Oil and Troubled Waters

Reducing the impact of the oil and gas industry on Alberta's water resources

Mary Griffiths and Dan Woynillowicz

April 2003

Pembina Institute
for Appropriate Development

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For more information on the Pembina Institute's work, please visit our Web site at **www.pembina.org**, or contact

The Pembina Institute
Box 7558
Drayton Valley, AB
T7A 1S7

Tel: 780-542-6272
Fax: 780-542-6464
e-mail: info@pembina.org

About this Report

Fresh water is a precious yet finite resource. Recent extended periods of drought in Alberta have underscored the importance of this resource for Albertans, increasing awareness of the need for conservation. Use of water by the upstream oil and gas industry has become an issue of public concern. This paper examines the effects of conventional oil and gas activities, oilsands production and coalbed methane development on water resources. Recommendations are made for improving government policy to promote the wise management and conservation of water in the oil and gas industry.

Acknowledgements and Disclaimer

The authors would like to thank all the people who have helped make this document possible by providing information, answering questions or reviewing the draft text. Their contributions have helped to significantly improve this paper. In particular we thank the following:

Don Bester, Butte Action Committee; Mike Burt, OPTI Canada Ltd., Kin Chow, Canadian Society for Unconventional Gas; Dr. Bill Donahue, Research Associate, Department of Biological Sciences, University of Alberta; Dr. Bill Gunter, Alberta Research Council; Paul Manuel, Syncrude Canada Ltd.; Eric Mewhinney, Hydrogeologist; David Pryce, Canadian Association of Petroleum Producers; Sally Ulfsten, Stop and Tell Our Politicians; Alberta Environment staff; Mike Wenig, Canadian Institute of Resources Law; and Bob Willard and others at the Alberta Energy and Utilities Board.

We appreciate the support and assistance provided by all our colleagues in the Pembina Institute, but especially that of Robert Hornung, Tom Marr-Laing and Randee Holmes.

The contents of this paper are entirely the responsibility of the Pembina Institute and do not necessarily reflect the views or opinions of those who are acknowledged above. The research and writing of this paper were made possible in part by the individuals who provide financial contributions to the work of the Pembina Institute, and whose support we deeply appreciate.

About the Authors

Mary Griffiths joined the Pembina Institute as an Environmental Policy Analyst in May 2000 to work with the Energy Watch program. She was co-author of the book *When the Oilpatch Comes to Your Backyard: A Citizens' Guide to Protecting Your Rights*, published by the Pembina Institute in 2001. Mary works on air quality issues as a member of the Board of Directors of the West Central Airshed Society and with subcommittees of the Clean Air Strategic Alliance. She has helped evaluate the environmental impact of energy projects, including oilsands developments and coal-fired power plants. Mary is currently reviewing the environmental impacts of new developments in Alberta, such as the extraction of coalbed methane and the underground storage of carbon dioxide. She has long been an advocate for the protection of the environment, both in her previous employment and in her volunteer activities. Mary holds a Ph.D. (Medical Geography), University of Exeter, UK and a B.A. (Geography), University of Exeter, UK.

Dan Woynillowicz has been with the Pembina Institute since May 2001 when he graduated from the University of Calgary with a B.Sc. in Environmental Science. He is responsible for providing analytical review and critique of government policy and legislation, and industrial project applications and Environmental Impact Assessments, with a focus on the Alberta energy sector. Dan is an environmental representative on several multistakeholder consensus-based decision-making groups in the Ft. McMurray area, including the Wood Buffalo Environmental Association; the Terrestrial Environmental Effects Monitoring Group and its Science Subcommittee; and the Cumulative Environmental Management Association Surface Water Working Group. He has been engaged in consultations with oilsands project proponents and participated in public hearings. Dan is also Vice-Chair of the Alberta Environmental Network Steering Committee.

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1. Introduction

Water is a finite resource essential to the very survival of humans and all other forms of life on Earth. Water is also an important input for many agricultural, commercial, or industrial activities. In regions where water supply is constrained or at risk, competition between these interests can give rise to conflict.

In Alberta, a combination of continued dramatic economic growth, increases in human population, several years of drought conditions, and longer term questions about the impacts of climatic change, has raised serious concerns about the sustainability and usage of Alberta's surface and groundwater[1] supplies. These concerns have been expressed by agricultural producers experiencing a shortage of water to support their livestock and crops. As local groundwater resources are depleted, some towns have been forced to pipe in water from a distance. While the source of these problems may be complex and interrelated, Albertans are becoming increasingly aware of the need for a significant change in the stewardship of the province's water resources.

In recognition of this the Alberta government undertook public consultation in 2002 to develop a water strategy for the province. The Minister's Water Forum[2] revealed a concern on the part of Albertans about the use of water by the oil and gas industry, in particular the use of fresh[3] water for oil field injection.[4]

The Pembina Institute agrees that the usage of water by industry, and the oil and gas industry in particular, is an important matter — both environmentally as well as economically. Our concerns are not restricted to oil field injection, but include the broader range of usage in the conventional oil industry, and, increasingly, for the extraction of oil from oilsands in the northern half of the province. Furthermore, the emerging development of large-scale coalbed methane extraction in the province could introduce an additional layer of concerns affecting the province's surface and groundwater supplies.

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[1] "Groundwater" means all water under the surface of the ground whether in liquid or solid state. *Water Act,* section 1(1)(v).

[2] The Minister's Water Forum was part of the initial phase of developing a new Water Strategy for Alberta. At the Forum, held on June 6 and 7, 2002, over 100 invited Albertans met to review results of the "Water for Life" public consultation process and to suggest priorities for addressing the issues. The report of the Forum is available on-line at www.waterforlife.gov.ab.ca

[3] Fresh water is used in this paper to refer to water that is not saline. Saline water is defined as water containing over 4000 milligrams of total dissolved solids per litre (mg/l TDS). *Water Act, Ministerial Regulation, Alberta Regulation 205/98*, section 1(1)(z). This water is referred to as "usable" water by the Alberta Energy and Utilities Board (EUB). Fresh water is sometimes referred to as potable water, meaning, in a general sense, water that could be made fit for consumption. However, the definition of "potable water" in the Environmental Protection and Enhancement Act, section 1(zz), is restricted to water that is supplied by a waterworks system and used for domestic purposes. Potable water should meet the *Guidelines for Canadian Drinking Water*, which apply in Alberta, and contain no more than 500 mg/l TDS; http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/summary.pdf. Water with higher levels of TDS, up to approximately 1,000 mg/l TDS, may be used for watering livestock; even higher levels may be used for irrigation. Fresh water is generally found closer to the Earth's surface than is saline water. For the most past, the concentration of TDS (and thus the salinity of the water) increases with depth, as saline water is of greater density than fresh water. Some types of bedrock, such as sandstones, are relatively permeable and capable of transmitting significant quantities of water. In Alberta sandstone aquifer flow systems tend to be isolated from other regional flow environments by rocks of very low permeability, such as shale. This separation may prevent water movements between aquifers.

[4] "The injection of potable water into oil fields troubles many Albertans. Many feel this use is wasting a valuable resource. The oil industry feels this use of water provides continued economic benefit. This matter requires study." Alberta Environment, 2002. *Water for Life: Alberta's Strategy for Sustainability*, Minster's Forum on Water Summary Report, Executive Summary, p. 6; http://www.waterforlife.gov.ab.ca/html/results.html

It is our view that an enhanced regulatory management regime is required to encourage industry to avoid the use or disturbance of freshwater resources as much as possible, and to optimize efficient use where usable water continues to be required. Doing so could help minimize the potential for future conflict between competing uses, and provide for longer-term sustainability of Alberta's water resources. Recommendations to help achieve this objective are provided in the last section of this report.

Since fresh water is a finite resource, it is important to identify ways to encourage its more efficient use. While the focus of this report is on the oil and gas industry, many of the issues and recommendations can be broadly applied to other sectors of Alberta's economy, in particular other industrial activities.[5]

The Pembina Institute has written this report as a contribution to the public consultation currently being conducted by the provincial government in developing its Water Strategy: *Water for Life: Alberta's Strategy for Sustainability*.[6] The timely and effective implementation of a strategy that ensures the conservation and wise, sustainable use of the province's limited water resources is imperative.

