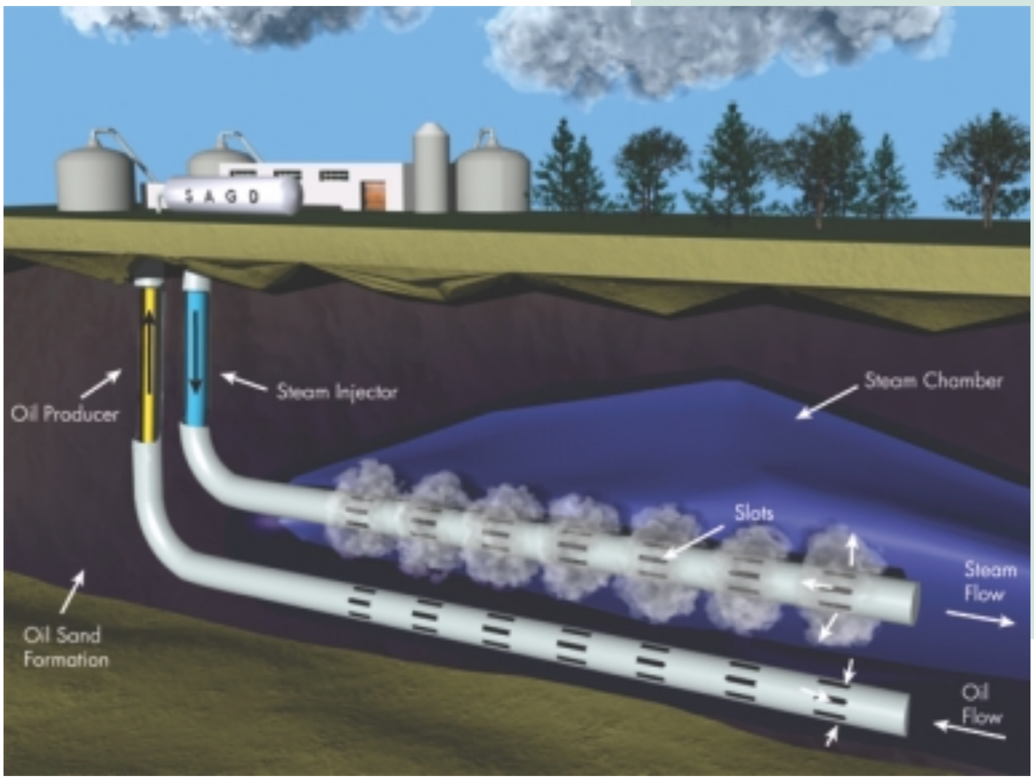
The bitumen and water (from the condensed steam) then drains by gravity to the lower producer well where it is pumped to the surface.

The water and bitumen are returned to the central facility by another above-ground pipeline, which separates the bitumen from the water and recycles the water to produce more steam.

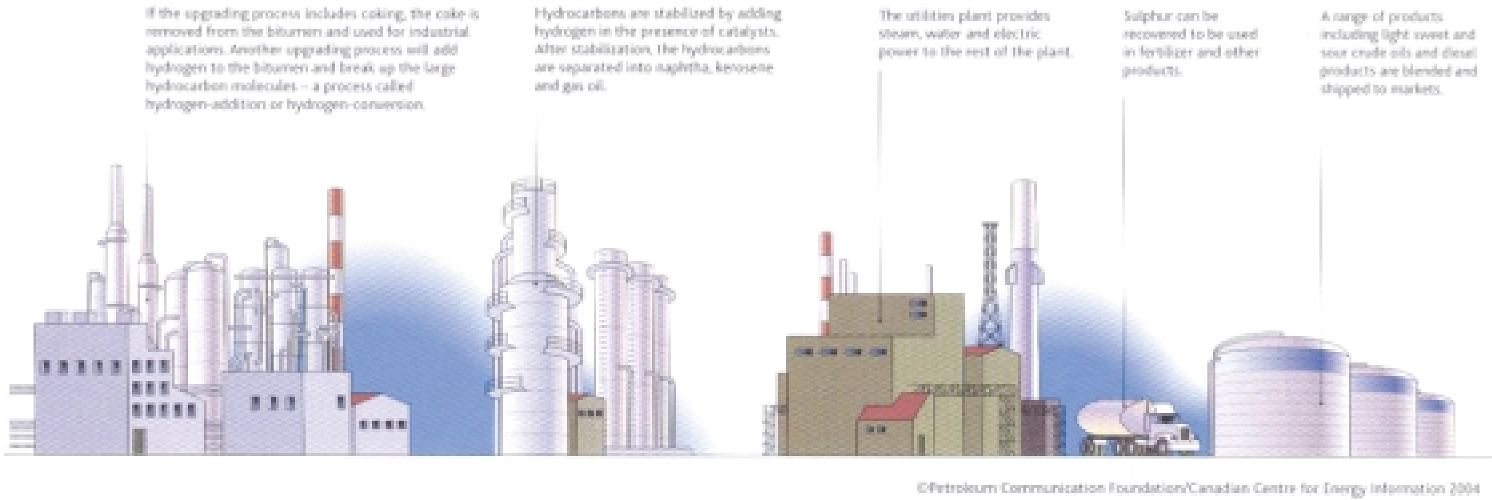
Extracting a barrel of bitumen using SAGD technology requires

- *2.5 to 4 cubic metres of steam to produce 1 cubic metre of bitumen*
- *1000 cubic feet of natural gas,[69] enough to heat a Canadian home for about 5.5 days.*

The SAGD process recovers between 60%-80% of the bitumen found in the geological formation.



◀ *FIGURE 10: Schematic of a steam assisted gravity drainage (SAGD) operation*



▲

FIGURE 11
Schematic of oil sands upgrading
SOURCE: CENTRE FOR ENERGY

UPGRADING OIL SANDS TO SYNTHETIC CRUDE OIL

Producing the final synthetic crude oil from bitumen requires two stages of upgrading.

The first stage cracks the large bitumen hydrocarbons into smaller molecules. This is done using either coking or hydrocracking or both. In the coking process, excess carbon is removed when high temperatures (circa 500°C) crack the bitumen molecules by vaporizing them. The excess carbon forms a solid residue called coke. The coke, which resembles coal, is then stockpiled as a waste by-product. Hydrocracking involves the addition of hydrogen to bitumen molecules that are cracked using a catalyst, such as platinum.

The second stage of upgrading is called hydrotreating whereby high pressure and temperatures (300-400°C) are used to remove nitrogen and sulphur.

In hydrotreating, metals, sulphur and nitrogen are removed using a catalyst in a hydrogen environment.

The nitrogen is removed as ammonia and is usually used as a source of fuel, while the sulphur by-product is converted to elemental sulphur and either transported for use in other industrial processes (e.g., production of fertilizers) or stored in massive sulphur blocks.

About 65% of the bitumen is upgraded in Alberta to form light, sweet synthetic crude oil.[70] *The remainder is transported by pipeline to other regions of Canada and the United States for upgrading.*

One barrel of synthetic crude oil produces enough gasoline to fill three-quarters of a Chevy Avalanche's gas tank, or enough to drive it about 490 kilometres.[71]

Bitumen must first be upgraded or transformed into synthetic crude oil before it can be refined.
PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

▼

2.2 Fuel for the Oil Sands

Both surface mining and in situ operations are energy intensive endeavours. Natural gas is used both to generate the heat necessary to extract the bitumen from the oil sands and as a source of hydrogen to upgrade the bitumen into synthetic crude oil. Natural gas has traditionally been selected as the fuel of choice because it was relatively clean burning, readily available and (until recently) cheap.[72] Table 2 shows how much natural gas is consumed on a per-barrel basis to produce bitumen and convert it into synthetic crude oil. The oil sands industry consumes about 0.6 billion cubic feet of natural gas per day, enough to heat 3.2 million Canadian homes per day.[73,74]

In 2012, to produce two million barrels per day will require approximately two billion cubic feet of natural gas per day, more than 1.5 times the amount of natural gas that would be available from the proposed Mackenzie Valley Pipeline (Figure 12).[75] This daily requirement is roughly equivalent to the amount of natural gas needed to heat all of the homes in Canada for a day.[76]

▲ *Suncor installed scrubbers in 1996 to reduce SO_2 emissions, achieving a 75% reduction in SO_2 emissions relative to 1990. Regional SO_2 emissions are expected to grow to 295 tonnes per day, which is higher than currently approved emission rates, but lower than the actual emission rates of the early 1990s.* PHOTO: SUNCOR ENERGY

"Burning a clean fuel to make a dirty fuel is a form of reverse alchemy, like turning gold into lead. It also leaves less gas for more sensible uses, such as making electricity and heating your home.... When you calculate the toll on gas reserves, the cleanest and most versatile hydrocarbon, the oil sands don't look like a godsend after all."

Eric Reguly, May 28, 2005
The Globe and Mail[78]

Activity	Volume of Natural Gas Consumed (cubic feet) per Barrel of Bitumen
Surface mining and upgrading	Approximately 750 (250 extraction and 500 upgrading)
In situ production and upgrading	1500 (1000 extraction and 500 upgrading)

▲ *TABLE 2: Natural gas consumption for bitumen and synthetic crude oil production*[77]

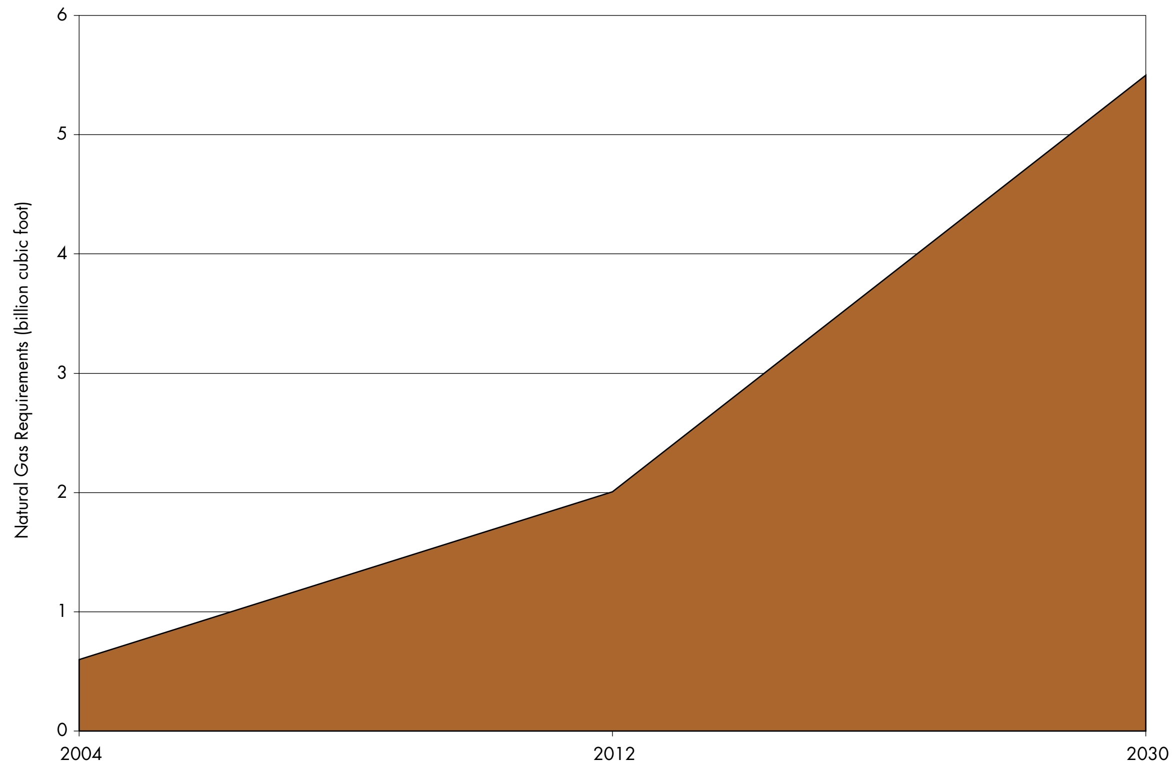


FIGURE 12: Projected natural gas demand for oil sands production 2004–2030 [79]

NUCLEAR ENERGY IN THE OIL SANDS – AN EMERGING DEBATE

With natural gas prices on the rise, oil sands companies have quietly mulled the idea of using nuclear energy to produce synthetic crude oil. This is not the first time that nuclear energy has been considered. In 1958, a collective of oil companies approached the governments of Alberta and Canada with a proposal to detonate a 9-kiloton atomic bomb underground to liquefy bitumen so it could be pumped to the surface.[80] While the proposal was considered a number of times, it was never implemented.

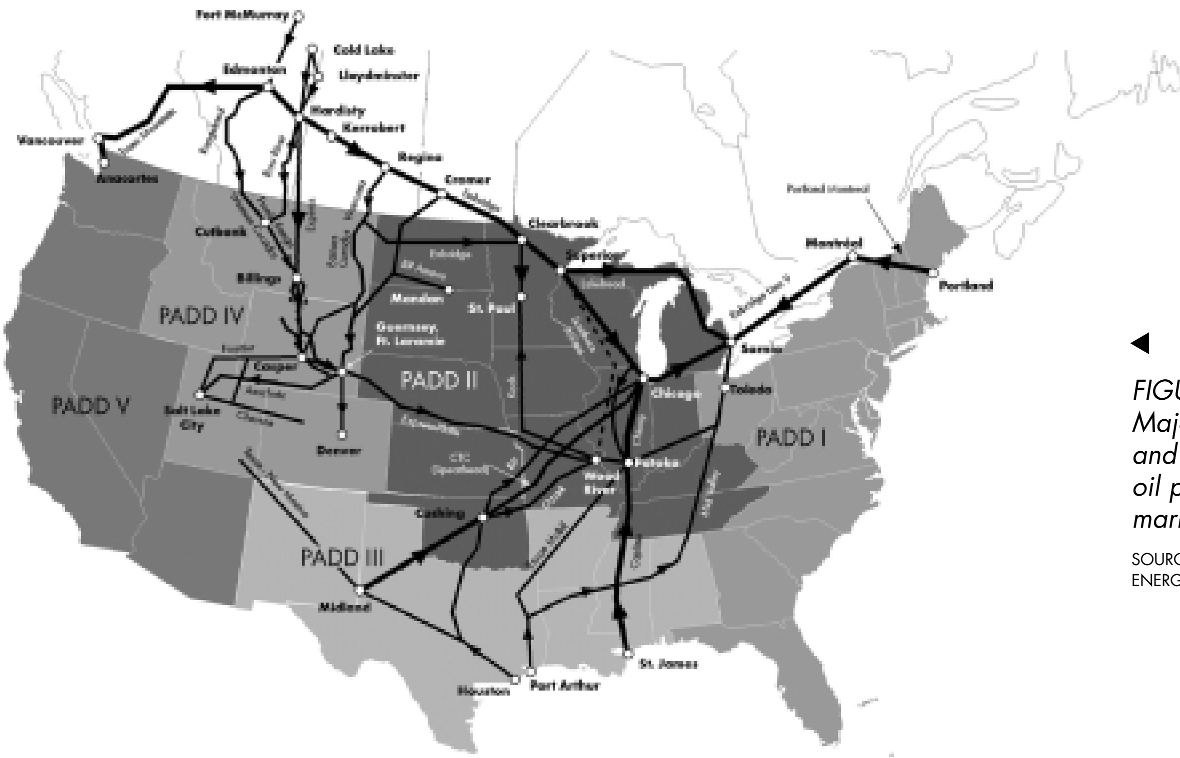
In 2003, the Canadian Energy Research Institute concluded that advanced CANDU reactors could be economically viable in the oil sands.[81] In September 2005, Total SA, who has a stake in the Surmont in situ project and is in the process of acquiring Deer Creek Energy Limited, publicly opened the debate by announcing that it was considering the construction of a nuclear facility in the oil sands region between 2020 and 2025.[82]

Alberta's premier, Ralph Klein, has reportedly dismissed the idea because of concerns with nuclear waste disposal. But he also noted that he was firmly against using natural gas because it represents "a tremendous waste of a resource."[83] The Canadian environmental community has long advocated against the use of nuclear power in Canada because of environmental risks, hazardous waste issues and poor economic performance. Many stakeholders would likely oppose proposals for the use of nuclear energy in the oil sands.

The oil sands industry is coming under fire for its ever-increasing demand for high quality, clean-burning natural gas. Moreover, the purchase of natural gas is a major cost for mining and in situ operations (15% and 60% of the total operating costs respectively), and projections of rising natural gas prices have prompted oil sands producers to actively seek alternative sources of energy.[84,85]

At the present time, gasification of coal or oil sands residue (i.e., the coke by-product of upgrading) appears to be the most likely alternative source of energy to fuel the oil sands.[86,87] However, unless mitigating technologies are also employed, the alternatives to natural gas pose an even greater environmental and climate threat.

2.3 Transportation to Refineries



◀ *FIGURE 13: Major Canadian and U.S. crude oil pipelines and markets.*

SOURCE: NATIONAL ENERGY BOARD

Moving synthetic crude oil and bitumen from the oil sands producers to refineries is accomplished through a network of pipelines that run from Fort McMurray to Edmonton and Hardisty. While some refining occurs in the Edmonton region, most of the oil sands product is pipelined to Ontario, the Midwest and Rocky Mountain regions of the United States, or to British Columbia and Washington.[88,89] (Figure 13)

There are several new proposals to expand the pipeline capacity between Fort McMurray and Edmonton, and from Edmonton to both eastern Canada and to the West Coast for export to California and Asia-Pacific markets, chiefly China.[90] Enbridge is proposing a new pipeline, the Gateway Pipeline, from Edmonton to a new, deep-water marine terminal in Kitimaat, British Columbia, from where synthetic crude oil will be exported to China, other Asia-Pacific markets and California.[91]

In addition to a proposal to expand the capacity of its TransMountain pipeline, Terasen is considering a pipeline to Kitimaat to compete with Enbridge's Gateway pipeline.[92] Construction of these terminals and their use by oil tankers would require a lifting of the moratorium on tanker traffic along the Pacific coast. These proposals have already encountered significant public opposition.