[5] Other industrial activities include those indicated in the "commercial" and "commercial (cooling)"sectors in Figure 1. They include petrochemical industries, power plants, pulp mills and all other major industrial users of water that require a licence or approval for their water requirements.
[6]Alberta Environment; http://www.waterforlife.gov.ab.ca/

2. Overview of Water Use by the Oil and Gas Industry

2.1 Scale of use

In 2002, 380 million cubic metres of surface water was allocated by the province of Alberta for use by the petroleum industry for oil extraction and processing. This quantity represents approximately 4% of all freshwater allocations (see Figure 1 and Table 1).[7] One-third of this surface water allocation is designated for oilfield injection, which includes not only the volume used for enhanced oil recovery in conventional oilfields, but the water used to generate steam for the in situ extraction of bitumen from oilsands deposits where this is obtained from surface water.[8] This percentage may appear small, but, as it is most commonly disposed of into deep geological formations, this water is permanently removed from the ecosystem.[9] When water is used for irrigation or for industrial or domestic use, most of it eventually finds its way back into the hydrologic cycle, by evaporating to the air, flowing to the surface water environment, either directly or indirectly, through sewage treatment plants, or replenishing groundwater. The remaining two-thirds of the oil and gas industry's surface water allocation is for industrial processes associated with the oil and gas industry. This includes the water used for oilsands extraction at surface mines, as well as for oil and gas processing.

Groundwater allocations to oil and gas industry in 2002 totalled 58 million cubic metres. While this volume is smaller than that allocated from surface waters, it represents more than one-quarter of all the fresh groundwater allocated in Alberta. Most of this water is allocated for oilfield injection in conventional wells and as make-up water for steam generation for in situ bitumen extraction, including steam–assisted gravity drainage.[10] As a result, this water is also permanently removed from the hydrologic cycle.

While the removal of fresh surface and groundwater from the hydrologic cycle is one major concern, this paper also examines ways to promote conservation and reduce the total use of fresh water by the oil and gas industry.

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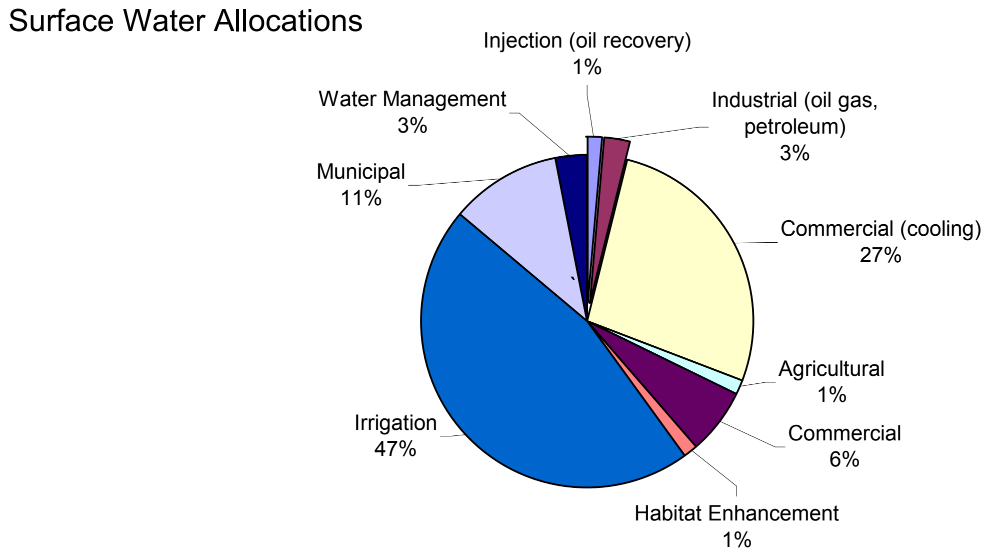
[7] Alberta Environment, personal communication, April, 2003. All figures in this paragraph and in Figure 1 and Table 1 are from Alberta Environment, *Groundwater and Surface Water Allocations, 2002.*

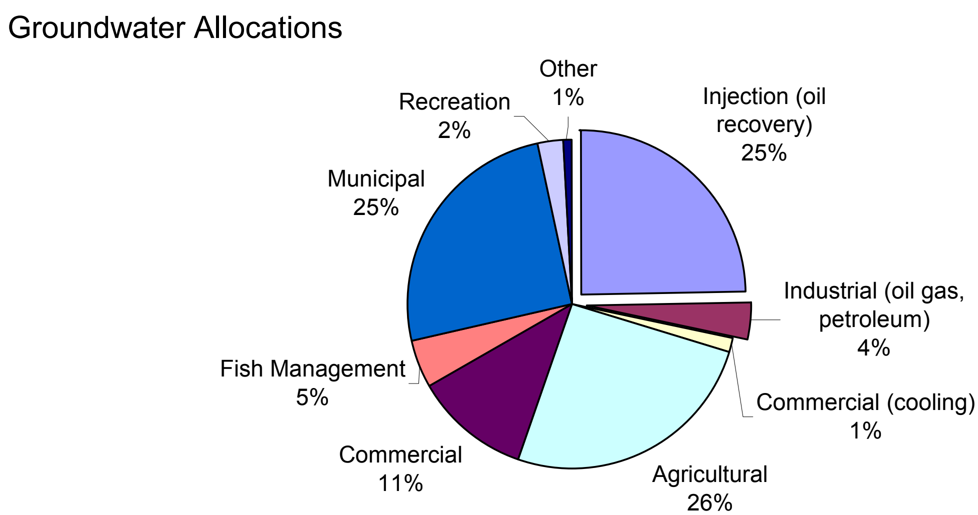
[8] This includes activities in the Ft. McMurray area and much of the water that is used in the Cold Lake area. However, some groundwater is also used in the Cold Lake area (when the level of Cold Lake falls below its cut-off point). The Peace River is used for bitumen extraction in the Peace River area. Alberta Environment, personal communication, February 2003.

[9] "Permanently" means for geologic lengths of time of hundreds of thousands of years or more.

[10] Most steam-assisted gravity drainage projects use groundwater, as they are generally located away from large surface sources.

Figure 1: Allocation of Surface Water and Groundwater for All Purposes in Alberta, 2002[11]





[11] Source data from Alberta Environment. The "commercial" and "commercial (cooling)" sectors in the pie charts include the licensed use of water for all industrial purposes. This includes such activities as petrochemical plants, power plants and pulp and paper mills and all other major industrial users of water that require a licence or approval.

2.2 Forms of use

The oil and gas industry uses water in many different ways, depending on the resource being exploited and its location. Key activities that use water include conventional oil production, where a hole is drilled to allow the fluid oil to be pumped to the surface; oilsands production, where the oil is in the form of heavy bitumen which does not flow freely; coal bed methane extraction; and oilfield waste disposal in salt caverns.

2.2.1 Conventional Oil Wells

While relatively small quantities of water may be used to form drilling muds,[12] the single largest use of water by conventional oil wells is associated with oilfield injection. When a conventional well is first drilled, the oil may come to the surface under its own pressure or be pumped up mechanically. Later in its producing life, as the reservoir pressure drops, water can be pumped into the underground formation to create enough pressure to displace the oil. The oil can then be pumped to the surface, leaving some of the water behind. Initially, considerable quantities of water may be used to enhance oil recovery. Water that returns to the surface with the oil is recovered and re-injected into the formation. After a few years, the proportion of water that is recycled increases and as much as 80% of the water may be recycled as oil production declines. The water that replaces the oil remains underground and is thus permanently removed from the hydrologic cycle.

In many cases saline water can be used instead of fresh water for enhanced oil recovery. Natural gas or natural gas fluids (such as ethane, propane or butane) or carbon dioxide (CO_2) can be used to maintain reservoir pressure and/or reduce the viscosity of oil and encourage its release.[13, 14]

In addition to using water, oil wells may produce water. This water is saline. Some older oil fields may produce more than 10 litres of saline water for every litre of oil.[15] This saline water is separated from the oil and pumped back underground into the oil producing formation.

2.2.2 Oilsands

There are two broad categories of technologies used to extract the heavy oil (bitumen) from oilsands deposits. Where deposits are close to the surface, surface soil and sedimentary rock are first stripped off, and then the bitumen may be removed from open-pit mines. This is the method used for the majority of bitumen currently produced in the Ft. McMurray oilsands region. Where the oilsands deposits are too deep to economically access through mining, the oil may be extracted through in situ operations. There are a variety of in situ processes, but all generally operate on the basis of injecting steam into the bitumen deposits to reduce viscosity so that the oil can be drawn to the surface. Unlike surface mining, in situ technology offers the benefit of removing the bitumen from the ground while leaving the sand in place. However, these processes require the input of large quantities of water.

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[12] Drilling muds are used to lubricate the drill bit and transport cuttings to the surface when a well is first drilled. See Table 1 for the volume of water allocated for this purpose.

[13] Petroleum Communication Foundation, 1999. *Our Petroleum Challenge: Exploring Canada's Oil and Gas Industry,* p. 49.

[14] While CO_2 may be an alternative to the use of water for enhanced oil recovery, there are various concerns to be addressed before considering the widespread storage of CO_2 underground as a means of reducing the amount of CO_2 in the atmosphere. It is not yet known what the risks of leaks are from different types of geological strata and how long the CO_2 will remain underground. The Pembina Institute also believes that attention to underground storage of CO_2 should not divert resources away from the development of renewable energy, which is a known way to reduce greenhouse gas emissions.

[15] Petroleum Communication Foundation, 1999. *Our Petroleum Challenge: Exploring Canada's Oil and Gas Industry,* p. 82.

2.2.2.1 Open-Pit Mining Operations

When oilsands are mined, it is necessary to first remove the water from the adjacent strata to prevent flooding of the mine area. The removal of water through this "dewatering" process can lower the overall water level in the area and may affect other aquifers and surface water bodies, including regional wetlands that are dependent on groundwater recharge.

Muskeg drainage and overburden dewatering is needed before the mine site can be stripped. This is achieved through a technique known as ditching, which involves digging one to two metre deep drainage ditches with 100 metre spacing. Where overburden water-containing sands are deeper, sumps or wells with drainage pumps are required. Generally, water from muskeg drainage and overburden dewatering is passed through polishing ponds, which allow suspended sediments to settle out, before it drains into natural water bodies (creeks, streams etc.).

It is often necessary to depressurize the basal aquifer[16] and to actively drain the mine pit area to control runoff and seepage water accumulation in the pits. The quality of the basal depressurization water varies, but is usually brackish to saline and high in total dissolved solids. As such, it needs to be handled in an appropriate manner to ensure environmental impacts are minimized. There are a variety of handling options for this water including treatment and use in the extraction process, treatment and discharge to surface water bodies, and re-injection into basal water sands on the lease.

Extracting the oil from the oil/sand mixture requires large amounts of water. Water first enters the extraction process when warm water is added to the mined oil sand to create a slurry that can be pumped through pipelines to a bitumen extraction facility. Warm to hot water is also used to dilute the slurry and to begin separating the viscous oil from the sand. After passing through the extraction process, a portion of the water can be recycled back for additional extraction. However, some water remains with the oil, and eventually is disposed of, along with the sand and unrecovered hydrocarbons as tailings.[17] These tailings are usually stored in large ponds until they can be used to begin filling in the mined out pits. While improvements in recapture and recycling technologies have reduced the amount of water that remains in the tailings, considerable quantities of water are still disposed of in this manner.

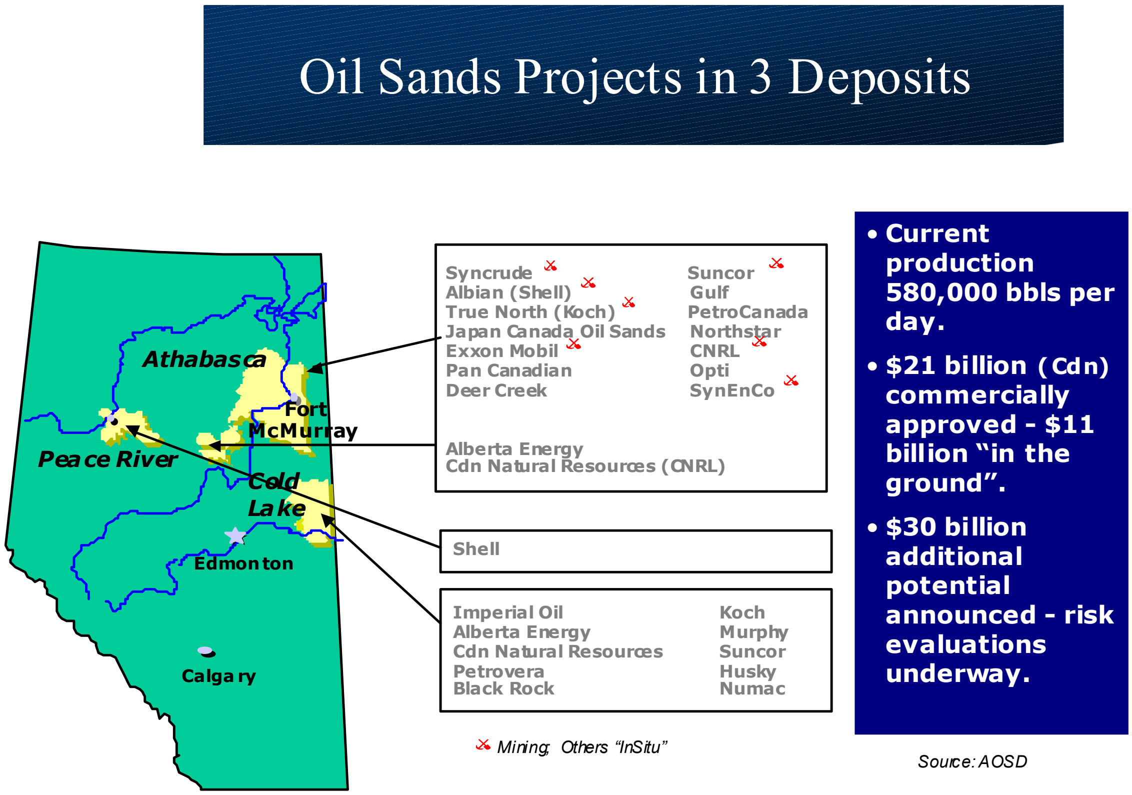
In addition to the water used by both in situ and surface mining operations to extract the bitumen from oilsands, water is also used to upgrade the bitumen into lighter forms of oil for transport and sale to market.[18]

2.2.2.2 In Situ Operations

There have been in situ operations in the Cold Lake area for over two decades. However, now that the Steam Assisted Gravity Drainage (SAGD) technique has been commercially proven, many more in situ projects are under development or planned for the large area between Ft. McMurray and Cold Lake. There are also oilsands deposits in the Peace River area, where one company is currently operating (see Figure 2).[19]

[16] "Basal aquifer" describes the water-bearing sands, gravel or fractured rock that is found at the bottom of a geological formation, underlying the bitumen-saturated sands. The water at this depth is usually saline.
[17] The actual proportion of water that is recycled depends on the process used.
[18] Upgrading involves cracking the large carbon molecules into smaller ones. Water is also used for cooling, but this water is later used in bitumen-sand separation.
[19] Carter, J., President and Chief Operations Officer, Syncrude Canada Ltd., 2002. *The Future of the Alberta Oilsands,* Alberta Science and Research Authority Retreat, June 7; http://www.aeri.ab.ca/sec/new_res/docs/ASRA_pres_carter_oilsands.pdf

Figure 2: Current and Future Oilsands Projects in Alberta[20]



Given that only 19% of Alberta's oilsands can be surface mined, in situ recovery will likely become the primary means for accessing the majority of the Athabasca region's substantial oilsands reserve.

The in situ bitumen extraction process uses large amounts of water to generate steam that is pumped into the Earth to heat the bitumen and reduce its viscosity, thus allowing it to be pumped to the surface. Depending on the nature of the formation, varying amounts of water remain in the formation and cannot be recovered along with the produced bitumen. Even though in the SAGD process an average of 90% of water is recycled, the process still requires large volumes of water to make up the losses.