Once transported to Canadian and American refineries, synthetic crude oil is converted into a wide variety of petroleum products. From a barrel of oil, approximately 72% (by volume) is refined into transportation fuels (40% to gasoline, 25% to diesel fuel, 7% to jet fuel). From the refineries, these fuels are transported by tanker trucks to local gas stations.

▲ *The upgrading plants are massive complexes that take years to build.*

PHOTO: MELINA MARA. © 2005, THE WASHINGTON POST. REPRINTED WITH PERMISSION

3 Climate Change Consequences

3.1 Escalating Greenhouse Gas Emissions

▲ *The oil sands are the single largest contributor to GHG emissions growth in Canada.*
PHOTO: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE

The science of climate change leaves little doubt that deep reductions in global greenhouse gas emissions (GHG) must be achieved if we are to prevent drastic worldwide impacts from climate change. These reductions will need to go far beyond the requirements of the Kyoto Protocol: industrialized countries such as Canada need to reduce their GHG emissions to 80%-90% below the 1990 level by 2050.[93]

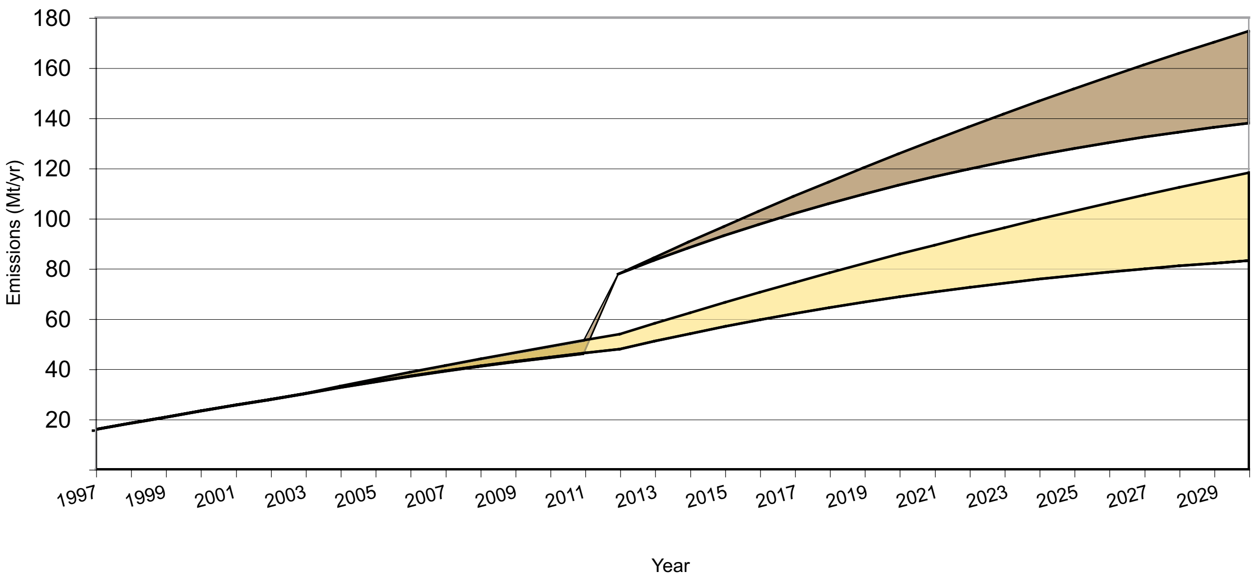
The oil sands are the single largest contributor to GHG emissions growth in Canada. While the emissions intensity of producing oil sands has decreased substantially, i.e., 26% over the past decade, the rapid rate of new development has more than consumed these gains.[94]

In 1997, the upstream fossil fuel producing industry (activities encompassing the extraction, production and transportation of raw oil, natural gas and coal) accounted for 98 megatonnes (Mt) of GHG emissions, of which 16% (16 Mt) was emitted from oil sands operations.[95] The most recent estimate of GHG emissions for the entire oil sands industry is for the year 2000, when the industry emitted 23.3 Mt, or 3% of Canada's total GHG emissions.[96] To project future GHG emissions growth from the industry, we have created four scenarios (Table 3). As shown by Table 3 and Figure 14, even the best-case scenario (Scenario 1) will lead to significant growth in GHG emissions.

If oil sands development is not curtailed or more aggressively managed, Canada will have to shoulder its responsibility in the global effort to reduce emissions by requiring the industry to implement technologies that cut the emissions intensity of production, or to offset GHG emissions by investing in emission reductions elsewhere.

Scenario and fuel type	Annual reduction in GHG intensity	2015 – annual GHG emissions (megatonnes)	2030 – annual GHG emissions (megatonnes)
Scenario 1 – natural gas	2.3%	57	83
Scenario 2 – natural gas	1%	66	118
Scenario 3 – oil sands residue (e.g., coke)	2.3%	94	138
Scenario 4 – oil sands residue (e.g., coke)	1%	97	175

▲ *TABLE 3: Scenarios for GHG emissions from oil sands in 2015 and 2030*[97]



▲ *FIGURE 14: GHG emission projections for anticipated oil sands production to 2030*

OIL SANDS AND CANADA'S EVER-INCREASING "KYOTO GAP"

The federal government regularly produces projections of Canada's future GHG emissions under a so-called business-as-usual scenario in which governments implement no policies or measures to reduce emissions. The difference between projected business-as-usual emissions in 2010 (the middle year of the five-year period to which the Kyoto target applies) and the Kyoto target is commonly referred to as the Kyoto gap. The Kyoto gap measures the amount by which annual emissions must be reduced below the business-as-usual level to reach the Kyoto target. The federal government has repeatedly increased its estimate of Canada's Kyoto gap, to a significant degree because of increased projections of oil sands production:

The emissions projection produced by the federal government in April 1997 showed a Kyoto gap of 138 Mt.[98]

In October 1998, the Kyoto gap was updated to 185 Mt, with 45% (21Mt) of the increase attributed to new projections for oil sands production.[99]

In December 1999, a further update resulted in a Kyoto gap of 199 Mt.[100]

In February 2002, the Kyoto gap was further revised to 238 Mt, with 18 Mt of the new increase attributed to an additional rise in projected oil sands production.[101]

In April 2005, the government stated that the Kyoto gap is "likely in the area of 270 Mt."[102] *It is widely understood that yet more increases in future oil sands production were, once again, a key factor in this latest increase to the gap.*[103]

It should be noted that the details of why the business-as-usual scenarios needed revision in February 2002 and April 2005 have never been published.

3.2 A Matter of Emissions Intensity

Canada is one of the most energy-intensive countries in the industrialized world. Our energy intensity has declined over the past two decades, but it still remains high because of our energy-intensive industries. Much of Canada's energy production and consumption is fossil fuel based; therefore, the economy's GHG intensity – commonly referred to as carbon intensity – is similarly high. Canada's emissions of GHGs relative to GDP are 25% higher than for the industrialized world as a whole.[104] According to Environment Canada, this high carbon intensity relative to other OECD countries is the result of increased consumption of fossil fuel for electricity generation, increased energy consumption in the transportation sector and growth in fossil fuel production for export.[105]

While Canada's obligation to reduce GHG emissions requires efforts to reduce the carbon intensity of our economy, significant growth in oil sands development will produce the exact opposite. Production of synthetic crude oil from the oil sands is a more GHG intensive endeavor than producing conventional light or medium crude oil.

"Living up to Canada's commitment to Kyoto and at the same time ensuring continued growth together with transition to a less emission-intensive economy is the biggest single economic and political challenge for Canadian energy policy in the coming years. Curbing GHG emissions is all the more challenging as Canada's emissions are growing along with its production and exports of energy which consume large quantities of fossil fuels."

International Energy Agency, January 2005[106]

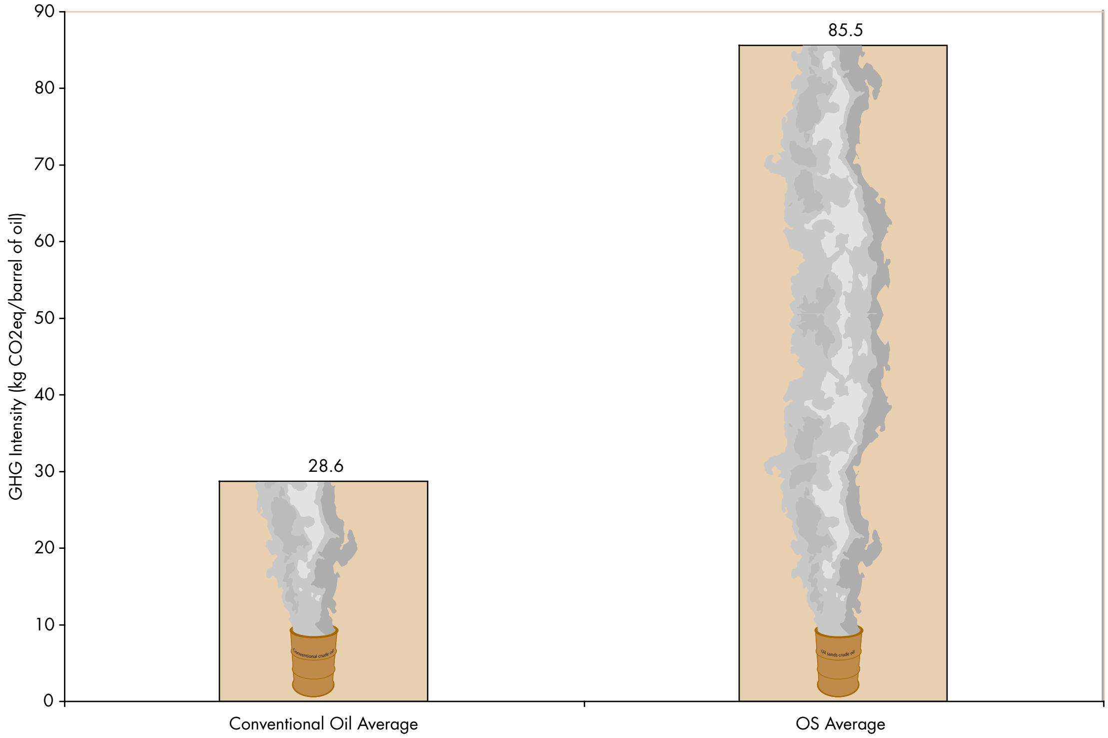


FIGURE 15: Average GHG intensity for conventional oil production versus oil sands synthetic crude oil [107]

As seen in Figure 15, the GHG intensity of synthetic crude oil production from the oil sands is significantly higher than the average intensity to produce conventional oil in Canada. Therefore, as increasing production of synthetic crude oil from the oil sands offsets the decline of conventional oil, the net GHG emissions from the oil industry are set to rise dramatically. While there are a variety of end-of-pipe solutions in the oil sands under evaluation, such as carbon capture and storage, and alternative energy sources, such as deep geothermal, they are years, if not decades, away from full-scale implementation.

3.3 Canada's Climate Contradiction

In December 2002, the federal government ratified the Kyoto Protocol legally binding Canada to reduce its GHG emissions to 6% below the 1990 level between 2008 and 2012. Despite this obligation, Canada's energy strategy remains focused on accelerating growth in oil sands production, the most GHG-intensive form of oil production. This stark contradiction in policy clearly demonstrates the need for Canada to more closely align its energy strategy with its climate obligations.

In April 2005, the government replaced its 2002 *Climate Change Plan for Canada* with a new plan: *Moving Forward on Climate Change – A Plan for Honouring Our Kyoto Commitment.* This new plan lays out the necessary steps for Canada to

OIL SANDS AND THE CLIMATE CONTRADICTION

"We must ensure that there is nothing, as we move forward to implement Kyoto, that in any way undermines or impedes the growth of projects like the oil sands and obviously their contribution to the prosperity of this country."

Deputy Prime Minister Anne McLellan, 2002[108]

"Canada's position on GHG emissions reduction is ambivalent. It can be described as someone trying to ride two horses galloping in opposite directions. One horse pulls energy investments towards the fossil fuels sector, thus increasing GHG emissions. The opposite horse pulls programmes and policies aimed at reducing GHG emissions."

Charles Caccia, former Chair, House of Commons Standing Committee on Environment and Sustainable Development, 2002[109]

▲ *Growing GHG emissions from the oil sands threaten Canada's ability to meet its Kyoto obligation and diminish its international reputation.* PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

achieve a 270 Mt reduction in annual GHG emissions by 2010. An essential component of this plan is a Large Final Emitters (LFE) system of mandatory emissions targets and trading to secure GHG emission reductions by heavy industry, including the oil sands sector. Large Final Emitters are responsible for nearly 50% of Canada's GHG emissions.

However, industry lobbying has led to government plans to require only 36 Mt of reductions from Large Final Emitters during 2008-2012. So although responsible for nearly 50% of Canada's GHG emissions, they will only be required to achieve 13% of the 270 Mt reduction target. Targets for new facilities in the LFE system are to be set at the level of "best available technology

Project	Kyoto compliance cost ($/barrel)*
Canadian Natural Resources Ltd. Horizon Mine & Upgrader	$0.18
OPTI/Nexen Long Lake SAGD	$0.34
Petro-Canada Mackay River SAGD	$0.12
Syncrude Mines & Upgrader	$0.24
Suncor Mines, SAGD & Upgrader	$0.24
Albian Sands Athabasca Oil Sands Project	$0.15
*Assumes $15/tonne and 85% free permit allocation	

▲ *TABLE 4: Predicted Kyoto compliance costs for oil sands operators*[110]

economically achievable" (BATEA). If the government accepts oil industry arguments that its current technology is already BATEA, then new oil sands facilities could be exempted from any meaningful contribution at all to Canada's Kyoto effort. The government has estimated, and industry has confirmed, that these targets represent a worst-case cost of no more than 25 cents a barrel to the oil industry (Table 4). Given that oil prices are likely to remain above US$50 per barrel, this is an economically insignificant and inadequate contribution to Canada's Kyoto effort.

Certain companies have acknowledged the need to take action to reduce their GHG emissions thereby demonstrating an ability and willingness to go further than what is likely to be required of them by the federal government. For example, after receiving approval for its Athabasca Oil Sands Project (AOSP), Shell Canada committed to achieving a 50% reduction in GHG emissions relative to its projected emissions intensity of 65 kilograms of GHGs per barrel of bitumen. The company plans to do this through a combination of reduced energy consumption, improved energy efficiency, the purchase of domestic offsets and feasibility studies regarding $C0_2$ capture.[111] This example clearly demonstrates that the industry can go well beyond what the federal government expects of it.

3.4 Taking Meaningful Action

Both government and business leaders widely recognize climate change as one of the greatest and most pressing challenges of the 21st century.[112]

To effectively tackle this challenge will require strong leadership and action in both the short and long term on the part of government and the oil sands industry.

"The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action. It is vital that all nations identify cost-effective steps that they can take now, to contribute to substantial and long-term reduction in net global greenhouse gas emissions."

Statement by the National Science Academies of all G8 countries, China, India and Brazil. June 2005[113]

▲ *Only about 10% of the tar sands are actually oil. Therefore, vast quantities have to be mined to produce one barrel of oil.*

4 Environmental Impacts

4.1 Cumulative Environmental Impacts

The expression "death by a thousand cuts" is often used to describe the accumulation of environmental impacts resulting from multiple industrial activities. Technically referred to as "cumulative environmental impacts," the accumulation of impacts may appear insignificant on their own but can lead to significant and often irreversible ecological damage. In few places is this concept more tangible than in the Athabasca oil sands region, where a proliferation of in situ and surface mining operations are rapidly degrading the regional environment.

The boreal forest ecosystem is resilient, but it can only withstand so much degradation before its ability to recover is exceeded. This proverbial "tipping point," referred to as an ecological threshold or environmental limit, represents the extent of change that an ecosystem can endure before this change is irreversible. As the industrialization of the northeast quadrant of Alberta continues unabated through oil sands development, forestry, and conventional oil and gas, threats to the region's long-term ecological sustainability escalate.

We need to ensure we have the scientific information to understand how the boreal ecosystem – its air, land and water – will react to the impacts of development. It would then be possible to determine, for example, how much water can be removed from the Athabasca River before fish populations are affected, how much habitat can be destroyed before wildlife species are lost and how much air quality can change before the ecosystem is irreversibly stressed.

The following sections describe how the oil sands industry impacts the region's water, land and air and provide projections of the even greater impacts that will accompany planned development to approximately 3.7 million barrels per day of oil sands production.[114] If production reaches five million barrels per day (or higher) by 2030, the environmental impacts will be even greater than those described below.

> *"There is no environmental minister on earth who can stop the oil from coming out of the sand, because the money is too big. But we have to be very strict on environmental impact."*
>
> ***Stéphane Dion, Federal Minister of Environment***[115]

CUMULATIVE SOCIO-ECONOMIC IMPACTS

As the hub of regional oil sands development, the Regional Municipality of Wood Buffalo (RMWB) is growing rapidly and changing. First Nations and Métis people make up approximately 6% of the RMWB's population, the vast majority of whom live in small communities outside Fort McMurray.[116,117] The RMWB is struggling with the socioeconomic impacts such as lack of affordable housing and insufficient infrastructure e.g., roads and schools. The regional First Nations and Métis face similar challenges as they seek to balance the benefits of job creation and a booming economy with ensuring that their culture, the region's environment and their traditional way of life are preserved. Not unlike cumulative environmental impacts, the rush of development is having cumulative socioeconomic impacts. While beyond the scope of this report, managing these socioeconomic impacts is also an urgent issue.

4.2 Troubled Waters

▲ *Oil sands operators rely on large amounts of fresh water to extract the bitumen from the oil sands.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

The scale and growth of surface mining and in situ development pose water use and management challenges that will need to be overcome to prevent significant environmental impacts. The predominant technologies for extracting bitumen from the oil sands all rely on large amounts of fresh water, which is withdrawn from both groundwater and surface water bodies (rivers and lakes).

Oil sands mining operations impact water resources in a number of ways, both directly and indirectly, as a result of muskeg and overburden drainage, aquifer dewatering, withdrawal of water from the Athabasca River and the long-term management of tailings. The Alberta Chamber of Resources has identified water use as one of the top four challenges for oil sands mining operations.[118]

Similarly, in situ operations can impact the quantity and quality of both groundwater and surface water bodies (including wetlands). From lowering the levels of groundwater aquifers to the production of large volumes of waste associated with water treatment, in situ operations pose a number of risks to water resources.

4.2.1 The Athabasca River

The Athabasca River is the longest river in Alberta, winding 1,538 kilometres from its source, the Athabasca Glacier in Jasper National Park, to Lake Athabasca in Wood Buffalo National Park. It enters Lake Athabasca at the Peace-Athabasca Delta, the largest boreal delta in the world, and one of the most important waterfowl nesting and staging areas in North America.[119]

Oil sands surface mining operations upstream of the delta have been listed as one of the threats to its integrity because large amounts of water are withdrawn from the Athabasca River for use in the extraction process.[120] Between two to five barrels of water are withdrawn from the Athabasca River for each barrel of bitumen extracted. Less than 10% of the water approved for withdrawal is returned to the river.[121] The Athabasca River's ecosystem requires adequate flows and natural seasonal variations to support healthy fish populations. This relationship is referred to as the river's instream flow needs and is the amount of water the river needs to sustain a healthy environment. The Athabasca River has less water flowing during the winter months, so habitat for the many fish species e.g., northern pike, walleye and burbot that spend the winter in the Athabasca River is limited. Therefore, further reductions in flow because of water withdrawals could reduce the amount of habitat available for fish.

▲

Oil sands companies are currently licensed to divert a total of 349 million cubic metres of water from the Athabasca River, enough to satisfy the needs of a city of two million people.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

◀

The Athabasca River flows into the Peace-Athabasca Delta, the largest boreal delta in the world, and one of the most important waterfowl nesting and staging areas in North America.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

After five years of gathering information, Alberta Environment plans to identify how much water must remain in the river to provide adequate habitat for the fish. Then the department can make informed decisions about how much water can be withdrawn during the winter while ensuring that the ecosystem is fully protected. However, considering the industry's assertion that alternatives to water-based extraction technology will likely not emerge for 20 years,[123] it is also critical for industry and government to manage the timing and development of future projects (whether singly or as a region) to ensure that the Athabasca River is protected.

"The tailings ponds in Canada would not be legal in the United States under our environmental laws."

Tom Bachtell, Wind River Resources Corp[122]

4.2.2 A Tailings Legacy

Water used for extraction at oil sands mines ends up in tailings – a slurry of bitumen, water, sand, silt and fine clay particles – that is pumped to tailings ponds. While commonly referred to as ponds, these enormous bodies of water and the dykes that contain them are some of the largest human-made structures in the world. Collectively, they cover an area of land greater than 50 square kilometers.[124]

In these ponds, the sand, silt and fine clays slowly settle to the bottom. Then as much water as possible is pumped back to the extraction plant and reused in the extraction process. Because of the bitumen that remains in the tailings, the ponds pose a number of environmental risks including the migration of pollutants into the groundwater system and leakage into the surrounding soil and surface water.[125]

One such group of pollutants are the naphthenic acids that are a naturally occurring family of compounds found in bitumen. During the bitumen

▶ *Tailings ponds already cover an area of land greater than 50 square kilometers.*

PHOTO: CHRIS EVANS, THE PEMBINA INSTITUTE

TAILINGS PONDS

Approximately six cubic metres of tailings are created for every cubic metre of bitumen produced. The tailings are comprised of 3-5 cubic metres of water and approximately 1.5 cubic metres of fluid fine tailings.[126,127,128]

Syncrude's Southwest Sand Storage (SWSS) Facility is one of the three largest dams in the world.[129]

Existing tailings ponds can be seen from space.

Syncrude's Mildred Lake tailings pond contains more than 400 million m^3 of tailings, enough to fill 160,000 Olympic-sized swimming pools.[130,131]

Suncor's mining operations include nine tailings ponds that cover an area of 2,280 hectares.[132]

▲ *Tailings ponds pose a number of environmental risks including the migration of pollutants into the groundwater system and the leakage into the surrounding soil and surface water.*

PHOTO: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE

extraction process, these acids become concentrated and end up in the tailings ponds. The concentration of naturally occurring naphthenic acids in rivers in the region is generally below 1 milligram per litre (mg/ L) but may be as high as 110 mg/L in tailings ponds.[133]

The water in tailings ponds is also acutely toxic to aquatic life.[134] Although recent studies indicate that acute toxicity in wild mammals is unlikely under worst-case exposure conditions, repeated exposure may have adverse health effects.[135] In addition, the presence of the bitumen in the tailings ponds means that migratory birds that might be tempted to land must be scared away by propane cannons (a noise deterrent) and floating scarecrows.

The ultimate objective is to wait for the fine clay particles to settle in the tailings and become what is known as fluid fine tailings. This can take anywhere from a few decades to 150 years depending on the technology employed.[136] These fluid fine tailings pose a reclamation challenge because they are simply too wet and toxic to incorporate into a reclaimed landscape. The National Energy Board characterizes the problem of managing fluid fine tailings as "daunting" – the volume of fluid fine tailings produced by Suncor and Syncrude alone will exceed one billion cubic metres by the year 2020, enough to fill 400,000 Olympic-sized swimming pools.[137] If a company were not able to cover the cost of cleaning up tailings ponds, these costs could become major public liabilities.[138]

▼

Noise from propane cannons and floating scarecrows are used to deter migratory birds from landing in the oil-slicked tailings ponds.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

New technology that produces consolidated or thickened tailings is now being used to reduce the amount of fluid fine tailings and create tailings material that can be incorporated into a reclaimed landscape. But even with these technologies there will be fluid fine tailings that require special management. The industry is currently suggesting that these fluid fine tailings be placed in the mine pit after mining is complete and "capped" with water from the Athabasca River. In theory, these "end pit lakes" will be deep enough (65-100 metres) and of a great enough volume to ensure that the contaminants will be adequately diluted before draining into the Athabasca River watershed. Whether these lakes will support aquatic life and become sustainable aquatic ecosystems is still unknown.

Surface mine operators have committed to only discharging water that meets Alberta's Surface Water Quality Guidelines from these end pit lakes.[139,140] However, in the absence of any demonstration end pit lakes, the feasibility of this commitment or the necessary mitigation should it prove impossible remains unknown. Further, these guidelines do not include water quality limits for some of the chemicals, such as naphthenic acids, found in the fluid fine tailings that will be placed in the end pit lakes. Despite concern about the persistence and aquatic toxicity of naphthenic acids, Alberta Environment does not have any regulations for this toxin.[141]

At the joint federal-provincial regulatory panel hearing for Shell's Jackpine Mine – Phase 1 (now approved), the above issues were raised by a number of concerned stakeholders. In response, the Joint Panel, composed of a federal appointee and two members of the EUB, directed the EUB, Alberta Environment and Alberta Sustainable Resource Development to work with industry to develop tailings management performance criteria.[142] While this work was to be completed by June 30, 2005, the government has not, at the time of writing, published these performance criteria.

4.2.3 Freshwater Aquifers

Both oil sands mining and SAGD operations can impact freshwater aquifers by lowering their levels and creating a similar decrease in water levels in streams, ponds, lakes and wetlands that are connected to groundwater. The study of the hydrogeology of the region has only just begun. Consequently the flow of water between aquifers of varying depths is not well understood. When groundwater is pumped from a well, it causes a decrease in the pressure and water levels in the aquifer around the well. This decrease in pressure can cause water from aquifers closer to the surface to "leak" down, which can cause lowering of water in wetlands, reduced discharge of groundwater to streams, lakes and wetlands, and the lowering of the water table.[143] This is referred to as a drawdown effect.

Once the mine pit is excavated, groundwater levels are often lowered in the area to prevent flooding of the pits. Because multiple mines may be pumping water from an aquifer, the removal of groundwater from a large area of the landscape can lower the groundwater level in adjacent areas.

This can result in reduced groundwater flows to peatlands, wetlands and other surface water bodies.

The area impacted by the drawdown effect of removing this water can be up to 100 square kilometres.[144] Because prevention of pit flooding is considered essential, even if significant impacts are detected (e.g., wetlands drying out), there is not any possible mitigation.

In situ projects also impact freshwater aquifers through the SAGD technology used to recover bitumen. After the recovery, 90%-95% of the water, known as produced water, is de-oiled and treated so it can be reused in the steam generator. Because some of the water is lost in the treatment process, additional groundwater must be withdrawn. For every cubic metre of bitumen produced, about 0.2 cubic metres (200 litres) of additional groundwater must be added to produce more steam. To minimize the need to use freshwater aquifers, almost all SAGD projects in the region use some fresh groundwater mixed with saline groundwater (from deeper formations). While the use of saline groundwater for SAGD operations avoids additional demands on freshwater aquifers, treating it for use in the steam generators produces large volumes of solid waste.

4.2.4 Waste from Water Treatment

When saline water or produced water is being used at SAGD facilities for steam production, it must either be blended with fresh water or treated. The wastes from desalinization and other treatment processes are landfilled or injected into disposal wells that are drilled in deep, porous rock formations. Given the substantial volumes of water used by SAGD operations, the amount of solid waste produced is significant. For example, between 2005 and 2025 EnCana's Foster Creek SAGD operation will dispose of 48 million cubic metres of sludge into deep wells and send almost 260,000 tonnes of waste to landfill.[145]

To minimize the cost of transporting waste to regional landfills, many operators are constructing their own landfills and disposal wells. This has led to a proliferation of waste disposal facilities, another long-term environmental concern. The predominant use of landfills is also a serious issue because "disposing concentrates and effluent sludge in landfills could have significant environmental and ecological impact on the nearby soil and groundwater due to the high concentration of acids, hydrocarbon residues, trace metals and other contaminants."[146]

4.2.5 Troubling Trends in Water Use

Canadians are increasingly concerned about the long-term sustainability of surface and groundwater resources and the health of aquatic ecosystems. In the midst of a drought and public concerns about the quantity and quality of fresh water, the government of Alberta developed its Water for Life strategy in 2003.[147] During the development of this strategy, the public identified the use of water by the oil and gas sector as one of its key concerns.

During the consultation for the Water for Life Strategy in 2003, the public identified the use of water by the oil and gas sector as one of its key concerns.

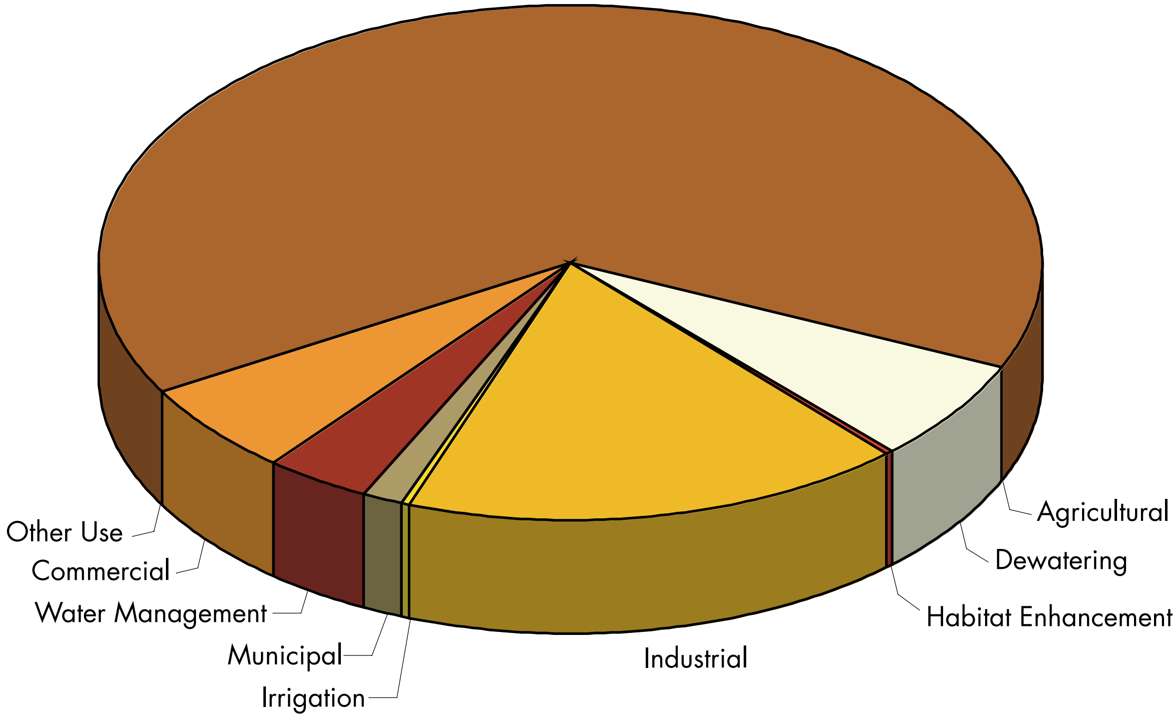
PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Despite the government's commitment to addressing this concern, water use for oil sands mining and SAGD operations is growing at an incredible rate. Of all the users of water from the Athabasca River, oil sands mining operations are by far the largest and the fastest growing. (Figure 16).

Approved oil sands mining operations are already licensed to divert 349 million m³ of water per year from the Athabasca River. This is approximately two times the volume of water required to meet the municipal needs of Calgary, a city of almost one million people, for a year.[149] Further exacerbating the matter is the fact that, unlike most other water users, only one of the six approved oil sands mines discharges water back to the river. Planned oil sands mines, which have yet to receive approval, would push the cumulative withdrawal of water from the Athabasca River to 490 million m³ per year (Figure 17).[150]

The amount of freshwater used for SAGD operations is also of concern. Most of the oil sands deposits in Alberta (93%) can only be accessed using in situ technologies such as SAGD, and therefore the future demand for groundwater is likely to grow exponentially. Because it is more expensive to drill wells into deep saline

FIGURE 16: Licensed surface water allocations from the Athabasca River and its tributaries, 2005 [148]



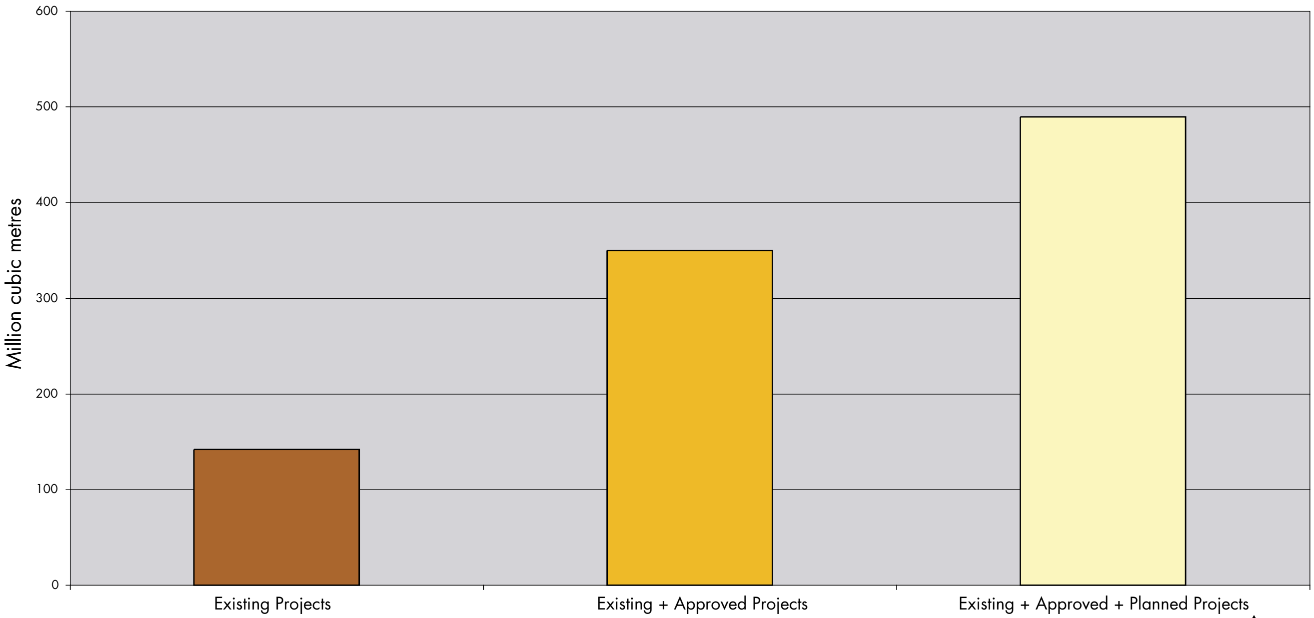


FIGURE 17: Cumulative Athabasca River water allocations for existing, approved and planned oil sands mining operations

aquifers and treat the saline water for use in the steam generators, use of freshwater is projected to continue to grow. The demand for fresh surface and groundwater for in situ oil sands projects in Alberta (Athabasca, Peace River and Cold Lake oil sands deposits) is projected to more than double between 2004 and 2020 (Figure 18).