In addition, to meet the technical requirements for steam generation, water must be of a high quality; this requires treatment. Depending on the form of treatment, water may be lost in the treatment process as a waste stream (for example it remains within the lime sludge, or as a concentrated brine disposed of to deep wells). To date, pilot and commercial SAGD in situ processes have required approximately 2.5 to 4 units of water for every unit of oil recovered. Given that water fills the pore spaces left when oil is removed, unless the reservoir is pressurized and there is no consolidation of the formation, the net permanent loss is expected to be approximately one barrel of water for every barrel of oil recovered.[21] A

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[20] Figure supplied by Syncrude Canada Ltd. Reproduced here with permission.
[21] D. Pryce, Vice-President, Western Canada Operations, Canadian Association of Petroleum Producers, personal communication, March 2003.

non-thermal recovery method, using solvents, is being developed to assist bitumen extraction, which could reduce the need for water.[22]

To date, all commercial SAGD operations in the Athabasca oilsands region have relied on fresh groundwater to generate steam. However, efforts to use brackish or saline water are currently being made by a number of operators, and one proponent in the Ft. McMurray region has committed to using brackish water as a source of water, in addition to fresh water, to the extent that it is technically and economically feasible.[23]

2.2.3 Coalbed Methane Extraction

Conventional natural gas wells do not usually have major impacts on water (except if a well is not properly cased, when gas can seep into aquifers).[24] However, as Alberta's conventional gas wells become depleted and the North American demand for gas continues to grow, increasing attention is being paid to the province's coalbed methane (CBM) resources. With current estimates indicating that the gas volumes contained within Alberta coal could be approximately three times the volume of conventional gas,[25] widespread extraction of CBM in the near future is probable.[26]

CBM is methane gas that is stored in coal beds.[27] The methane molecules were formed during the conversion of organic matter into coal and are adsorbed onto the coal's surface. In the US thousands of wells have been drilled to extract CBM; CBM now represents about 7% of US gas production.[28] In Canada, plans for the exploitation of the resource are just being developed, with several of the CBM projects underway in Alberta classified as "experimental" schemes and some as commercial development.[29] One of the key challenges associated with the extraction of CBM concerns water.[30, 31]

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22 Alberta Energy Research Institute, 2002. VAPEX Process Engineering and Economics, in *Energy Horizons*, Vol.1, Issue 1, October, p. 5.; http://www.aeri.ab.ca/sec/new_res/docs/e_news/issue_01.pdf

23 *"OPTI/Nexen are now prepared to commit to include McMurray brackish water as a source, in addition to fresh water supplies, for the base project design. To the best of our knowledge, the Long Lake project will be the first SAGD project in the Athabasca area to include significant amounts of McMurray brackish water as a make-up source to a SAGD project."* Source: Letter from Mike Burt, OPTI Canada Inc. dated January 14, 2003 to Gail MacCrimmon, Pembina Institute, regarding the updated water balance for the Long Lake Project. OPTI/Nexen defines "brackish" as water with more than 4000 milligrams/litre total dissolved solids (mg/l TDS), which is the same as the Alberta Environment definition of saline. The brackish water that OPTI intends to use will have approximately 30,000 mg/l TDS. Mike Burt, OPTI Canada Inc., personal communication.

24 As a well ages, water may be pumped to the surface of the well with the natural gas. This produced water is separated from the gas at the surface and re-injected into deep wells.

25 Alberta Energy Research Institute, 2002. Coal Bed Methane Simulation, in *Energy Horizons,* Vol. 1, Issue 1, October, p. 5; http://www.aeri.ab.ca/sec/new_res/docs/e_news/issue_01.pdf

26 The Canadian Society for Unconventional Gas (CSUG) (www.csug.ca) has recently been created by industry to provide information as unconventional gas resources, such as CBM, begin to be developed in Canada.

27 Canadian Association of Petroleum Producers, 2003, *Coalbed Methane;* http://www.capp.ca/default.asp?V_DOC_ID=843

28 Western Governor's Association, 2002. Environmental Summit on the West, Coal Bed Methane Development in the West: Breakout Session I; http://www.westgov.org/wga/initiatives/enlibra/methane_summit_II.htm

29 Alberta Energy, 2002. *Alberta examines the potential for coalbed methane development*. News release, October 22; http://www.gov.ab.ca/acn/200210/13392.html Includes hyperlink to report on *The Potential for Coalbed Methane (CBM) Development in Al*berta, prepared for Alberta Energy by Heath and Associates, September, 2001; http://www.energy.gov.ab.ca/gmd/docs/Coalbed_Methane_Final_Report_Sept_2002.pdf

30 Harvie, A., 2002. *Legal and Regulatory Aspects of Coalbed Methane Development;* http://www.macleoddixon.com/content/eng/lawyers/329_12092.htm

While coal seams may be dry, they may also contain considerable quantities of water. The water may be fresh or saline, with saline water usually occurring at greater depths. Where there is water in the seams, it is necessary to "dewater" this coal to reduce the pressure and allow the methane to desorb from the coal. Initially, large quantities of water and only small, uneconomic quantities of gas may be produced. Gradually the produced water will decrease and methane production will increase. The actual volume of water produced will depend on the structure of the coal seams, the natural fracture (or "cleat") volume and other local properties of the coal seams, plus the well density.

If the CBM water is fresh, there are two main issues with CBM extraction as far as water is concerned: the impact of dewatering on freshwater aquifers and the way in which the produced water is handled. The dewatering of shallow freshwater aquifers has the potential to lower the water table as well as possibly affecting surface water bodies. With several wells per section, there could be a significant drawn down of water, possibly impacting landowners who may then have to drill deeper wells.[32]

The disposal of the water may also pose problems. In theory, there are several ways in which water from the coal seams may be disposed or diverted:

1. surface discharge to rivers, streams, ponds, lakes or wetlands
2. use of the water, e.g., for crops or livestock
3. injection or recharging of groundwater aquifers
4. discharge to evaporation ponds
5. deep well disposal.

The method used will depend on whether the water is fresh or saline and on government policy. Alberta Environment currently decides how fresh water will be handled on a site-specific basis. Fresh water may be suitable for watering livestock or irrigation, even if is not suitable for human consumption. Alberta Environment does not routinely require the injection of fresh water to recharge aquifers, but might propose this in some cases. The Alberta Energy and Utilities Board (EUB) regulates the collection and disposal of saline water. Disposal will usually be through deep underground injection into another saline aquifer.

2.2.4 Salt Caverns

Water is also used by industry to create salt caverns for storing both oil and gas and oilfield waste. Salt beds underlie a broad belt of the Prairie provinces, extending from the southwestern corner of Manitoba northwestward across Saskatchewan and into Alberta. There are extensive deposits underlying a large area in east–central and northeastern Alberta, extending into the extreme northwest part of the province.[33, 34] The geology of these deposits varies, but in east–central Alberta where they are thickest their aggregate thickness is over 400 metres. The extraction of salt, primarily for use by the chemical industry, began more than 60 years ago. Once a cavern has been created, it may later be used to store liquid petroleum gas (ethane, propane, butane, etc.) and natural gas, as well as for waste disposal.[35, 36] The caverns that are

[31] United States Geological Survey, 2000. Water Produced with Coal-Bed Methane; http://pubs.usgs.gov/fs/fs-0156-00/fs-0156-00.pdf

[32] The Canadian Society for Unconventional Gas points out that, given many of the coal seams being targeted for development are much deeper than currently used or known aquifers, there is an opportunity to use the water in these unused or unknown aquifers associated with CBM development, without any impact on currently used aquifers.

[33] Hamilton, W.N., 1996. *Salt in East-Central Alberta,* Abstract in Alberta Geological Survey, Bulletin 29; Alberta Energy and Utility Board; http://www.ags.gov.ab.ca/AGS_PUB/ABSTRACTS/Bull029.shtml

[34] Canadian Salt Producers, Natural Resources Canada; http://www.nrcan.gc.ca/mms/efab/mmsd/minerals/salt.htm

[35] CCS Energy Services; http://www.ccsenergyservices.com/cav.html

created when the salt is removed are essentially impermeable, so that no fluid or gas can escape through the surrounding rock salt. Salt caverns may also be created purely to provide storage for hydrocarbon wastes, if the salt is not suitable for industrial use.

To remove salt for industrial and commercial use large quantities of fresh water are pumped into the salt layer.[37] The salt dissolves in the water and the resultant brine, which may contain up to 25% salt, is then pumped back to the surface for use. The actual volume of water required varies, but on average approximately 10 cubic metres of water are needed to create one cubic metre of cavern storage space.