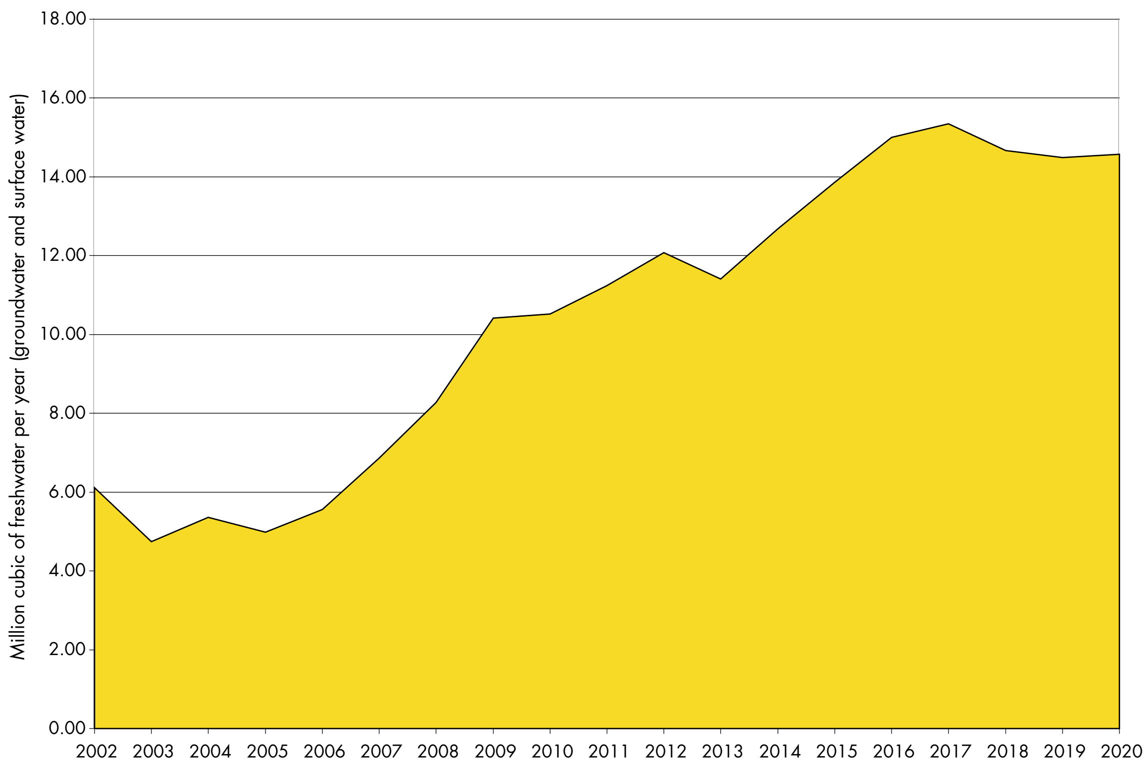


FIGURE 18: Future water demands for in situ oil sands production in Alberta[151]

4.3 Transformed Lands

"Canada's boreal forests represent enormous environmental wealth – for biodiversity, clean air and clean water. Their conservation should be a priority of every Canadian."

Environment Canada, Western Boreal Conservation Initiative[152]

"The world's boreal forest, a resource of which Canada is the major trustee, is under siege."

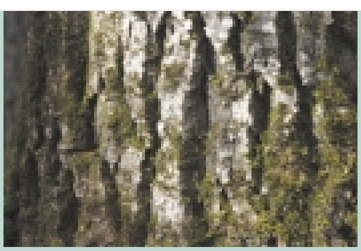
Senate Sub-committee on the Boreal Forest, 1999[153]

4.3.1 The Boreal Forest

Described as a global endowment, Canada's boreal forest stretches for 310 million hectares across the country, covering about 30% of Canada's landmass.[154] A mosaic of interconnected forest and wetlands, the boreal forest supports a wide range of biodiversity and fulfills critical ecological services such as climate regulation and carbon storage.[155] Canada's boreal forest contains 35% of the world's wetlands and has the largest coverage of peatlands in the world.[156] It provides habitat for many important wildlife species and has the highest diversity of breeding bird species in North America.[157]

The Athabasca oil sands deposit is situated wholly within this boreal forest. The region is not only subject to in situ and surface mining development but also to conventional oil and gas production and logging operations. Within the region, Alberta Pacific Forestry Limited (Al-Pac) holds a Forest Management Agreement (FMA) for 5.8 million hectares of land, the majority of which is within the Athabasca oil sands region.[158]

Environment Canada has warned that the development of the oil sands presents "staggering challenges for forest conservation and reclamation."[159] Surface mining operations drastically alter the landscape and lead to changes in surface and groundwater flows.



The boreal forest is an interconnected mosaic of interconnected forests and wetlands. In fact ecologists say that "wetland" might be a better term to describe the great northern forest since 40% of the boreal forest landscape in Alberta consists of wetlands. The forest provides critical ecological services including carbon storage and climate regulation. Environment Canada has warned that the development of the oil sands presents "staggering challenges for forest conservation and reclamation."

PHOTOS: DAVID DODGE, THE PEMBINA INSTITUTE

In addition to directly removing large areas of wildlife and bird habitat, areas of habitat surrounding surface mines may be less frequented by wildlife because of noise and the presence of humans. To allow wildlife to move between virtual "islands," effective habitat corridors of undisturbed land between projects are essential.

While in situ operations are considered by some to impose less impact on the land than surface mines, the network of seismic lines, roads, power line corridors, pipelines and other infrastructure create a patchwork of fragmented habitat.[160] Fragmentation occurs when extensive, continuous areas of habitat are reduced to isolated and usually smaller patches of habitat. This can reduce the amount of habitat available and the movement patterns of wildlife and birds. While it appears more benign than the expansive open pit mines, habitat fragmentation "may be the most serious threat to biological diversity and is the primary cause of the present extinction crisis."[161]

4.3.2 Surface Mining and Reclamation

During surface mining operations rivers are diverted, wetland complexes are drained and the thin boreal forest soils are stripped away. The future reclaimed landscape that is currently being proposed by the industry will be radically different from the original mosaic of wetlands and forest. Current plans will lead to the creation of dry, forested hills instead of wetlands, a larger percentage of lakes (the end pit lakes), and the absence of peatlands, which take thousands of years to develop and cannot be recreated.[162] In the coming decades, almost 10% of the region's wetlands will be converted, mostly by oil sands operations, and permanently removed from the landscape.[163]

Wetlands account for approximately 40% of the boreal forest landscape in Alberta and fulfill an important ecological role.[164] In addition to being important habitat for rare plants and wildlife, wetlands and peatlands act as a sponge, regulating both surface and groundwater flows by absorbing water from spring snowmelt and summer storms and recharging groundwater aquifers in times of drought. In addition, they act as natural filters, cleansing the water that passes through them.

For the lands affected by oil sands development to be returned to the Province of Alberta, a company must demonstrate that it has reclaimed the land to an "equivalent land capability." This is defined as "the ability of the land to support various land uses after

▲

During surface mining operations, rivers are diverted, wetland complexes are drained and the thin boreal forest soils are stripped away.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

"Today the boreal region is undergoing human-induced changes of unprecedented magnitude and rapidity, many of which are potentially irreversible in cultural timeframes."

Global Forest Watch Canada[165]

OIL SANDS RECLAMATION: PAST, PRESENT AND FUTURE

Oil sands mining represents the most intensive and environmentally damaging method of oil extraction in Alberta, involving the drastic alteration of surface and subsurface materials.[166,167]

Very little area directly affected by mining operations has been restored to land with equivalent capability to the pre-mined land, and after 40 years of mining no operations have received a reclamation certificate.

Suncor states that it has reclaimed 858 hectares of land since it started operations in 1967, less than 9% of its total land disturbed to date.[168] *Syncrude's operations have disturbed 18,653 hectares, with 4,055 hectares of land reclaimed.*[169]

In response to growing criticism, the industry has adopted what it refers to as "progressive reclamation," which aims to reclaim land as quickly as is technically possible. However, even with progressive reclamation, virtually no reclamation is undertaken for the first 20-30 years of a project.

conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical."[170,171] It is important to note that this definition does not require that the pre-disturbance ecosystem be re-created. It is likely that the reclaimed landscape will lack the biodiversity of its pre-disturbance state, and it is acknowledged that it will be a major challenge to re-establish self-sustaining ecosystems.[172]

As noted in Section 4.2.2, the tailings produced using consolidated tailings technology will be incorporated into the reclaimed landscape. While they pose fewer challenges than the fluid fine tailings, consolidated tailings have some reclamation challenges of their own because of their high concentrations of salt[173] and the presence of bitumen and naphthenic acids. Because of the toxicity of naphthenic acids it has been noted that reclamation of tailings into terrestrial and aquatic landscapes at the end of a mining operation must "address residual levels of naphthenic acids and their rate, fate, and transport in the environment."[174]

Surface mining will result in irreversible impacts to entire watersheds because

▲ *Reclamation of mines and old tailings ponds present a very significant challenge. Some doubt whether boreal forest can be reclaimed to something resembling the natural ecosystem that once existed. Since mining began in the late 1960s none of the reclaimed lands have been certified as reclaimed.* PHOTO: THE PEMBINA INSTITUTE

it is not possible to re-create the ecological diversity and inter-relationships of the boreal ecosystem. For example, the approved and planned development of several surface mines in the Muskeg River watershed threatens to damage the entire watershed.[175] Environment Canada has stated that this level of impact to the Muskeg River watershed may be irreversible.[176]

Given that widespread reclamation using tailings material has not yet been demonstrated, there is significant uncertainty with regards to the long-term stability of created landforms, the long-term performance and survival of native vegetation species, and the ability to restore landscape biodiversity. Despite all the uncertainty, applications for new surface mines take successful reclamation as a given. Canadian Natural Resources Ltd. stated in the environmental assessment for its Horizon Mine: "Mitigation paired with reclamation assumes a post-project success rate of 100%. Residual effects are considered on this basis. Uncertainty with reclamation methods is assumed to be resolved with ongoing reclamation monitoring and research."[177]

This optimism is not shared by all stakeholders. Al-Pac's 2005 Forest Management Plan, which lays out its harvest plans for the next 200 years, states that "in cases such as oil sands developments, the *productive status is removed from the landbase for the length of the timber supply analysis/FMP - 200 years*. These lands *may* be returned to productive ecosystem status *(emphasis added)*."[178] At best, reclamation of the oil sands region will be large-scale experiments that are unlikely to restore a self-sustaining boreal forest ecosystem within the next century.

▲
In some oil sands reclamation work, trees are growing on reclaimed lands, but biologists are still questioning whether a self-sustaining boreal forest ecosystem can ever be re-created.

PHOTO: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE

The woodland caribou is a threatened species and can be very sensitive to disturbance and habitat loss.

PHOTO: CPAWS

THREATS TO WOODLAND CARIBOU

Woodland caribou have been designated as "threatened" under Alberta's Wildlife Act and the federal Species at Risk Act (SARA). They are extremely sensitive to disturbance and stay well back from clearings such as roads, seismic lines and well sites. The combination of forestry, oil and gas, and oil sands development is continually shrinking the areas of effective habitat that can support viable populations. Cleared paths such as seismic lines have made it far easier for hunters as well as wolves and other predators to access areas where the caribou are located.

4.3.3 Fragmented Forests

Fragmentation has a negative effect on species that require extensive tracts of habitat such as interior-nesting birds and large carnivores.[179] In addition, the construction of new roads and corridors increases access for hunting and other recreational uses that can place additional pressures on wildlife populations.

Fragmentation of the forest by in situ operations begins as soon as oil sands companies acquire a mineral lease, which allows them to begin exploration. New roads are constructed to access the area, and a network of intersecting seismic lines and exploration well sites are cleared. Although progress has been made to reduce the width of seismic lines, the region is covered with seismic and well site scars. This is because the oil industry is still not required to replant seismic lines and well sites with trees after the soil has been reclaimed. Environment Canada has noted that clearing in the boreal forest for seismic exploration by the oil and gas industry, including the oil sands industry, equals or exceeds the amount removed by the forestry industry each year.[180]

The Al-Pac FMA that overlaps much of the Athabasca oil sands deposit has

Environment Canada has noted that clearing in the boreal forest for seismic exploration by the oil and gas industry, including the oil sands industry, equals or exceeds the amount removed by the forest industry each year.

PHOTO: DAN WOYNILLOWICZ, THE PEMBINA INSTITUTE

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FIGURE 19:
Satellite image of the oil sands from an altitude of 320 kilometres
SOURCE: TERRASERVER.COM

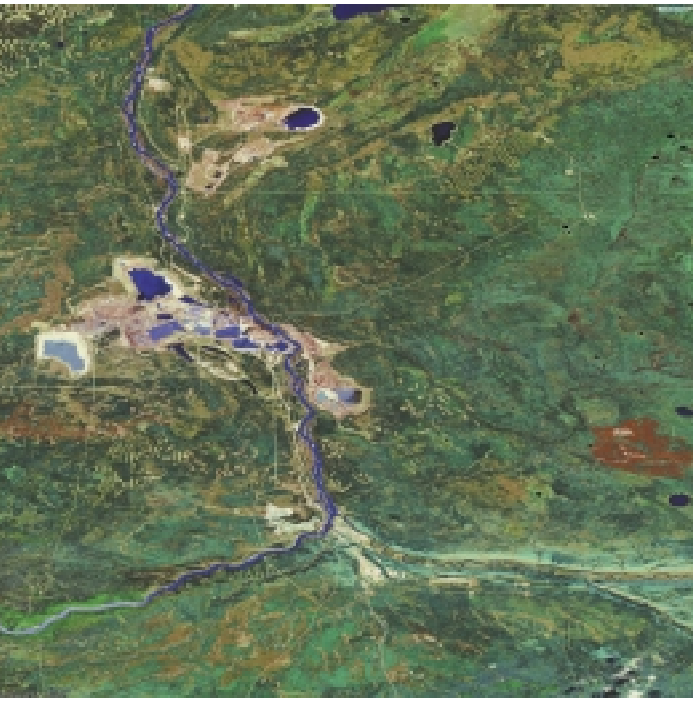

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FIGURE 20:
Satellite image of an area of in situ development, Cold Lake Alberta
SOURCE: TERRASERVER.COM

more than 100,000 kilometres of linear developments, with an average density of 1.8 kilometres per square kilometre within its FMA (that is, within one square kilometre of forest there exists 1.8 kilometres of linear cuts).[181] If forestry activity persists at current levels and the energy sector expands as predicted, the average density of linear developments will increase to over five kilometres per square kilometre.[182]

As one of the most sensitive animals in the boreal forest, woodland caribou are used as an indicator of the health of the boreal ecosystem. Woodland caribou habitat quality has declined by 23% over the past several decades in the Al-Pac FMA. Further declines are expected if trends in industrial development continue.[183]

4.3.4 A Growing "Footprint"

The "footprint" of oil sands development in Alberta's boreal forest is growing rapidly. Individual mines range in size from 150 to 200 square kilometers. Mine pits and massive tailings ponds are easily visible to the naked eye from the altitude of an orbiting space shuttle (Figure 19), and an aerial overview of areas with in situ operations reveals a spider web of above-ground pipelines and well pads (Figure 20).

Approximately 1,807 oil sands lease agreements are in place covering an area of 32,000 square kilometres.[184] While this may seem like a substantial number of leases, close to 80% of oil sands areas are still available for exploration, leasing and development.[185] The amount of landscape destruction experienced to date is only a hint of what is still to come (Figures 21 and 22).

▲

Archie Waquan, former Chief of the Mikisew Cree.
PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

"When industry talks about footprint, sometimes I think it's an overused term. A footprint... how I know it, is after two or three rains it's gone. A footprint. The footprints you see up north here are not exactly footprints, okay."

Chief Archie Waquan, Mikisew Cree First Nation[186]

"What's happening to the boreal forest within the 3,450-square-kilometre oil sands Surface Mineable Area of northeast Alberta, can legitimately be described as an ecological holocaust."

Dr. Richard Thomas[187]

THE OIL SANDS "FOOTPRINT" IN PERSPECTIVE

Existing, approved and currently planned oil sands mines and in situ projects in the region will directly impact more than 2000 square kilometres of boreal forest. This is

- *Approximately 28,465 NFL football fields.*
- *Approximately 2.5 times larger than Calgary and 3 times larger than Edmonton*
- *More than 5 times the size of Denver.*
- *Almost the size of Tokyo – home to 12 million people.*

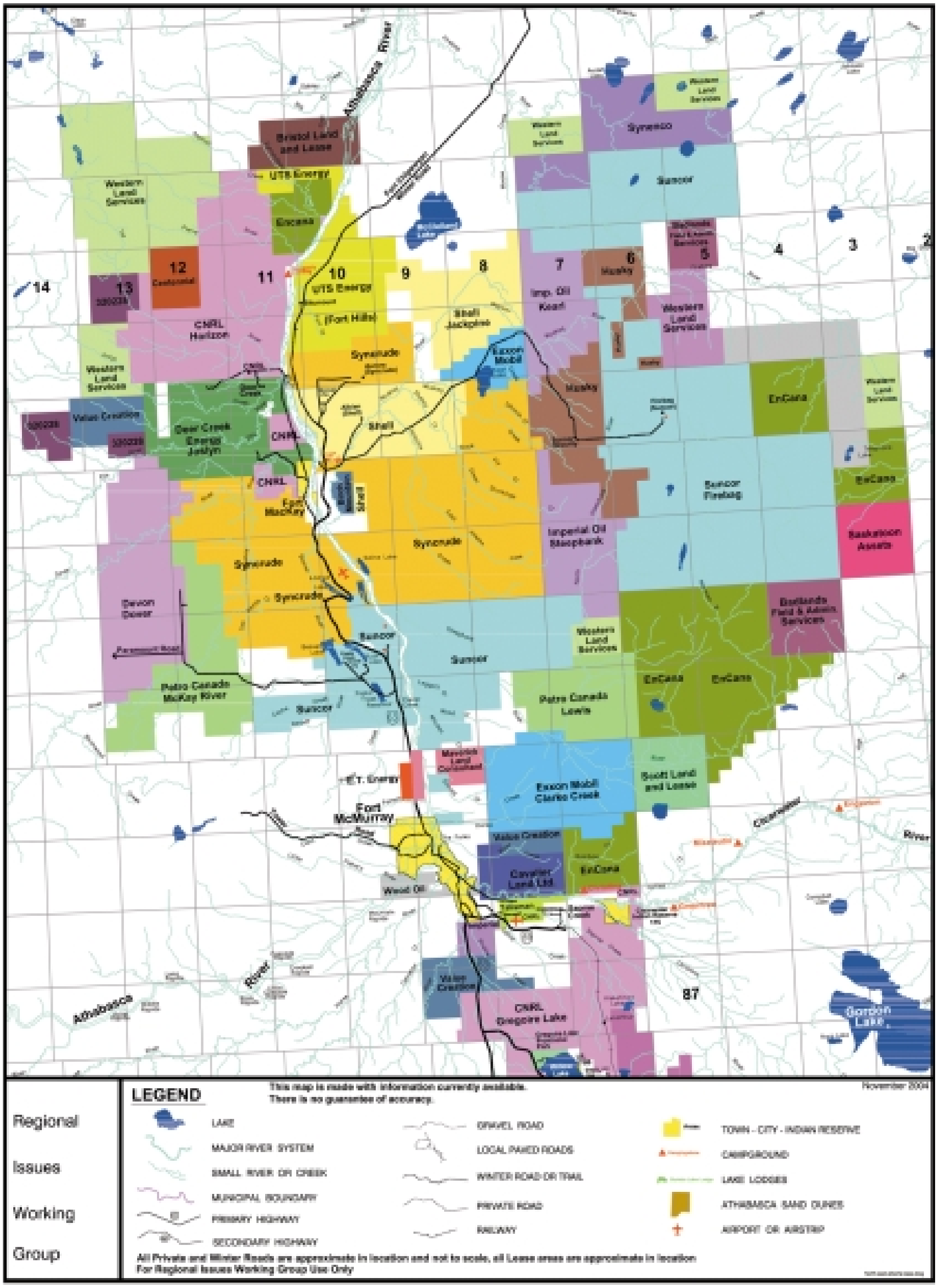


FIGURE 21: Current oil sands leases north of Fort McMurray – Athabasca Oil Sands

In 2003, Alberta Environment reported that the Athabasca oil sands region had approximately 430 square kilometres of land that had been directly impacted, approximately 90% of which was the result of three oil

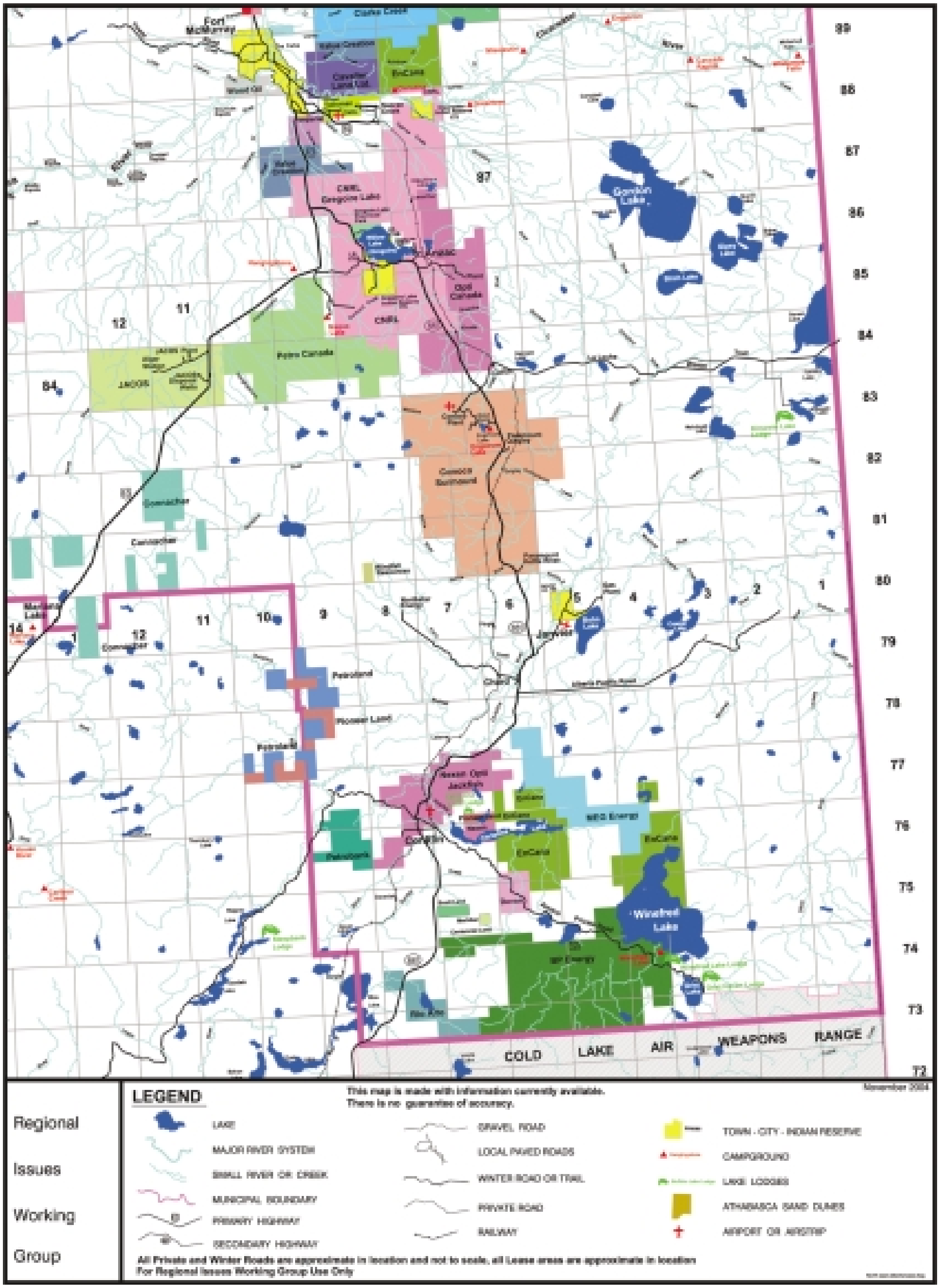
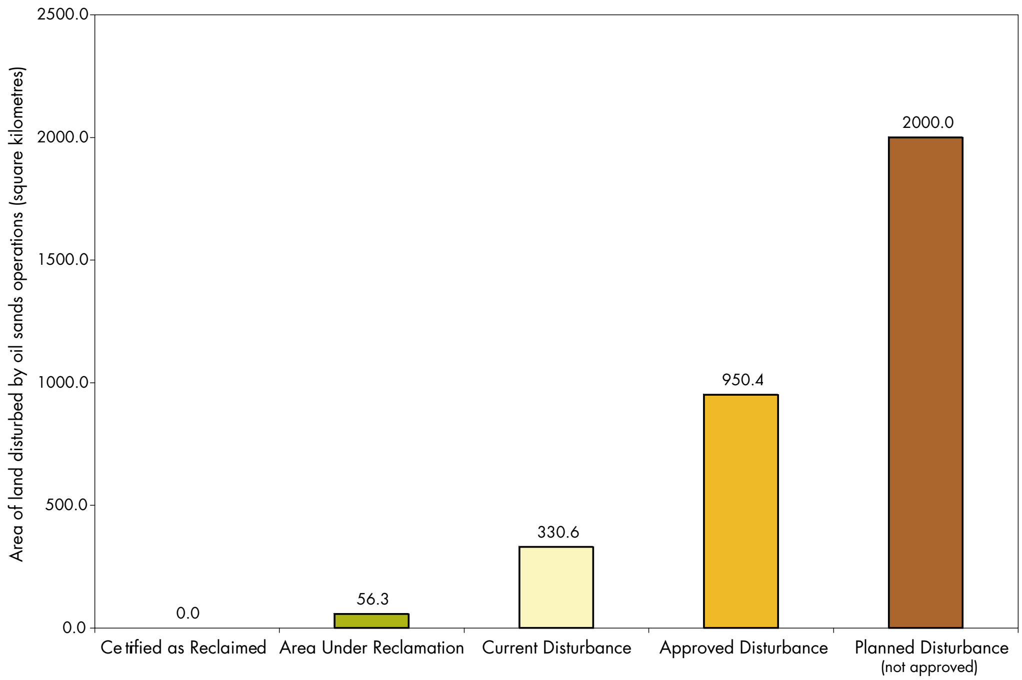


FIGURE 22: Current oil sands leases south of Fort McMurray – Athabasca Oil Sands

sands mines and two SAGD operations.[188] By mid-2004, the total amount of land either already impacted, or approved for future disturbance by oil sands operations, was 950 square kilometres.[189]

The most recently filed environmental impact assessment (EIA) has projected that currently planned oil sands development in the region will lead to a cumulative disturbance of more than 2000 square kilometres.[190] This growing footprint is illustrated in Figure 23.

FIGURE 23: Land disturbance and reclamation in the Athabasca oil sands region [191]



4.4 Polluted Air

4.4.1 A Pollution Capital

The rapid expansion of the oil sands is driving up the pollution emitted in Alberta. According to PollutionWatch, companies in Alberta emitted more than one billion kilograms of air pollutants in 2003, which puts Alberta in the #1 spot in the country for air releases from industrial sources.[192]

Every day the oil sands industry consumes enough natural gas to heat 3.2 million Canadian homes for a day.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Criteria Air Contaminants (CACs) are the most common air pollutants released by heavy industry burning fossil fuels. CACs are defined as "air pollutants that affect our health and contribute to air pollution problems" and include such things as nitrogen oxides ($N0_x$), sulphur dioxide ($S0_2$), volatile organic compounds (VOCs) and particulate matter (PM) - all of which are emitted in large volumes by oil sands operations.[193] Table 5 provides an overview of the human health effects and environmental impacts associated with these pollutants.

TABLE 5:
Effects of criteria air contaminant emissions on human health and the environment

Pollutant	Effects on Human Health	Effects on the Environment

Nitrogen oxides (NO_x)	• Irritates the lungs and increases susceptibility to respiratory infections [194]
	• Combines with VOCs in the presence of sunlight to form ground-level ozone, which can cause damage to human health [195]
		• Is a major component of acid rain, which can [200]
		  • leach essential nutrients from the soil and thereby negatively affect health and rate of growth of trees
		  • reduce capacity of lakes and soil to neutralize acids and potentially change the pH condition of lakes and soil
		  • alter lakes and soil that become acidified
		• Can create a "fertilizer effect," called eutrophication, which can alter the types of plants and animals that can live in the boreal forest [201]
		• Can combine with VOCs in the presence of sunlight to form ground-level ozone [202]
		• Contributes to the formation of smog and haze

Sulphur dioxide (SO_2)	• At high levels can cause premature death, increased respiratory symptoms and disease, decreased lung function, as well as alterations in lung tissue and structure, and in respiratory tract defence mechanisms [196]	• Is a major component of acid rain • Contributes to the formation of smog and haze
Particulate matter ($PM_{2.5}$)	• Can be carried deep into the lungs • Has been linked with heart and lung problems such as asthma, bronchitis and emphysema [197] • Strong links between high levels of airborne sulphate particles and increased hospital admissions for heart and respiratory problems, and higher death rates from these ailments [198]	• Is composed of organic and elemental carbon particles from combustion of fossil fuels as well as sulphur and nitrogen compounds that can contribute to acid deposition • Contributes to the formation of smog and haze
VOCs	• Individual VOCs can be toxic to humans • Benzene is a VOC emitted by oil sands operations. It is carcinogenic to humans and a non-threshold toxicant, which means that there is some probability of harm at any level of exposure [199]	• Can combine with NO_x in the presence of sunlight to form ground-level ozone [203] • Contributes to the formation of smog and haze.

While several other toxic pollutants are also emitted such as heavy metals, polycyclic aromatic hydrocarbons (PAHs)[204] and ammonia, they will not be discussed in detail.

The oil sands industry has reduced the volume of pollutants it emits (referred to as emissions intensity) to produce a barrel of synthetic crude oil. Despite these efforts, the emissions intensity of oil sands production for common pollutants remains higher than that of conventional oil production because there are many more steps involved in producing synthetic crude oil from oil sands (Figures 24 and 25).

FIGURE 24: Nitrogen oxide intensity of producing synthetic crude oil from oil sands versus conventional oil in Alberta[205,206]

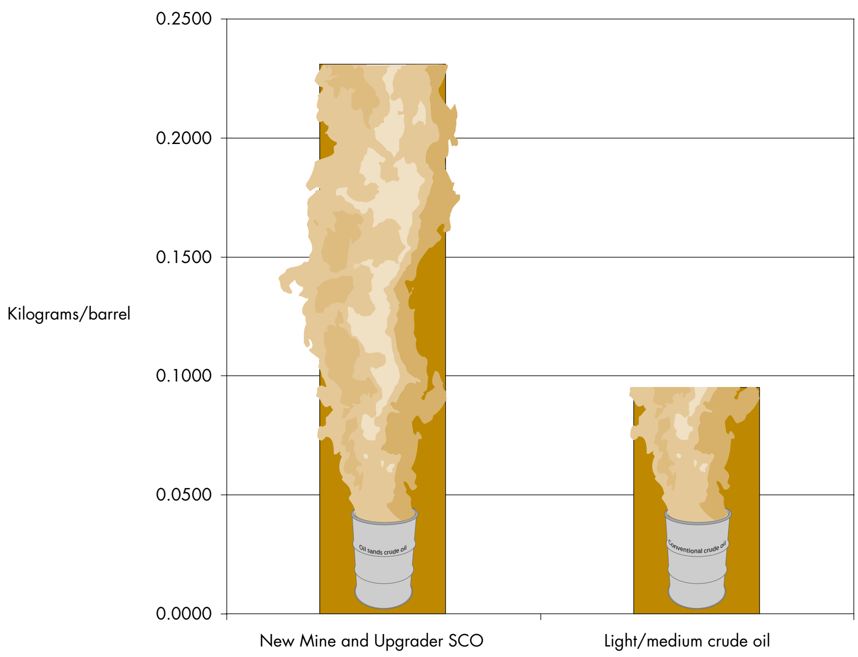


FIGURE 25: Sulphur dioxide intensity of producing synthetic crude oil from oil sands versus conventional oil in Alberta[207]

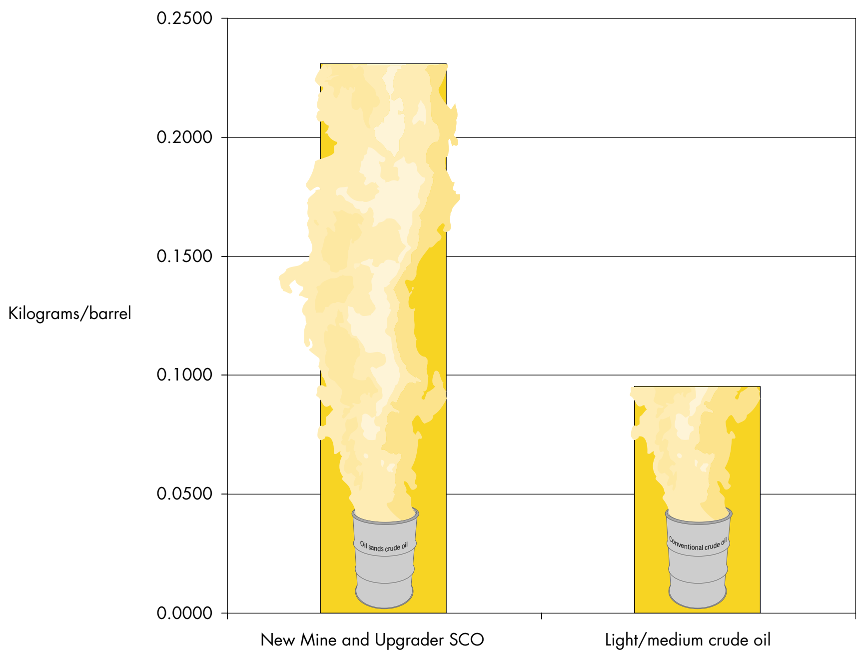
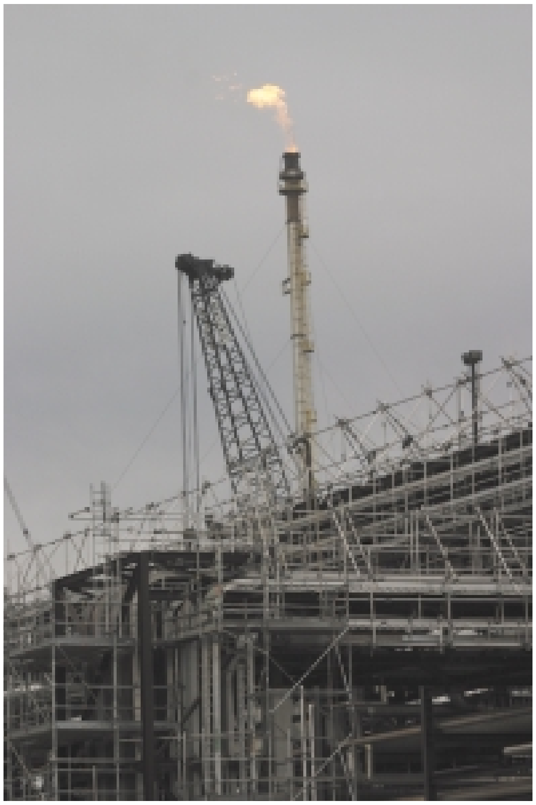


TABLE 6:
Steps required before oil can be refined

Crude Oil	Synthetic Crude Oil	
Pumpjacks to bring oil to the surface Pumps to ship the oil by pipeline to a central facility	Mining and extraction: Mine vehicles to uncover and transport the oil sands deposit Heated water and agitation to extract bitumen from sand and clay Tailings ponds Mine vehicles to fill in pits and reclaim mine	In situ: Steam injection to liberate bitumen from sand and clay Pumpjacks to bring the oil to the surface Pumps to ship the bitumen by pipeline to a central facility Energy to treat and reuse water
Heaters to separate water and other impurities Removal of sulphur compounds if present	Upgrading to break down the bitumen using high heat and pressure Removal of sulphur compounds	

In 2003, Syncrude and Suncor's facilities were ranked number one and two respectively as Alberta's largest emitters of CACs.[208] Similarly, their facilities ranked fifth and eleventh among the most polluting facilities in Canada.[209] The anticipated growth of air pollution from oil sands development promises to keep Alberta ranked number one in Canada for air pollution for decades, with more oil sands facilities likely to join the national Top 20 list of polluting facilities.