While the chemical composition of some salt formations makes the salt unsuitable for commercial use, a cavern may be created solely for storage purposes. Where a cavern is being constructed or enlarged purely for storage purposes, the salt may be removed using industrial wastewater or under-saturated brine. However, if a large volume of wastewater is unavailable, a licence may be given to use fresh water for the period necessary to construct the cavern.[38] The resultant brine will be injected into deep wells. The new cavern will be used to store oilfield waste, while at the same time enabling the recovery of oil that rises to the surface of the oily wastes.

2.3 Licensed vs. actual use of water

Table 1 shows the volume of fresh water that Alberta Environment had allocated in water licences and approvals for use by the oil and gas industry in 2002. The total licensed amount was 438 million cubic metres. This is twice the amount of water used annually by the entire City of Calgary.[39]

However, these figures for the oil and gas industry do not present the actual volume of water used by the industry, but the allocation granted by a licence or approval. The licence indicates the maximum volume of water that a company can withdraw from a given source. In many cases, a company will use less than the maximum permitted, but the exact withdrawals are not known as Alberta Environment (the licence granting authority) does not track the actual volumes of water used. The EUB requires industry to report on the exact volume of water used (although, as outlined in Section 2.5, it is necessary to estimate the volume of fresh groundwater that is used). From the figures reported to the EUB figures, it appears that the volume of water used for oilfield injection is less than one fifth of the volume allocated.[40] According to these figures, the volume of fresh water used for oilfield injection was more than 32 million cubic metres (see Section 2.5), but far less than the 183 million cubic metres allocated by Alberta Environment (see Table 1, combined figures for fresh surface water and fresh groundwater). Some allocations will have been made to new development (such as steam-assisted gravity drainage), which will use more of their allocations as they expand their operation. In other cases, a large quantity may have been allocated and used in the past, but the volumes required may have declined. In enhanced recovery from conventional oil

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[36] Thomas, R.L. and R.M. Gehle, 2000. *A Brief History of Salt Cavern Use.* Keynote address at Salt 2000; www.solutionmining.org (see General Information)

[37] National Petroleum Technology Laboratory, US Department of Energy, Salt Cavern Information; http://www.npto.doe.gov/saltcaverns/index.html. A description of the process is given in *Gulf Coast Salt Domes and Salt Caverns;* http://www.solutionmining.org/Introduction%20to%20Solution%20Mining/Salt.htm

[38] One company, CCS Energy Services, currently has an approval to take nearly 3 million cubic metres of water from the North Saskatchewan River each year until 2006. For comparison, the total volume of water treated at the municipal water treatment plants in Edmonton in 2001 was 127 million cubic metres.

[39] In 2001, the City of Calgary, with a population of 971,500 (almost one-third of Alberta's population), withdrew 212 million cubic metres from the Bow and Elbow Rivers.

[40] It has been suggested that the oil and gas industry uses 40–60% of their allocation. See D. Pryce, Vice-President, Western Canada Operations, Canadian Association of Petroleum Producers, cited in *EnviroLine*, Vol. 13, No. 12 & 13, August 27, 2002, p. 2. The EUB figures indicate a lower proportion.

wells, a large volume of water is required at the start, but as oil recovery declines, much of the water is recycled and smaller volumes are required to make up the balance.[41]

It is important to note that industry may also use saline water, for which no licences are required (see Section 2.5). The licensing of fresh water for oilfield injection projects also varies, depending on whether a project is in the White Area or Green Area of the province, as described in Section 2.4.

Table 1: Allocation of Fresh Water to Oil and Gas Industry in Alberta, 2002[42]

Source of water	Volume in million m^3	% of total volume water allocated
Surface water		
Injection (oil recovery methods*)	133	1.4
Industrial (oil, gas, petroleum**)	237	2.6
Drilling (developing oil/gas wells)	10	0.1
Groundwater		
Injection (oil recovery methods)	50	24.7
Industrial (oil, gas, petroleum*)	8	3.8
Drilling (developing oil/gas wells)	0.1	0.1
Total allocation	438	

*includes water used for steam-assisted gravity drainage schemes[43]
**includes allocation for oilsands processing[44]

A review of the historical data on the use of fresh water by the oil and gas industry could be useful; combined with information on the intensity of water use[45] it could be used to help predict future trends in the demand for water. Such a review of historical water use and projection of future trends was attempted in a report prepared for the Canadian Association of Petroleum Producers (CAPP).[46]

The historic records on surface water use that were available for the CAPP report are limited. Records for allocations are available from around 1950 until 1992. They show that authorized diversions of surface

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41 Unless there is a water management plan, a water licence must now be issued with an expiry date (*Water (Ministerial) Regulation*, section 12). Permission for temporary diversions (such as for oilfield injection) that were issued under the former Water Resources Act, expire by December 2003, five years after the Water Act came into force. When a temporary licence is renewed, Alberta Environment can examine the actual volume of water currently required and consider the relationship between supply and other demands for water.
42 Table compiled from data provided by Alberta Environment, April, 2003.
43 Alberta Environment, personal communication, August 2002.
44 The total allocation for industrial (oil, gas, petroleum) includes 138 million cubic metres of water allocated to three oilsands projects near Ft. McMurray.
45 "Intensity of water use" means the volume of water use for a particular process.
46 Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry,* Chapter 5; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317 See also *Water Use by the Upstream Petroleum Industry;* http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38277

water for enhanced recovery increased consistently from 1953 until 1992, while surface water diversions for process water levelled off between 1978 and 1991. There is less information on actual use. Records for reported diversions are available only for the period 1980–1992 and it is not possible to distinguish between licensees who reported zero annual diversion from those who failed to file a return.[47] As a result of the poor data, it is difficult to project future demands for surface water.[48]

By contrast, data is available on the allocations of fresh groundwater from 1957 until 2001 (when the CAPP analysis was carried out). The graphs constructed from the data showed a continuous increase in the approved groundwater diversions for enhanced recovery throughout the province, although allocations for processing levelled off in the 1980s.[49] The changes in the actual volume of water diverted are discussed in Section 2.4, since the figures are different in the White and Green Areas of the province.

2.4 White vs. green areas in the province

The Alberta Environment policy on the use of fresh water by the oil and gas industry depends on whether a project is located in a White Area or Green Area of the province. The White Area includes all areas primarily used for agriculture, while the Green Area covers the forested north and the region along the Rocky Mountains (see Figure 3). In the White Area, the *Ground Water Allocation Policy for Oilfield Injection Purposes*[50] requires a company to investigate the use of non-potable ground water and non-water alternatives, before it considers the use of potable ground water.[51] Figures reported to the EUB indicate that the total quantity of fresh water diverted in the White Area for oilfield injection in 2002 was about 15% of the volume of saline water used.[52]

The Alberta Environment policy on groundwater does not apply in the Green Area. This probably explains why the volume of fresh water used for oilfield injection in the Green Area is three times the volume of saline water. Although the use of saline water for oil well injection in the Green Area has gradually increased, it was only 1.3 million cubic metres in 2000, compared with 4.2 million cubic metres of fresh water.[53]

[47] Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry,* p. 5-3; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317

[48] Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry,* Chapter 6; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317

[49] The allocations for processing levelled off after about 1982 in the White Area and after 1990 in the Green Area of the province.

[50] Alberta Environment, 1990. *Ground Water Allocation for Oilfield Injection Announced,* News Release and Fact Sheet, March 27.

[51] This policy is emphasized in the February 2003 revision of the *Groundwater Evaluation Guideline (Information Required when Submitting an Application under the Water Act)*. This policy uses the terms potable and non-potable, instead of fresh and saline.

[52] Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry*, p. 5-9; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317. In 2000, 1.6 million cubic metres of fresh groundwater was used for oilfield injection, compared with approximately 11 million metres of saline water. (CAPP indicates that 11.6 million cubic metres of saline water was injected in 1999.)

[53] Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry*, p. 5-10; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317. The CAPP study separated the EUB data into the White and Green Areas of the province, based on the location of the wells.

Figure 3: White and Green Areas of Alberta

The difference between the White and Green Areas is also seen in the historic data analyzed for the CAPP report. The data on actual groundwater diversions was divided into saline and freshwater wells on the basis of arbitrary criteria.[54] It appears that the use of fresh groundwater used for enhanced recovery has been decreasing in the White Area since 1971 (even before the *Ground Water Allocation Policy for Oilfield Injection Purposes)* and by 2000 the total volume diverted for enhanced recovery was about one quarter of the total volume licensed.[55] By contrast the volume of saline groundwater used for enhanced recovery in the White Area has increased dramatically. The volume of fresh groundwater used in the Green Area has also declined to less than half the volume used in 1971, and in 2000 the amount used was less than one-fifth of the volume licensed for diversion.[56]

2.5 Fresh vs. saline water

Fresh water is sometimes referred to as useable water. Fresh water is found in rivers and in groundwater near the surface. At greater depths, however, the water contains higher concentrations of salts (measured in terms of total dissolved solids).[57] Surface water and shallow groundwater have low levels of total dissolved solids and, after purification to remove bacteria, the water is fit to drink.[58] Water at greater depths may not be suitable for drinking, but may still be suitable for agriculture and industry.[59] Saline water is not only unfit for drinking, it is also unsuitable for irrigation, as the salt would build up in the soil, first limiting and later preventing the growth of crops.[60] It may, however, be used for some oilfield purposes.

Alberta Environment does not require a company to obtain a licence to withdraw saline groundwater, and therefore does not maintain records on the use of saline water by the oil industry.[61] The EUB has estimated that 47 million cubic metres of water were used in 2001 for oilfield injection.[62] According to the figures provided by the EUB, less than one-third of the total volume used for oilfield injection in 2001

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[54] Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry,* p. 5-8. http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317 It was assumed that any water well deeper than 200 metres and not completed in aquifers above the Belly River Group was a source of saline water.
[55] Ibid., p. 5-9.
[56] Ibid., p. 5-10.
[57] Saline water is defined as water containing over 4000 milligrams of dissolved solids per litre. *Water Act, Ministerial Regulation*, Alberta Regulation 205/98, section 1(1)(z).
[58] Drinking water must have no more than 500 milligrams total dissolved solids according to the *Guidelines for Canadian Drinking Water*, which apply in Alberta; http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/summary.pdf
[59] The depth at which water becomes unsuitable for human consumption varies widely across the province, but most fresh water is at depths of less than 400 metres.
[60] Alberta Surface Water Quality Guidelines specify the limits for substances in water for different purposes. The guidelines are available at http://www3.gov.ab.ca/env/protenf/publications/SurfWtrQual-Nov99.pdf
[61] Water Act, Ministerial Regulation, Alberta Regulation 205/98, Schedule 3, Diversions of Water or Operations of Works that are Exempt from the Requirement for a Licence, section 1(e).
[62] Willard, R. J., Senior Advisor, Applications Branch, Alberta Energy and Utilities Board. Letter to Mary Griffiths, Pembina Institute, June 27, 2002: "*The total make-up volume of water from all sources used for oilfield injection in 2001 was about 47 million m^3. Of this amount the EUB records show about 32 million m^3 from surface or near surface sources, lakes and rivers and . . . unlicensed shallow wells. This full amount would clearly be useable water. There is also about 5 million m^3 per year of injected water from licensed source wells. These are normally wells that were drilled deeper than 150 metres; but the EUB records may also include some very old licensed wells that are shallower. We have not separated this group. Also some wells in Alberta produce useable water from depths of 400 metres or deeper. EUB records do not distinguish between useable and non-useable water for the licensed wells. As a result this 15 million m^3 will likely be non-useable water; however, there will be some useable volumes in this number." Note that in this letter "usable water" is comparable to the "freshwater" as defined in this paper; non-usable water refers to "saline" water.*

was non-useable (or saline) water. There is thus still considerable scope to increase the use of saline water.

A company's ability to use saline water, instead of fresh water, for oilfield injection is influenced by several factors including the chemical makeup of the water or the distance to a suitable aquifer. The chemical properties of the oil reservoirs also vary. Under some circumstances, saline water may react with the reservoir to form precipitates that affect oil reservoir viability. Fresh water may cause some clays to swell and create similar problems. Water used for steam generation at in situ SAGD projects must meet specific quality guidelines. Treatment or blending with fresh water may be necessary to meet the technical specifications of current steam generation technologies.

While it is not always a simple matter to substitute one source of water for another, the fact that saline water is used far more often than fresh water in the White Area of the province (see Section 2.4), and is now being included as a source for in situ SAGD projects in the Athabasca oilsands region, demonstrates that there is potential to substantially decrease the amount of fresh water currently being used by the industry.

3. Current Impacts and Future Concerns

The large quantities of water used by the industry for both enhanced oil recovery and oilsands extraction are of considerable concern for the sustainability of Alberta's water resources; in the case of CBM the amount of water that is produced may be an issue.

3.1 Enhanced oil recovery

The injection of fresh water for enhanced oil recovery is a concern since this water is removed from the hydrologic cycle. The fact that nearly one quarter of all fresh groundwater allocations are for enhanced oil recovery is a special concern. The amount of fresh groundwater used for enhanced recovery in the Green Area of the province has been increasing rapidly. Although there has been a decline in the volume of fresh groundwater used for enhanced recovery in the White Area, any withdrawals for this purpose are problematic when there is a shortage of fresh water for agricultural and municipal uses. For example, in the Caroline area, the Butte Action Committee has protested the use of fresh water for oilfield injection. The committee is worried about dugouts going dry, river flows declining, and towns running short of water.[63] This is not surprising as groundwater levels have been falling as a result of drought and the increasing demand for water. The shortage of water in part of Central Alberta is so severe that there is a plan to construct a 66 kilometre pipeline to transfer drinking water from the Red Deer River to communities in the Ponoka/Lacombe area. The Alberta government passed the North Red Deer Water Authorization Act in 2002 to authorize this inter-basin transfer of water.

Not only have groundwater levels fallen in some areas, the flows in rivers are also declining. Recent research indicates that summer river flows across Alberta have only 50–60% of the volume they had at the beginning of the 20th century.[64]

The drought years of the last decade have shown that water is a scarce resource, not only in the traditionally dry south, but also in Central Alberta, including the Cold Lake area, and potentially in the north as well.

3.2 Oilsands

The experience of rural residents in the Cold Lake area indicates the type of problems that can occur. Imperial Oil started using steam injection to extract heavy oil in the area in 1980. They obtained their water from lakes and groundwater, which lowered the pressure in the deep freshwater aquifers.[65] This has

[63] The Butte Action Committee is concerned that an oil company that was given a water allocation from the North Saskatchewan River was able to sell part of their allowance to another company. While a company cannot charge for the water itself, they can charge a processing fee for filtering the water. The committee has encouraged companies to use alternatives to fresh water for enhanced recovery. Don Bester, Butte Action Committee, personal communication, November, 2002.

[64] W.F. Donahue, Research Associate, Dept. of Biological Sciences, University of Alberta, personal communication, November 2002.

[65] Alberta Energy and Utilities Board, 1999. Decision 99-22. Imperial Oil Resources Limited Cold Lake Production Project Mahkeses Development; http://www.eub.gov.ab.ca/bbs/documents/decisions/1999/d99-22.pdf See section 5.1.2.3: *"The Board agrees with the positions that the past pumping of deep Quaternary aquifers has caused declines in water levels as great as 60 m in the pumped wells, and that these declines translate to lower water levels, changes in magnitude and direction of hydraulic gradients, and, eventually, lowering of the water table at locations that may be tens of kilometres away from the pumping centres. The Board further agrees that these effects were transmitted beyond Imperial's lease and into areas occupied by private residents."*

accentuated the decline in groundwater levels resulting from drought conditions.[66] Landowners have had to drill deeper wells; and some have found that water drawn from lower levels is of inferior quality.[67] In some places localized impacts to groundwater quality have occurred as a result of well casing failures and seepage from ponds, pits and landfills.[68]

Such impacts may not be restricted solely to groundwater. Changes in lake levels have also been recorded for many lakes in the Cold Lake region. For example, Muriel Lake in the Cold Lake area has lost half its water in the last 25 years. A detailed study has been undertaken in an attempt to determine the relative impacts of drought, land use change and development, surface drainage disturbance, and the diversion of water for use by the oil industry.[69]

The protection of water resources is not important only for human uses, but for ecological integrity as well. Adequate flows in Alberta rivers are essential to meet the instream needs of fish and other aquatic biota. Reductions in even the seasonal flow of rivers can have serious impacts downstream, as has been evidenced by the impact of the Bennett Dam on the Peace/Athabasca Delta. Since the Bennett Dam was constructed spring floods have drastically declined, and the Delta area is drying up. This in turn has had impacts on wildlife and the livelihood of aboriginal hunters and trappers.