Extracting and upgrading the oil sands into synthetic crude oil requires the burning of large amounts of fossil fuels and therefore emits significant amounts of air pollution.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

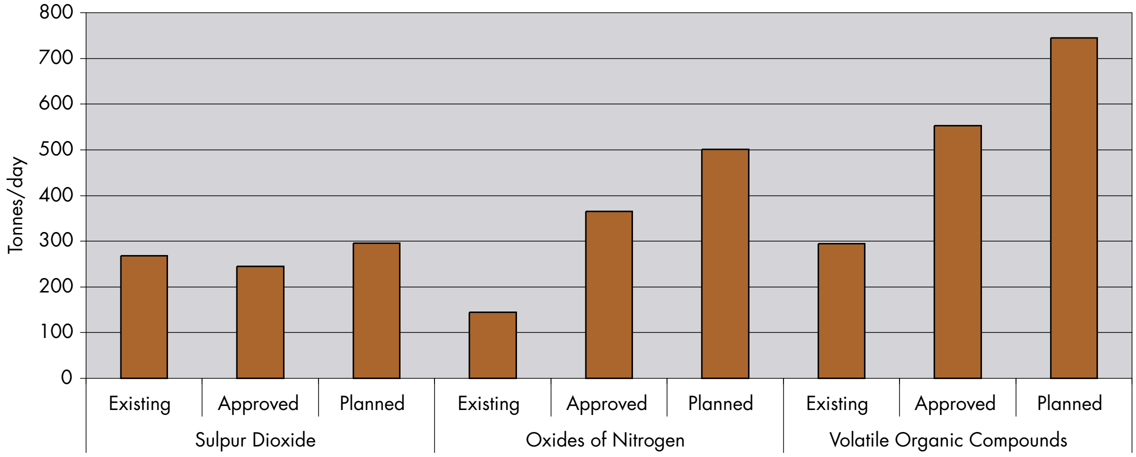
4.4.2 The Impacts of Increasing Air Pollution

Since commercial oil sands production began, the residents of Fort McMurray and other towns in the region have expressed concerns with air toxins and acid-forming pollutants. Extracting and upgrading the oil sands into synthetic crude oil requires the burning of large amounts of fossil fuels and therefore emits significant amounts of air pollution. The air quality in the Fort McMurray area is the same or better than in Calgary or Edmonton.

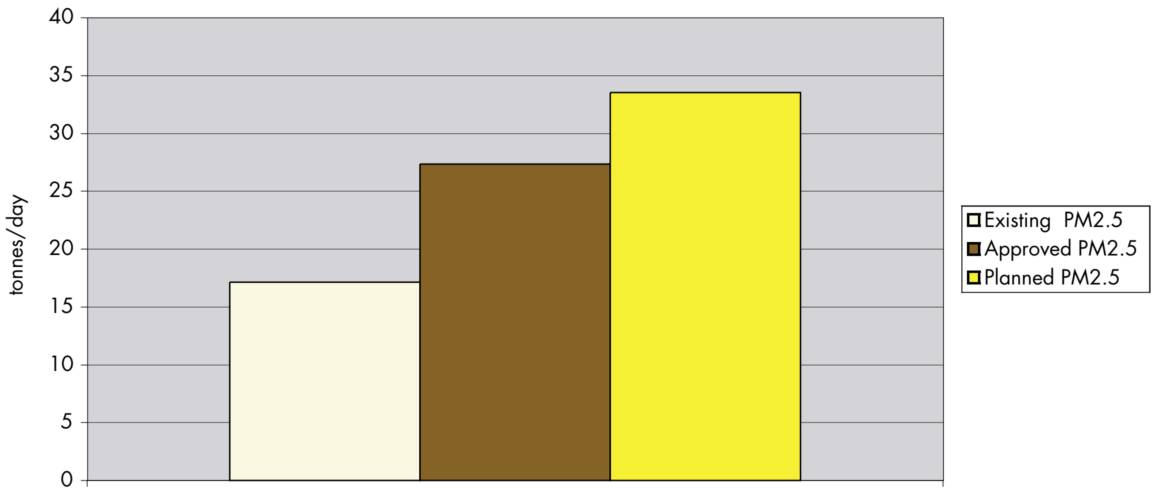
However, the air quality of the region will be further degraded as oil sands production rises to 2.5 million barrels per day, when facilities that have been approved go into production, and then to 3.7 million barrels per day when currently planned facilities also go into production.[210] (Figures 26 and 27).

NB: Companies evaluate three oil sands production scenarios when they assess the impacts from combined air pollution:

Existing	Currently polluting sources
Approved	Existing + government-approved sources
Planned	Existing + approved + projects awaiting approval



▲ *FIGURE 26: Total air emissions existing, approved and planned for the Athabasca oil sands region*[211]



▲ *FIGURE 27: Total particulate matter ($PM_{2.5}$) emissions existing, approved and planned for the Athabasca oil sands region*[212]

Sulphur that is removed from the bitumen during upgrading is stored in large sulphur blocks.

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

BITUMEN

Bitumen contains sulphur that must be removed at the upgrading stage so that the bitumen can be sent to a refinery. Most of it is converted into elemental sulphur, but some is released to the air. The total currently approved level of sulphur dioxide releases from all sources in the Athabasca oil sands region is 245.5 tonnes/day.[215]

KEARL OIL SANDS

Imperial Oil's Kearl Oil Sands Mine fleet of trucks and shovels account for over one-half of the project's emissions of $PM_{2.5}$. Fleet air emissions are dominated by 114 haul trucks that run 24 hours a day, 7 days a week, 365 days a year at peak production.[216] *Each truck has an engine that is roughly equivalent in size to a locomotive engine. Imperial's mine fleet will add approximately 376 tonnes of $PM_{2.5}$ per year to the region's airshed.*[217]

4.4.3 Future Trends in Air Pollution

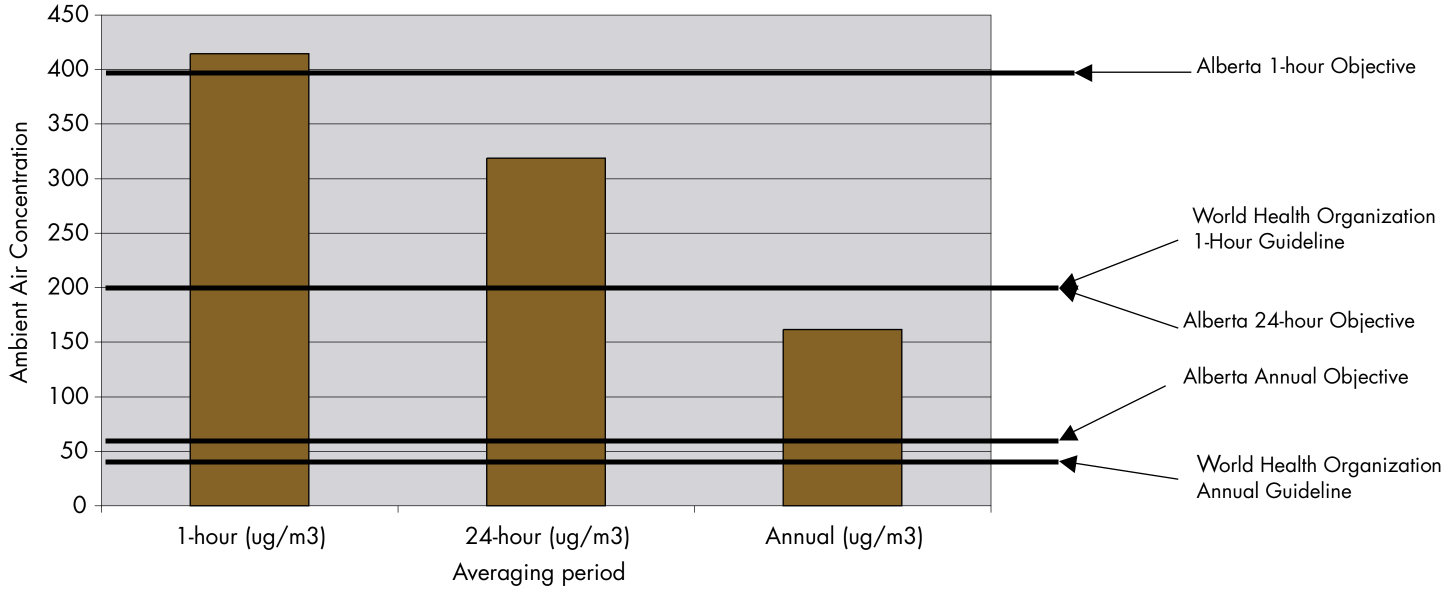
When environmental assessments are conducted to evaluate the impacts of increasing air emissions, the impacts from the proposed project are compared to an approved scenario. Computer-generated air dispersion models are used to predict the concentration of air pollutants for both the approved scenario and a planned scenario.

As depicted in Figures 28 and 29, modelling of today's approved scenario, which includes three operating mines and three mining operations at various stages of planning and construction, shows that maximum predicted ambient air concentrations of $N0_x$ and $S0_2$ already exceed provincial, national and international guidelines.[213] New projects will exacerbate this situation.

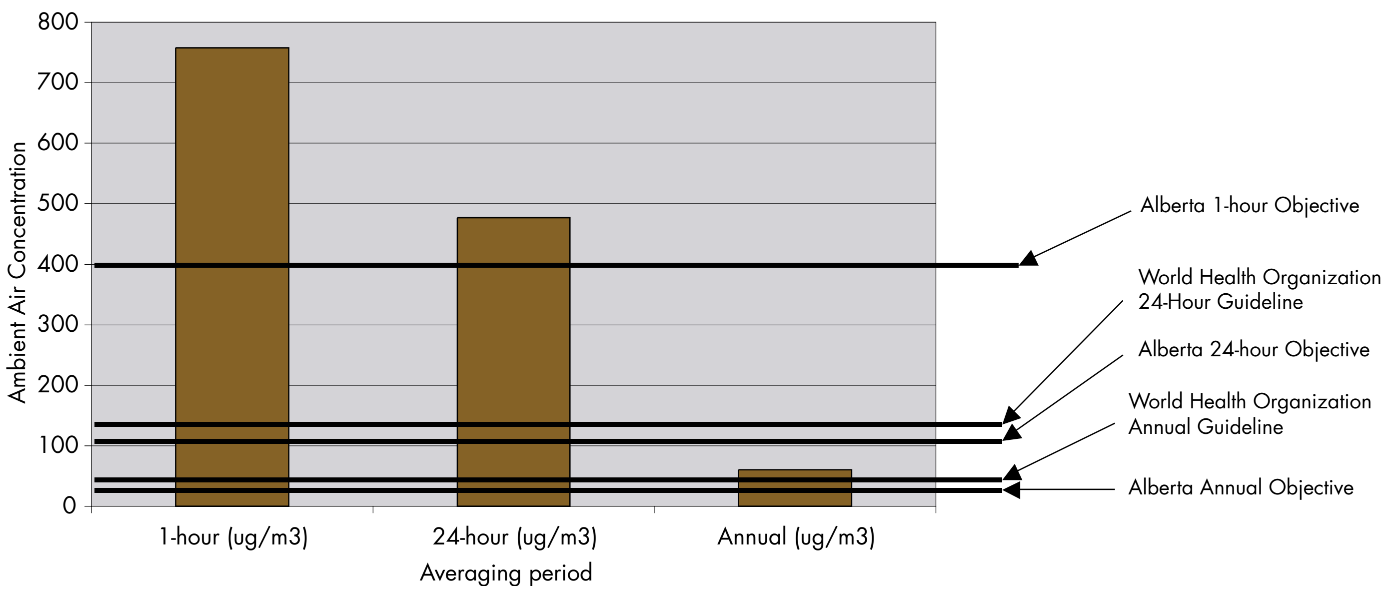
Particulate matter ($PM_{2.5}$) refers to microscopic airborne solid and liquid particles less than 2.5 microns in size. $PM_{2.5}$ is emitted directly when fossil fuel is burned. Emissions of $S0_2$, $N0_x$ and VOC also combine to form particulates in the atmosphere.

In response to human health concerns, the federal and provincial governments have agreed to establish a "Canada Wide Standard" for $PM_{2.5}$ at 30 micrograms per cubic metre (ug/m^3). This standard is to come into effect in 2010.[214]

This standard reflects a political tradeoff between economic activity and human health because numerous epidemiological studies on short-term response to $PM_{2.5}$ indicate adverse health effects well below the Canada Wide Standard level (15 ug/m^3 and



▲ *FIGURE 28: Approved scenario – predicted maximums for nitrogen oxides exceed guidelines* [218]



▲ *FIGURE 29: Approved scenario – predicted maximums for sulphur dioxide exceed guidelines* [219] potentially lower).[220] Recognizing that the 30 ug/m3 standard was inadequate, the Province has developed the Alberta Particulate Matter and Ozone Management Framework.[221] This framework was designed to prevent degradation of air quality in areas that are below the Canada Wide Standard level.

Modelling of the approved scenario shows that although $PM_{2.5}$ levels are rising, all communities in the region would experience concentrations below the Canada Wide Standard.[222] The planned scenario models predict further increases in $PM_{2.5}$. This means that seven communities will be subjected to levels higher than the Alberta Particulate Matter and Ozone Management Framework Level of 20 ug/m3 – the level that requires Alberta Environment to implement a management plan to prevent further degradation of air quality. [223,224]

Emissions of VOCs are also on the rise because of both emissions from burning fossil fuels (e.g., natural gas, diesel, coke) and the growing number of tailings ponds. (VOCs are a large category of pollutants that share one characteristic – they evaporate or volatilize into the air.) In 2002, Alberta was among the top four states and provinces in North America for emissions of VOC emissions.[225] Currently operating and approved oil sands developments account for more than 500 tonnes per day of VOC emissions.[226] Once planned oil sands development is considered, this total is predicted to grow to more than 750 tonnes per day.[227]

4.4.4 Acid Rain

When acid rain or particles fall onto the land, they are measured as the potential acid input (PAI). Expressed in kiloequivalents per hectare per year (keq/ha/yr)[228] PAI is used to evaluate the environmental impacts of acidifying emissions ($N0_x$ and $S0_2$). Scientists can estimate how much acid the land can withstand before the chemistry of its soil begins to change, resulting in changes to the types of plants and trees that make up the ecosystem. Land with sensitive soils can absorb less acid than land with non-sensitive soils. This amount of acid is referred to as the ecosystem's critical load.[229]

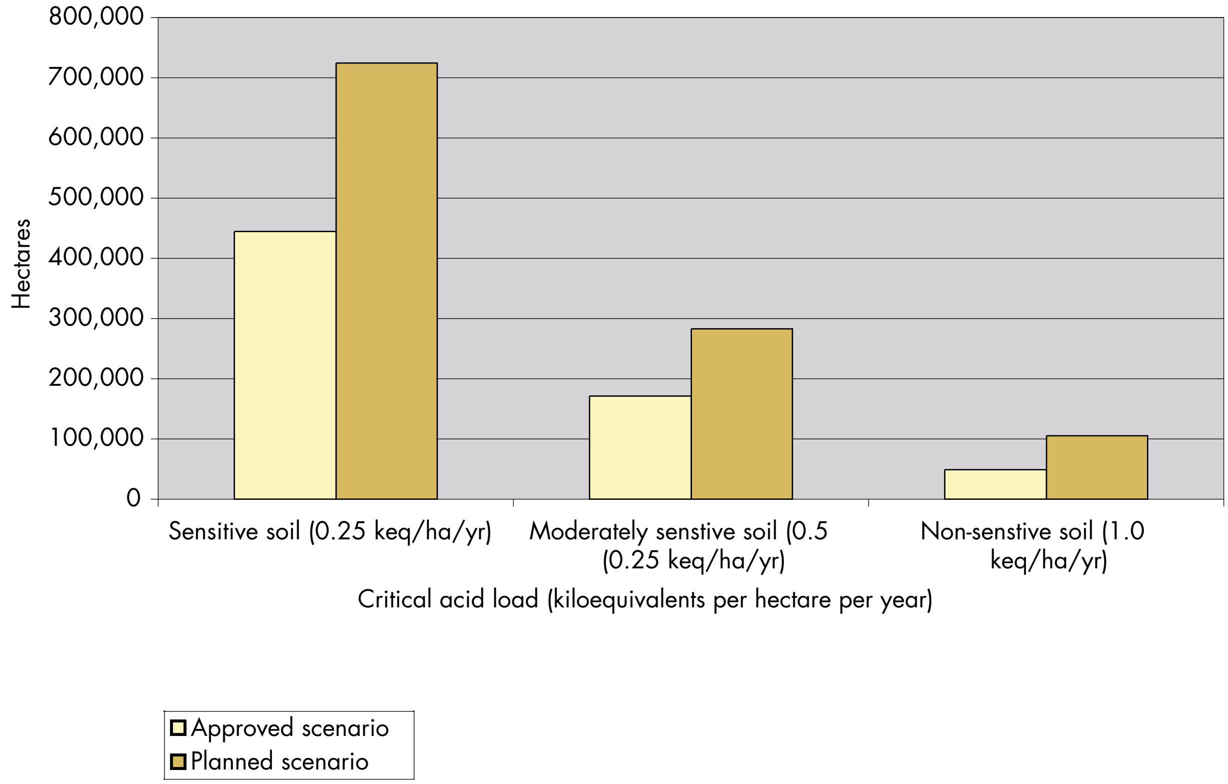
Critical loads have been determined for Alberta soils ranging from sensitive, to moderately sensitive, to not sensitive. If one were to assume that the entire area affected by emissions from oil sands operations has non-sensitive soil, a very conservative assumption, an area equivalent to almost 500 square kilometres is at risk from the acidifying emissions of oil sands projects that are already operating or have been approved to operate (Figure 30). This area will almost double to 1000 square kilometres in the planned scenario.[230]

Water bodies are also at risk of acidification in the Athabasca region. A 2004 study predicted that the acidifying emissions from planned oil sands development would result in the acidification of 25 lakes in the region.[231] This study only analyzed the sensitivity of 6% of the lakes in the region so this tally may be underestimated.

BENZENE

Benzene, one of the VOCs emitted by oil sands operations, has been the target of a successful nation-wide reduction campaign that started in 1995 in response to concerns about the level of human exposure. Actual releases of benzene and concentrations of benzene in the air have been reduced significantly, and the national reduction effort has now entered a second phase.[232] Meanwhile, benzene levels in the air in Fort McMurray and surrounding communities are rising in conjunction with rising VOC emissions in the oil sands.[233]

The massive tailings ponds account for the high VOC emissions in the region. For example Imperial Oil estimates that its tailings pond will account for about three-quarters of its total daily release of 74.01 tonnes of VOCs.[234]



▲ *FIGURE 30: Area of land above the critical load for acid deposition to soil*[235]

LONG RANGE TRANSPORT OF ACIDIFYING EMISSIONS

Acid-forming pollutants can travel hundreds or even thousands of kilometers. Alberta's oil sands development have the potential to contribute to the plume of acid compounds that travels across Canada and undermines efforts to reduce impacts in eastern Canada.