It is likewise important to protect groundwater. Withdrawals of groundwater that lower the water table can reduce the extent of wetlands in low-lying areas. Groundwater diversion also may impact wetlands or water tables in areas where aquifers are actively recharged from the surface (wetlands act as a sponge, increasing the residence time of the water within the flow system and gradually releasing it; otherwise it would run off quickly into streams and rivers). Wetlands can also contain rare plants and animals; these unique ecosystems need protecting.

Large increases in the demand for water for oilsands extraction and processing can be expected. Current production from oilsands projects is approximately 580,000 barrels per day,[70,71] but output is expected to increase by a factor of three by 2020.[72] This will greatly increase demands for water. Although assessments of water supply are made before an oilsands project is licensed, more information is needed concerning the cumulative impact of many operations within a limited area withdrawing immense volumes of groundwater. In many regions of the province, there is a lack of hydrogeological knowledge and hence uncertainty regarding the potential connectivity between groundwater and surface water. Alberta Environment requires applicants for licences to provide a hydrogeological assessment to estimate the impact that a planned drawdown will have on the aquifer and on other water users. However, due to the uncertain nature of the science of hydrology, it is not possible to know the exact impact that water withdrawal and disposal will have on water quality and water quantity in both aquifers and surface water

[66] When the pumping by Imperial and Amoco stopped, the groundwater pressures in the deep usable aquifers gradually returned to approximately their former levels Alberta Environment, personal communication.
[67] The EUB required Imperial Oil Resources Ltd. to improve the groundwater monitoring network and conduct additional studies to provide information on any water level responses to steam injection and other potential impacts. See EUB Decision 99-22, Section 8 Decision.
[68] EUB Decision 99-22, Section 5.2.3: *"The Board notes that Imperial is responsible for localized groundwater impacts resulting from casing failures and seepage from pits, ponds, and landfills at its Cold Lake operation."*
[69] W.F. Donahue, Research Associate, Dept. of Biological Sciences, University of Alberta, personal communication, November 2002.
[70] Carter, J.E., 2002. *The Future of the Alberta Oil Sands*, Presentation to the Alberta Science and Research Authority Retreat, June 7, 2000; http://www.aeri.ab.ca/sec/new_res/docs/ASRA_pres_carter_oilsands.pdf
[71] This is equivalent to over 95,000 cubic metres. A barrel is a measure of volume. When used as a measure for oil and petroleum products it equals 35 Imperial gallons. There are 6.098 (Imperial) barrels in a cubic metre.
[72] Bolger, L. *The Alberta Energy Research Strategy: An Integrated Approach.* Presentation to the Alberta Science and Research Authority Retreat, June 7, 2000; http://www.aeri.ab.ca/sec/new_res/docs/ASRA_pres_bolger.pdf

bodies. In northeastern Alberta, wetlands and peatlands are often largely dependent on groundwater recharge; hence water withdrawals resulting in drawdown effects will eliminate or severely impact these areas, many of which serve as important habitat and are ecologically significant.

The volume of water required for oilsands extraction depends on a variety of factors including operating conditions, ore grade and recycle rate. [73] It also varies over time. Cumulative water withdrawals from the Athabasca River could be at a level of potential impact during times of low flow. The Athabasca River has been subject to natural flow variation that has decreased flow during the low flow winter months to near record lows. Although licences contain provisions that allow Alberta Environment to impose low flow-cut-off levels as needed,[74] not enough is known about the actual in-stream flow needs of the Athabasca River. The In-Stream Flow Needs (IFN) sub-group of the Surface Water Working Group of the Cumulative Effects Management Association (CEMA) is currently engaged in scientific studies of the Athabasca River to determine the in-stream flow needed to sustain aquatic habitat and water quality. However, there are no results to date and any additional withdrawal increases the risk of imposing ecological and water quality impacts on the Athabasca River during periods of low flow. For this reason, the Oilsands Environmental Coalition[75] contends that there should be no new water allocations until the IFN sub-group determines the in-stream flow needs of the Athabasca River or until an interim limit is established to ensure the ecological integrity of the river is preserved. Alberta Environment is awaiting the outcome of the IFN subgroup before implementing any form of in-stream flow guidelines that would restrict use during periods of low flow. The group plans on having science-based objectives in place by the end of 2004 and to have developed an appropriate management system by the end of 2005.

In the past Alberta Environment granted unfettered licences to large oilsands companies for the volume of water required for start-up of their operations.[76] This start-up volume is substantially larger than volumes required for normal operations. The practice of granting water licences and approvals[77] set at the full start-up requirement withdrawal rate has allowed these companies to implement numerous large-scale expansions and new projects that have substantially increased their daily average water withdrawal

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[73] Suncor Energy Inc. and Syncrude Canada Ltd. each have a surface water licence that allows them to withdraw approximately 60 million cubic metres a year (Mm^3/y). In 2001 Syncrude withdrew 37 Mm^3/y and did not return any flow to the Athabasca River. Suncor, on the other hand, withdrew 42 Mm^3/y in 2000, but the net amount used was far less, since there was a return flow to the river of approximately 30 Mm^3/y. Albian Sands Energy Inc. has a licence of 55 Mm^3/y for the Muskeg River Mine, but water use is still low, since production has only recently begun. Sources: Suncor Energy Inc., *2001 Report on Sustainability*, Environmental Performance, Water; http://www.suncor.com/SD_Report01/env_water_1.html; Syncrude Canada Ltd, *Annual Report for 2001*, Performance Summary; http://www.syncrude.com/syn_library/lib_ar.html; Mike Baker, Albian Sands Energy Inc., personal communication.

[74] Alberta Environment currently imposes a 14.2 cubic metre per second passing flow on all licences for withdrawal from the Athabasca River. This serves as an interim objective until the work of the Instream Flow Needs subgroup is completed.

[75] OSEC is a coalition of Alberta-based environmental organizations with a long-standing interest in environmental issues associated with oilsands development. The current members of OSEC are the Ft. McMurray Environmental Association, the Pembina Institute, the Toxics Watch Society of Alberta, and the Environmental Resource Centre. Members of OSEC participate actively with other stakeholders through the Cumulative Environmental Management Association (CEMA) to develop environmental management systems intended to preserve and protect the long-term ecological integrity of the Athabasca region from industrial development. In addition to CEMA, OSEC members continue to assist with the planning and management of environmental assessment and monitoring in the region through other regional multi-stakeholder groups.

[76] Both Suncor Energy Inc. and Syncrude Canada Ltd. received licences for large allocations under the Water Resources Act for an undefined period of time.

[77] A water licence is required for the diversion of water, as set out in the *Water Act*, Part 4, Division 2 and *Water (Ministerial) Regulation*, Part 2. An approval is required for an activity (see *Water Act*, Part 4, Division 1 and *Water (Ministerial) Regulation*, Part 1), which includes drainage activities where the water is not put to productive use.

requirement without needing to apply for a new licence. Since the Water Act came into force in 1999, Alberta Environment grants licences with a 10-year renewal period, sufficient to meet routine operations (with a separate temporary licence to meet additional water requirements during start-up). However, licences granted before the Water Act came into force have been grandfathered, in recognition of commitments made under earlier legislation and the fact that investments had been made based on those commitments.[78] As a result, they have not been subject to re-evaluation or re-assessment for potential environmental impacts or the appropriateness of the magnitude of the allocation.