In an effort to proactively prevent environmental damage to the region's ecosystem from acid deposition, the government of Alberta has implemented an initial management framework developed by the Cumulative Environmental Management Association stakeholders. However, successful implementation is subject to the political will of government to implement the recommendations, and to provide adequate funding and human resources to ensure successful completion of key scientific research.

Preliminary national emissions projections from 2000 to 2020 predict that the general trend for $S0_2$ and $N0_x$ will be downwards by 8% and 16% respectively. However, emissions of $S0_2$ and $N0_x$ from oil and gas and oil sands development are predicted to increase during this time period.[236] Whereas $S0_2$ emissions are predicted to decline by 21% in eastern Canada and 38% in the US, they are expected to rise by 15% in western Canada.[237]

4.5 Managing Cumulative Environmental Impacts

4.5.1 Regulating and Managing the Oil Sands

The oil sands are a provincial resource, and therefore the government of Alberta is the primary regulator of their development. The government-appointed EUB is a regulatory agency tasked with ensuring "that the discovery, development, and delivery of Alberta's energy resources and utilities services take place in a manner that is fair, responsible, and in the public interest."[238,239] The EUB is the primary decision maker regarding proposed projects. Subject to EUB approval, Alberta Environment (AENV) is responsible for granting regulatory approvals and licenses for air emissions, water withdrawals and land disturbance. The regulatory authority of the government of Canada is limited to instances in which a proposed project requires a federal approval or permit, most commonly related to the Department of Fisheries and Oceans' (DFO) jurisdiction over fisheries.[240]

4.5.2 Creating a Plan

The regulatory agencies evaluate the environmental impacts of oil sands development on a project-by-project basis. However, as the second wave of development began in the mid-1990s, regional Aboriginal and Métis, community members and environmental groups noted that the project-by-project review of proposed oil sands development ignored the cumulative environmental impacts.

"Most of the world's forests are islands of wilderness in a sea of development. We'd like to flip that around in the boreal and have islands of economic development in a sea of wilderness."

Stewart Elgie, Canadian Boreal Trust[241]

◀ *The Athabasca River at sunrise near Wood Buffalo National Park.*

PHOTO: DAVID DODGE, THE PEMBINA INSTITUTE

Rather than altering its regulatory approach, in 1999 the government of Alberta crafted a Regional Sustainable Development Strategy (RSDS) for the Athabasca Oil Sands in recognition of "The unprecedented pace of development in the Athabasca Oil Sands Area" and the resultant "increased potential for effects on environmental quality, species diversity and abundance, and human health."[242] The purpose of the RSDS was to develop a framework that would, among other things: "Create an enhanced management framework that will adapt to the changing needs of the area, which will guide government's environmental and resource managers" and "Develop a strong foundation of environmental information and science to assist in making decisions on sustainable resource and environmental management in the region."[243]

4.5.3 Implementing the Plan

In 2000, the Cumulative Environmental Management Association (CEMA)[244] was established to work with the Government of Alberta to implement the RSDS by collecting scientific information and making recommendations for how best to manage the cumulative environmental impacts of industrial development in the region.[245] In the hopes of replicating Alberta's Clean Air Strategic Alliance (CASA)[246] success in developing provincial air quality management systems for other industrial activities, CEMA was established as a consensus-based, multistakeholder group comprised of representatives from the oil industry, the governments of Alberta and Canada, Aboriginal and Métis groups, and environmental non-governmental organizations.[247] The 72 environmental issues identified in the RSDS were prioritized, and it was anticipated that the highest priority issues (Category A) would be addressed within two years.

4.5.4 Slipping Timelines

In 2001, the government of Alberta released a progress report on the RSDS, in which it noted that, contrary to the RSDS plan that had stated that management objectives for category A themes would be completed in two years, no management objectives had been completed. This lack of progress was linked to "the complexity of the environmental issues and the consultative, interactive nature of the partnership process, and the work group's demand for a thorough approach make the strategy's original targets unrealistic."[248] Further, the report noted: "The effort required by the working groups is very intensive and necessitates individuals to commit their time over and above their regular work activities.... This is compounded by the increasing pace of development and large number of projects in the oil sands area that are often drawing on the same consultants."[249]

While all stakeholders have placed significant emphasis on the success of CEMA, it has been far less effective than originally envisioned. Between 2000 and the end of 2004, CEMA's working groups produced 52 reports and four recommendations to the government of Alberta, including one regional environmental management framework.[250] As demonstrated in Table 7, the timelines for CEMA delivering management plans have been consistently delayed and may not be complete before many more approvals are granted for oil sands development. Given the importance and scope of conducting research to define environmental thresholds and develop regional environmental management systems, undertaking this work in parallel to ongoing oil sands development is a challenge. The steady stream of applications for proposed oil sands projects submitted for regulatory and stakeholder review imposes a significant workload on the government and Aboriginal and ENGO members of CEMA, competing for their time and resources.

Regulatory decision makers such as the EUB have acknowledged that CEMA has not been keeping pace with the rate of oil sands development in the region. While the EUB has made recommendations to various provincial and federal government agencies regarding their role in ensuring that CEMA is effective and the RSDS is implemented, these agencies have done little in response. As a result, an ongoing lack of human resources and limited government leadership has hampered CEMA's ability to achieve its objectives.

LOTS OF TALK, LITTLE ACTION

"The [Energy and Utilities Board] Board notes that OSEC [the Oil Sands Environmental Coalition] has requested that the Board conduct a public inquiry into the ecological carrying capacity of the region. In this case, the Board believes that as long as the various initiatives are making adequate progress such an inquiry is unnecessary. However, it is clearly possible for a number of reasons that the proposed consensus based processes may not be able to move forward as quickly as needed. Accordingly, the Board has decided to reserve its decision on OSEC's request for a Section 22 proceeding, and may reconsider this request at some time in the future."[251]

Alberta Energy and Utilities Board, Muskeg River Mine Decision Report, 1999

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"In a series of decision in this area, the Board has placed significant reliance on the success of the CEMA process to verify that both existing and future oil sands developments remain in the public interest. The Board believes that CEMA's work is important and that the results will assist the Board in meeting its regulatory mandate to ensure that energy developments are carried out in an orderly and efficient manner that protects the public interest. The Board understands that CEMA is dealing with complex and difficult issues within a multistakeholder forum. Nonetheless, it is concerned with delays in the issuance of recommendations."[252]

Alberta Energy and Utilities Board, True North Fort Hills Mine Decision Report, 2002

■

"The [Joint Federal-Provincial Review] Panel has concerns that CEMA's effectiveness may also be influenced by the volume and complexity of its work, multiple priorities of stakeholders, and funding mechanisms that may not keep pace with CEMA's increased workload from oil sands expansions, new oil sands mining and in situ projects, and other contributors of regional cumulative effects"[253]

Alberta Energy and Utilities Board, CNRL Horizon Mine Decision Report, 2004

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"The [Joint Federal-Provincial Review] Panel understands that there is good support in general for CEMA but widespread concern about delays in delivery of environmental management objectives and plans &The Panel has serious concerns about delays in the issuance of recommendations and the ability of CEMA to meet the proposed timelines."[254]

Alberta Energy and Utilities Board, Shell Jackpine Mine – Phase 1 Decision Report, 2004

Working Group (WG)	Deliverable	Schedule set in 2001[255]	Schedule revised in 2002[256]	Schedule revised in 2004[257]	Current status 2005[258]
NO_x/SO_2 Management WG	Acid Deposition Management Framework	Q2* 2002	Q4 2002	Recommendation delivered August 2004	–
	Nitrogen Management Framework			2006	Deferred indefinitely
	Ground Level Ozone	Q4 2003	Q4 2003	2005	Deferred to 2006
Surface Water WG	Instream Flow Needs Management Framework	Q2 2004	Q4 2004	Q4 2005	Interim system by end of 2005 with further refinement in 2006
	Watershed Integrity Management Framework	Q4 2003		Q4 2005	Deferred to 2006
	Surface Water Quality Objectives	Q2 2003	Q3 2003	No longer being worked on by CEMA.	
Sustainable Ecosystem WG	Ecosystem Management Tools		Q4 2002	Completed February 2004	
	Management Systems for Cultural and Historical Resources	Q2 2002	Q4 2003	Q4 2005	Deferred to Q4 2006
	Management Systems for Wildlife and Fish	Q3 2003	Q4 2003	Q4 2006	Deferred to Q4 2007
	Management Systems for Biodiversity	Q1 2003	Q4 2004	Q4 2007	
Trace Metals & Air Contaminants WG	Trace Metals Management System	Q4 2001	Q2 2002	Implemented May 2002	
	Trace Air Contaminants Management Objective	Q1 2003	Q2 2003	Q4 2006	Deferred to 2007/08
	Health Risk Assessment for Fort McKay			2007	Revised to general health risk assessment 2007
Reclamation WG	Landform Design Performance Objective (landform design checklist)	Q4 2002	Q4 2002	Completed Q1 2005	
	Land Capability Classification System (2nd Edition)			Q4 2005	
	Revegetation Manual (2nd Edition)			Q4 2005	Delayed to 2006
	Criteria for Reclamation Certification	Q4 2004	Q4 2004	Q1 2005	Delayed to 2006
	Landscape Design Guide			Q1 2005	Q4 2005 Expected
	Guidelines on Practical Methods to Re-establish Biodiversity and Wildlife	Q4 2005	Q4 2005	Q4 2005	
	Guidelines for Designing End Pit Lakes			Q4 2007	
	Guidelines for Wetland Establishment (2nd Edition)			Q3 2009	

*Q = annual quarter (i.e., January–March (Q1); April–June (Q2); July–September (Q3); October–December (Q4))

▲ *TABLE 7: Projected timelines for CEMA Working Group deliverables from 2001, 2002 and 2005*

4.6 Protecting the Environment

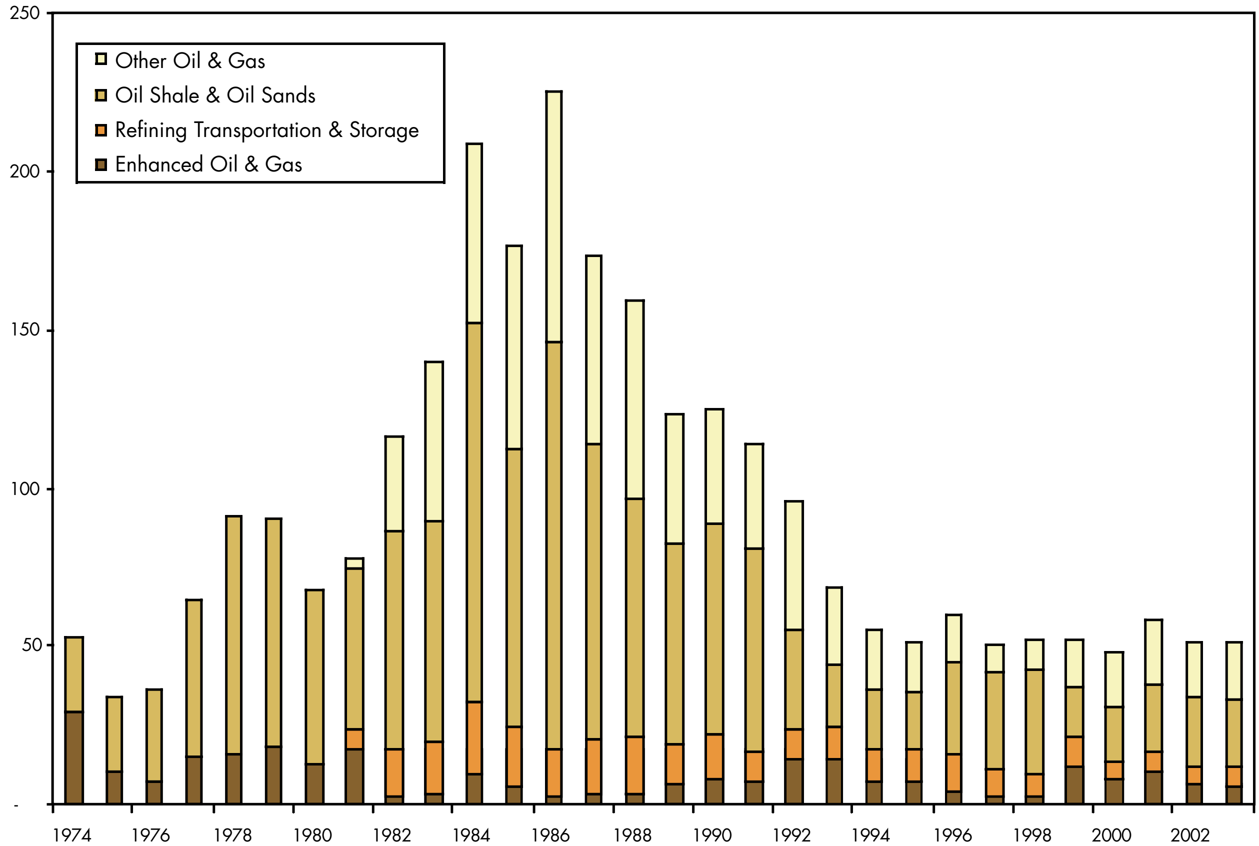
In the rush to develop the oil sands, efforts to proactively manage the cumulative environmental impacts have proven inadequate. Neither the government nor industry has placed enough priority on identifying the ability of the regional environment to withstand impacts and developing plans to manage oil sands development within these constraints. As a result, numerous proposed oil sands projects under regulatory review will be considered without the extent of scientific information and cumulative impact management systems recommended by the government's own Regional Sustainable Development Strategy (RSDS).

While the members of CEMA remain supportive of their role in advancing and developing regional environmental management systems, we believe a number of changes are required to enable the organization's success.

In addition, development should occur in a precautionary manner that continuously seeks to minimize environmental impacts. This continuous improvement can be driven by the establishment of clear environmental performance targets to encourage the oil sands industry to dedicate its considerable capacity for technological innovation towards achieving a reduction in environmental impacts.

▲ *A giant truck heading back to the mining area leaves an extraction plant*

5 Government's Helping Hand



Source: International Energy Agency Database of Research and Development Expenditure

▲ *FIGURE 31: Federal research and development budget for energy in Canada 1971–2003.*

The governments of Alberta and Canada have played a significant role in bolstering the industry and creating strong incentives for investment. Given projected oil prices, oil sands companies will be generating significant profits. Therefore, continued government generosity will shortchange the public owners of the resource. In the 1980s and 1990s, government assistance came in the form of generous research and development support (Figure 31) and incredibly favourable royalty and tax treatment.

These direct and indirect subsidies have contributed greatly towards overcoming technical and cost barriers and minimizing investment risk. Many of these subsidies are still in place today although the industry has attained an undeniable level of economic sustainability.

5.1 Rent Collection

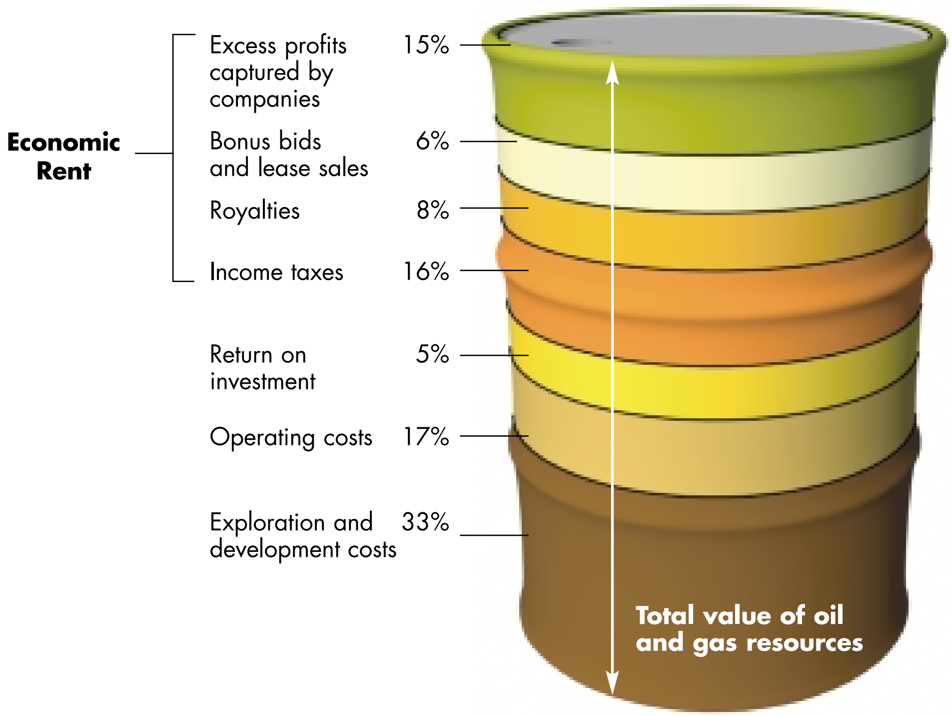
5.1.1 Government as Steward

In Canada the citizens of a province own the majority of its natural resources. The government is the steward of the oil sands and is responsible for ensuring that the owners receive maximum benefit from their development. The government allows companies to produce the oil and earn a fair return on their investment, while at the same time ensuring that a portion of the revenue from the sale of the oil is transferred to the citizens of Alberta. The owners receive the dual benefit of economic growth and job creation, while also being compensated for the liquidation of the non-renewable resource.

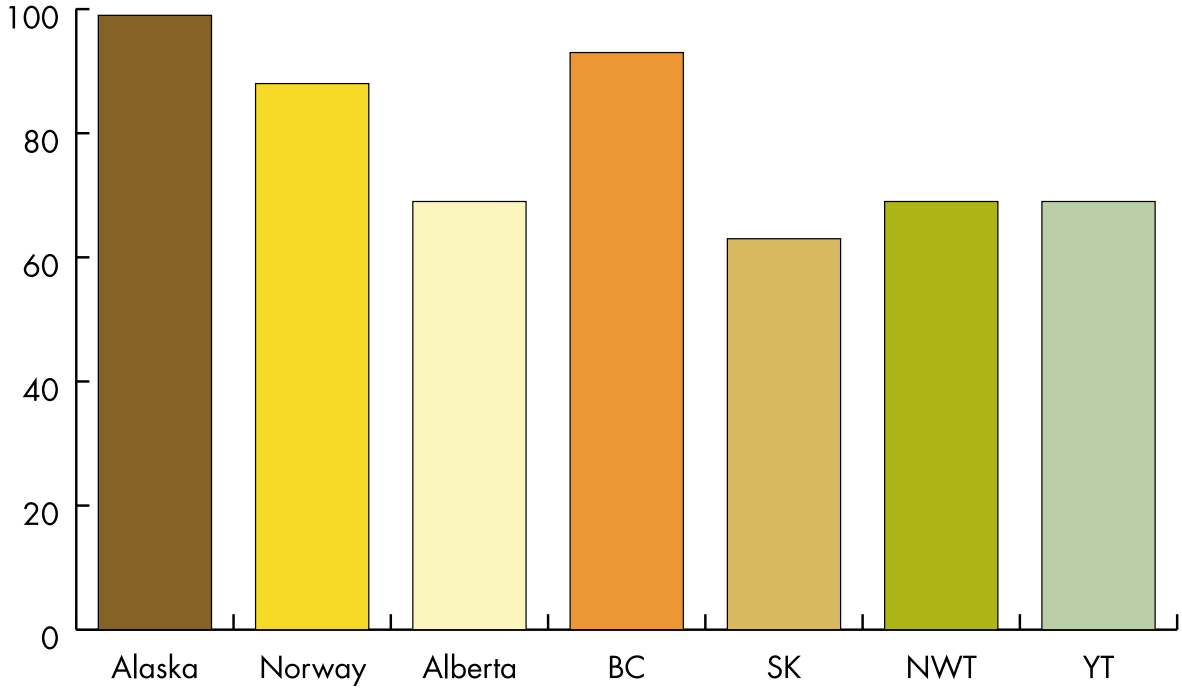
5.1.2 Fair Compensation?

The governments of Alberta and Canada are responsible for collecting the economic rent associated with oil sands production. Their role is to capture as much of the "economic rent" that is available on the sale of a barrel of oil on behalf of the citizens of the province (Figure 32). The economic rent is the amount left over after a fair return on investment plus all the company's costs to find the resource (exploration costs), construct facilities (development costs) and operate facilities (operation costs) have been deducted from the sale price of the oil. The provincial government collects economic rent by charging fees in exchange for the rights to develop certain oil sands deposits (bonus bids and lease sales) and by collecting royalties on the sale of the oil. The federal government has no direct jurisdictional authority over the development of a province's resources, but all Canadians benefit through the collection of federal taxes. If the provincial and federal government fail to capture all the available economic rent, oil companies receive profits in excess of their fair return on investment.

Successive years of windfall budget surpluses give the appearance that



▲ *FIGURE 32: The economic rent for a barrel of oil*



▲ *FIGURE 33: Average portion of economic rent captured in each region 1995–2002.*

the government of Alberta is doing an adequate job of collecting economic rent from its oil and gas resources. However, economic rent capture has been decreasing in recent years, reaching a low of 31% in 2000. Alberta's average collection of rent from conventional oil and gas between 1995 and 2002, while comparable to some other Canadian jurisdictions, was considerably lower than that of both Norway and Alaska (Figure 33).[259]

The government may choose to leave excess profits in the hands of companies to promote additional investment in exploration and development, and to encourage companies to risk investment when prices are uncertain or technologies are unproven. This has been an explicit strategy of both levels of government to promote rapid development of the oil sands.

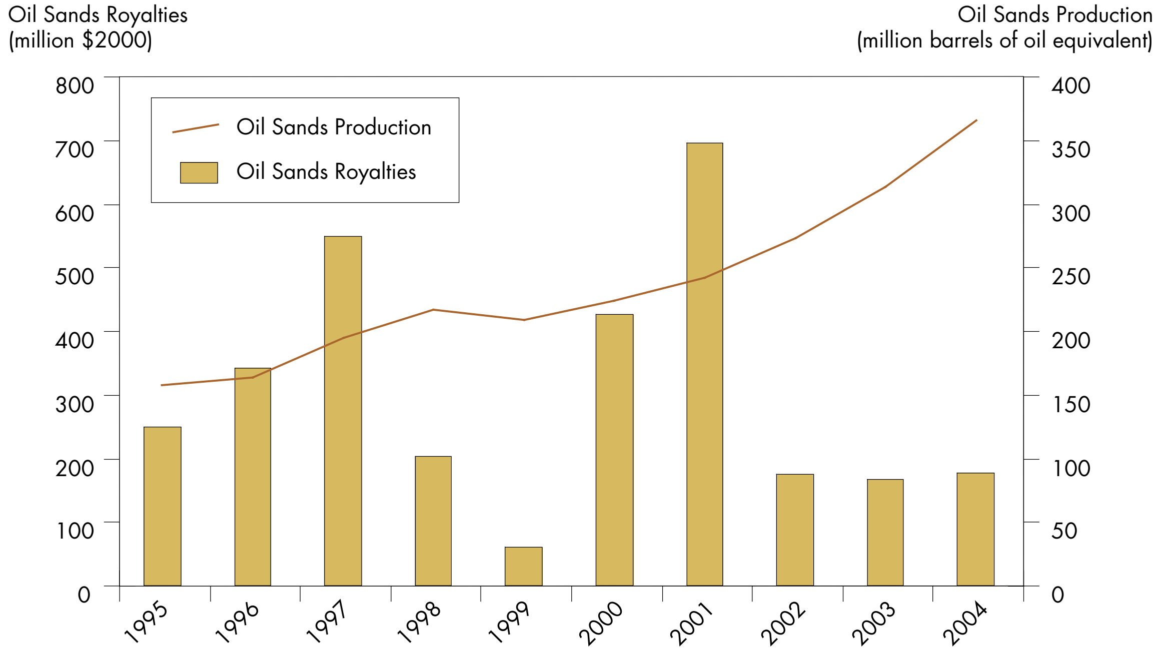
5.1.3 Alberta's Favourable Royalty Regime

In 1996, the government of Alberta acted on the recommendations of the National Oil Sands Task Force and implemented the Generic Royalty Regime with the following set of objectives:[260]

- Accelerating the development
- Facilitating development by private sector companies
- Ensuring that development is competitive with other petroleum development opportunities on a world scale

Under this regime, the Alberta government collects a 1% royalty until "project payout," which is defined to include all projects costs, including 100% of capital development and operating costs in the year incurred plus

> *"[Given the low royalties from oil sands production, it] appears that, at least implicitly, the government of Alberta has opted for higher activity levels in the oil and gas industry and a lower take on each unit of production."*
>
> ***Institute for Public Economics, 2002***[261]



▲ *FIGURE 34: Oil sands production and royalties 1995–2004.*

an acceptable rate of return. This means that new projects and expanded projects pay a very low royalty rate until all the initial costs have been recovered. After project payout is reached, the regime imposes a uniform 25% royalty payable on net project revenue, which equates to the gross revenue minus all costs.

With the significant increase in oil sands production taking place, one might expect to see a comparable increase in associated royalty revenues. However, the 1% royalty rate until project payout is a powerful incentive to reinvest profits from the oil sands into expansion, which further delays revenue collection by the Province. Figure 34 shows oil sands production is increasing (up 133% between 1995 and 2004), and royalties from oil sands are decreasing (down 30% over the same period). The Province obtained declining revenues for each barrel of oil equivalent (BOE) over this period (from $1.6/BOE of oil sands in 1996 to $0.5/BOE of oil sands in 2004).[262]

5.1.4 Federal tax breaks

The federal government provides generous allowances for "writing-off" capital costs related to oil sands developments to encourage investment in the oil sands. This means that when a company makes a capital investment (such as the purchase of new equipment or the construction of new or expanded oil sands projects), it can use 100% of that expenditure to reduce the amount of tax that it has to pay on income from the project. In other words, the company only pays federal income tax on the income from the project once it has written off all eligible capital costs.[263]

These tax rules make oil sands projects much more attractive and profitable than they would be otherwise. According to the Commissioner on the Environment and Sustainable Development, this results in a significant tax benefit relative to other energy sectors.[264]

The federal Department of Finance estimates that the tax benefits granted to oil sands companies are worth between $5 million and $40 million for every $1 billion invested.[265] Between 1997 and 2004, capital investments in the oil sands totalled $27.5 billion.[266] Using the range estimated by the Department of Finance, between 1997 and 2004 oil sands companies received a benefit of between $137.5 million and $1.1 billion for these generous capital write-offs.

5.2 A New Fiscal Regime

In the decade since the governments of Alberta and Canada modified the fiscal regime for the oil sands, continued reductions in operating costs combined with radically improved market conditions have changed the economics of the industry. The oil sands are now a mature and extremely profitable sector. Now outdated, unnecessary and increasingly detrimental, the royalty and tax regimes create a powerful incentive for rapid re-investment and growth. The current fiscal policy provides the oil industry and its shareholders with an inequitable share of the wealth derived from oil sands exploitation.

"Canada has shown that it can transform impossible energy dreams into reality. When the oil sands of the Athabaska [sic] were discovered in the 1960s, no technology existed to exploit them and the economics were simply crazy. It took decades of dedication and, especially, sustained federal support ($40 billion in various fiscal incentives and tax breaks) to eventually transform this impossible project into a thriving industry that will provide enormous amounts of both energy and wealth to the country for decades to come."

Stéphane Dion, Minister of the Environment, Government of Canada

The majority of wealth derived from non-renewable resources rightfully belongs to the public. Further, the non-renewable nature of this resource makes it imperative that this wealth be invested to benefit multiple generations.

▲ *From the air, the giant trucks look like little ants in the large mines. You can see the mine layering in this photo. The bottom of the mine is as deep below the surface of the former boreal forest as the length of a football field.* PHOTO: CHRIS EVANS, THE PEMBINA INSTITUTE

6 A Time for Stewardship and Leadership

Given the scale and pace of the development, it is clear that Canada has a global responsibility for demonstrating stewardship and leadership in preventing the current and rapidly increasing environmental impacts of oil sands exploitation. Furthermore, any development of the oil sands must be done in the context of a national strategy for the transition from environmentally intensive conventional energy to an economy based on sustainable energy.

The magnitude of the risks and opportunities arising from Canada's oil sands rush is unprecedented in the history of Canadian energy production. All Canadians, including future generations of Canadians, have a stake in the outcome. To improve society's overall wellbeing and protect the environment, we provide the following key recommendations, organized under four core themes, for responsible stewardship and leadership:

A SUSTAINABLE ENERGY SYSTEM IS ONE THAT

Provides the services of energy to meet peoples' needs today and the needs of future generations in an accessible, equitable and most efficient manner

Enables stabilization of atmospheric concentrations of greenhouse gases

Protects or restores the earth's air, land and water resources throughout its life-cycle

Is safe and results in no burdens of risk for future generations

Empowers communities to live satisfying and healthy lives

6.1 Responsible Use

To demonstrate leadership in the more efficient use of natural resources, and in light of the increasing demand for energy and the associated environmental implications of today's energy systems, the government of Canada should

- ***Develop a national energy framework by the end of 2006 with targets and supporting policies for energy efficiency, energy conservation, renewable energy and conventional energy in collaboration with the provinces, First Nations, industry and non-governmental organizations (NGOs).***
- ***Provide incentives for responsible consumption.***
- ***Regulate Canadian fleet fuel efficiency based on best available technology.***

6.2 Protecting the Climate

To ensure that the oil sands industry does its fair share in meeting Canada's GHG reduction obligations enshrined within the Kyoto Protocol, we recommend that the government of Canada

- ***Define Best Available Technology Economically Achievable (BATEA)-based targets for the oil sands industry at a level that ensures new and expanded projects make a meaningful contribution towards meeting Canada's emission-reductions obligations.***
- ***Invest in research and provide incentives to promote the commercialization of more efficient transportation-based technologies and the development of low-impact alternative fuels.***

Looking beyond 2012, we recommend that the governments of Canada and Alberta

- ***Require all existing and new oil sands operations to be carbon-neutral (net zero GHG emissions) by 2020 through a combination of actual reductions and emission offsets.***

6.3 Protecting the Regional Environment

Over the next two years, regulatory agencies will be asked to review proposed oil sands projects that will push production to approximately 3.8 million barrels per day, more than triple the current production. Over the next several years, regulatory agencies may be faced with proposals to further increase production to five million barrels per day or more. These public-interest decisions must be made in an informed and precautionary manner to ensure that cumulative environmental impacts are proactively managed. We recommend that

The government of Alberta

- ***Establish a conservation offset within the oil sands region by protecting an area of intact boreal forest of high conservation value that is representative of the region.***
- ***Establish interim environmental limits that protect human health and the environmental integrity of the region before approving additional oil sands development.***
- ***Establish clear reclamation expectations that ensure the long-term ecological sustainability of the region before approving additional oil sands development.***

The governments of Alberta and Canada

- ***Create the conditions for CEMA to successfully refine environmental limits and develop regional environmental management systems to guide decisions about future oil sands development. This will require the development of specific memoranda of*** *understanding between government and CEMA that include clear deliverables and a firm schedule, the provision of additional human and financial resources, and clear statements of political expectation and support for meaningful outcomes.*

- *Assume responsibility for those issues that will not or cannot be addressed through the CEMA process in a timely fashion. Commit to a process to consult with stakeholders and a schedule to implement new standards and systems to manage these issues.*
- *Ensure that industry maximizes their use of best available technologies to minimize the rate of increase of cumulative environmental impacts.*

6.4 Establishing an Equitable Fiscal Regime

A significant shift in the fiscal regime is required to achieve a successful transformation towards a sustainable energy future. This shift includes full incorporation of the polluter-pay principle into a revised regime.

We recommend that the governments of Alberta and Canada

- *Establish a timeline for eliminating federal subsidies, especially tax advantages, to the oil and gas sector.*
- *Redirect subsidies and favourable fiscal policies towards conservation of energy, energy efficiency and expansion of low-impact renewable energy.*
- *Maximize the collection of royalties and taxes to compensate current and future generations of Albertans and Canadians for the utilization of this publicly owned, non-renewable resource.*
- *Invest a portion of the wealth derived from royalties and taxes into a permanent fund for sustainable energy to foster further innovation in energy conservation, energy efficiency and the production of low-impact renewable energy.*

▲ *Suncor oil sands upgrader.* PHOTO: THE PEMBINA INSTITUTE

Endnotes

1 - 30

1 Data was taken from Table 2.3 and converted from hectares to square kilometres. Source: Alberta Energy and Utilities Board, *Alberta's Reserves 2004 and Supply/Demand Outlook/Overview* (2005), Statistical Series (ST) 2005-98, pp. 2-7.

2 The province of Alberta is 661,190 km^2 (260,000 mi^2) in area.

3 Population data source: http://www.woodbuffalo.net/population.htm.

4 Alberta Energy and Utilities Board, *Alberta's Reserves 2004 and Supply/Demand Outlook/Overview* (2005), Statistical Series (ST) 2005-98,p. 2.

5 The EUB defines established reserves as "Those reserves recoverable under current technology and present and anticipated economic conditions specifically proved by drilling, testing, or production, plus the portion of contiguous recoverable reserves that are interpreted to exist from geological, geophysical, or similar information with reasonable certainty."

6 Kevin Hall, "U.S. energy future rests with development of Canadian oil sands," October 6, 2005. *Knight Ridder Newspapers.*

7 Data was taken from Table 2.3 and converted from cubic meters to barrels using a conversion factor of 6.2929 barrels/cubic metre. Alberta Energy and Utilities Board. *Alberta's Reserves 2004 and Supply/Demand Outlook/Overview* (2005), Statistical Series (ST) 2005-98, p. 2-7.

8 Doug Barnett, *An Early History of the Athabasca Oil Sands,* http://www.usask.ca/education/ideas/tplan/sslp/yukon/bitumont.htm.

9 National Energy Board, *Canada's Oil Sands – Outlook to 2015* (2000), p. 15.

10 Nickle's Energy, Information, Technology. *Syncrude and Alta. Gov't reach agreement on tar sands development – still hinges on federal gov't export tax.* September 19, 1973, http://www.nickles.com/history/article.asp?article=history%5Chistory_0935.html.

11 http://www.centreforenergy.com/generator2.asp?xml=/silos/ong/oilsands/oilsandsHistoryXML.asp&template=1,1,1.

12 http://www.centreforenergy.com/generator2.asp?xml=/silos/ong/oilsands/oilsandsHistoryXML.asp&template=1,1,1.

13 National Oil Sands Task Force, *The Oil Sands: A New Energy Vision for Canada* (1995), p. 33.

14 National Oil Sands Task Force, *The Oil Sands: A New Energy Vision for Canada* (1995), p. 5.

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16 Between 1995 and 2004, Alberta's crude bitumen production increased from 482,000 barrels per day to 1.1 million barrels per day. Data was converted from cubic metres to barrels using a factor of 6.2929 barrels/ cubic metre. Source of 1995 data: Alberta Energy and Utilities Board. (2004), ST98-2004 – Graphs and Data – Section 2 Crude Bitumen. http://www.eub.gov.ab.ca/bbs/products/STs/st98-2004-data-2-bitumen.ppt. Source of 2004 data: Alberta Energy and Utilities Board, *Alberta's Reserves 2004 and Supply/Demand Outlook/Overview* (2005), Statistical Series (ST) 2005-98, p.2.

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The 2.3% emission intensity improvement is what Alberta Environment's Climate Change Plan is targeting. By 2020, Alberta will cut emissions in the province relative to GDP by 50% below 1990 levels. A 50% improvement over 30 years is equal to a 2.3% annual improvement, assuming that contribution of oil sands to Alberta's GDP remains at the same level. Expansion in the oil sands is expected to increase and so will its contribution to the GDP.

As an interesting note, in the last decade the oil sands have made a 26% reduction in emissions, which is equal to a 3% annual reduction. While this amount may not be sustainable over the long term it is not unreasonable to expect that a 2.3% improvement is possible especially when efficiency is driven by higher energy costs.

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Similar to EPEA, the Canadian Environmental Assessment Act (CEAA) includes Comprehensive Study Regulations that identify projects and classes of projects that require a comprehensive study. Included in the comprehensive study list are oil sands processing facilities and mines.

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