3.3 Coalbed methane

There are also concerns about potential impacts that drilling for coalbed methane (CBM) in Alberta will have on water.[79] In cases where coal seams are near the surface, dewatering may affect freshwater aquifers and cause a lowering of the water table. Some CBM areas in the US generate huge volumes of produced water and there have been some problems in the handling of this water. [80]

Due to different geological conditions, such as the permeability of the coal and the regional hydrodynamics, the volume of water associated with the gas varies from basin to basin.[81] In Alberta, the quantities of water are expected to be smaller than in the US[82, 83] because the coal seams in general appear to be less permeable than in some of the US CBM areas. In Canada some areas are even "dry."

The coal strata targeted by a CBM well will frequently be at a much greater depth than the freshwater aquifer being used by the landowner. Often water wells are less than 100 metres deep and there is not a single continuous aquifer from the landowner wells to the coal strata. Provided the aquifers are isolated, dewatering the coal strata will have no impact on the shallow aquifer being used by the landowner.

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[78] This included commitments made by the federal government before the Water Resources Act was in place.

[79] Alberta Department of Energy, 2001. *The Potential for Coalbed Methane (CBM) Development in Alberta,* Report prepared by M. Heath and Associates, September, 2001; http://www.energy.gov.ab.ca/gmd/docs/Coalbed_Methane_Final_Report_Sept_2002.pdf
Concerns with CBM are not limited to the dewatering issues discussed in this paper. They also include concerns about land fragmentation, methane leaks, venting and flaring of the methane gas, and noise associated with compressors. These issues have caused some concerned citizens to call for a moratorium on the approval for licensing CBM projects until specific guidelines are in place for CBM production. See letter from Rimbey and District Clean Air People to Neil McCrank, Chairperson, EUB and Minister of Environment Lorne Taylor, April 1, 2003. The Pembina Institute is preparing a public interest paper on CBM that will be published mid-2003.

[80] In the Powder River Basin in Wyoming the average well produces about 260 barrels of water a day (over 40 cubic metres/day) and the well density is about one well per 40 acres in producing areas (in 2000 the regulations were changed to allow only two wells per 160 acres). See Heath and Associates, September 2001, *The Potential for Coalbed Methane (CBM) Development in Al*berta, prepared for Alberta Energy, p. 31. The Powder River Basin Resource Council outlines some of these issues on their Web site at http://www.powderriverbasin.org/index.htm. In the San Juan basin, in northwest New Mexico and southwest Colorado, the water is generally saline and is disposed of through deep injection.

[81] US Geological Survey, 2000, *Water Produced with Coal-Bed Methane,* USGS Fact Sheet FS-156-00; http://pubs.usgs.gov/fs/fs-0156-00/fs-0156-00.pdf. The ratio of water to gas is highest when a well is first drilled and gradually declines; other things being equal, a mature field with more older wells will produce much less water than a field with many new wells that are in the dewatering stage. The water to gas ratio is 2.75 in the Powder River Basin, compared to 0.031 in the San Juan Basin.

[82] Canadian Association of Petroleum Producers, 2003, Media advisory, March 11. See background document: *Towards Responsible Development of Coalbed Methane in Canada;* http://www.capp.ca/default.asp?V_DOC_ID=843

[83] Canadian Society for Unconventional Gas; www.csug.ca

However, this does not alleviate the concerns about the dewatering of freshwater aquifers that may force nearby landowners to abandon existing wells and drill deeper ones. Nor does it reduce the need for effective regulatory management of CBM development in Alberta.

CBM projects may require up to eight wells per section.[84] This density of wells could occur over considerable areas of land, since a large number of CBM wells are necessary to produce an economic quantity of gas. Thus the effect of dewatering, if required, could be felt over a wide area. Wetlands and surface water bodies that depend on groundwater recharge may also experience a drop in water levels.

To ensure there will be no environmental risks, Alberta Environment at present requires an impact assessment of CBM projects before it will issue an approval for dewatering of non-saline aquifers. However, it is difficult to estimate long-term cumulative impacts by examining requests on a well-by-well basis. It is understood that the department is currently reviewing its policy

The management of saline waters that have been pumped to the surface is also an issue of concern. However, the industry does have experience with such issues since the handling of saline produced waters is a common occurrence for conventional well drilling programs. Under current regulations such waters must be deepwell injected to prevent contamination of soil, groundwater, fresh surface water and aquatic ecosystems. Ensuring ongoing effective regulatory oversight of this potential risk will be essential as CDM development expands within the province.

[84] This spacing is similar to conventional shallow natural gas well spacing, although the standard spacing for natural gas wells is one well per section.

4. Problems with Current Policy on Water Use by the Oil Industry

4.1 Determining priorities for water use

4.1.1 Competing Demands for Water

There are many competing demands for water. This is particularly problematic when water is in short supply when it becomes necessary to have some policy to determine who gets the right to access the water. The Alberta policy, as entrenched in the Water Act, has traditionally been "first in time, first in right." Moreover, when water licences were granted during the past century, they had no expiry date. Under the Water Act this has changed and new water licences may only be issued for a fixed period, unless there is a water management plan that provides for an exemption.[85] However, most licences issued under the previous Water Resources Act have been "grandfathered" with no expiry date.[86, 87]

These former policies fail to encourage conservation. The Water Act goes some way to addressing this issue, by allowing the transfer of water rights, and by enabling the government to withhold 10% of the amount transferred to meet instream flow needs. [88] However, the Water Act does not specify how priorities between alternate uses are to be determined when a transfer is requested.[89] It also does not deal with the issue of grandfathered water licences.

As is recognized in the government's preparation of a Water Strategy for Alberta, it is time to determine which uses of water are most essential and to adopt policies that encourage the conservation of water and that retain freshwater supply for the most essential needs. In particular this requires a review of the use of water by the oil and gas industry (see Section 4.1.2).

4.1.2 Use of Fresh Water for Oilfield Injection

There are increasing public concerns about the use of fresh water for oil field injection. These concerns apply to both surface water and groundwater and indicate the need for the government to take steps to reduce the oil and gas industry's use of fresh water.

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[85] *Water (Ministerial) Regulation*, section 12.

[86] Alberta Environment, personal communication, September 2002. The exception to this is some temporary permits for the diversion of groundwater, which were given an expiry date of December 2003 in Ministerial Order 10/99, relating to transitional issues under the Water Act.

[87] Only permissions for temporary diversions issued under the former *Water Resources Act* are required to expire within five years of the Water Act coming into force in 1999. *Water (Ministerial) Regulation*, section 72.

[88] The Water Act makes provision for the transfer of water allocations, provided the transfers are allowed under a Water Management Plan or approved by Order in Council. A public review must first be held and the Director must ensure that the transfer will not impair the rights of others (that is, household or traditional agricultural users or other licence holders) or create a significant adverse effect on the aquatic environment. The review process will give the public an opportunity to advocate for the protection of the ecological needs of aquatic life, as well as for the long-term optimal sustainable use for the water. In addition, the Water Act provides the ability for the Government to withhold up to 10% of the water that is being transferred under both permanent and temporary transfers of allocations. This holdback must be authorized in an approved water management plan or through an order of Cabinet and may be withheld to meet the needs of the aquatic environment.

[89] Alberta Environment is preparing an administrative guideline on transferring water allocations. The South Saskatchewan River Basin Management Plan, one of the major plans in development, does not indicate any preference for use.

As indicated in Section 2.4, the Alberta government has the *Ground Water Allocation Policy for Oilfield Injection Purposes*.[90] This policy requires a company to look for alternative sources before applying for a licence to withdraw fresh groundwater in the White Area of the province. There is no formal policy with respect to surface water. There are thus still large quantities of surface water and groundwater being used for oilfield injection in the White Area, despite the fact that agriculture and even municipalities have been facing shortages.

In the Green Area a company requiring a licence to divert groundwater for enhanced oil recovery is not required to review other water supply options, unless the location is close to the White Area. Since it is usually cheaper to use fresh groundwater (as it is closer to the surface than saline water and does not need processing or require more expensive equipment to withstand the corrosive effects of salt), a company will often use fresh water rather than saline. The fact that the *Ground Water Allocation Policy for Oilfield Injection Purposes* does not apply in the Green Area probably explains why the amount of saline water used in the Green Area is only about one quarter of the total used (see Section 2.4). The further development of oilsands in the Green Area of the province, such as the steam-assisted gravity drainage projects, will put increasing demands on water in the Green Area.

4.2 Inadequate reporting and monitoring of water use

Reporting and monitoring of water use is the first step in wise management. If one does not know exactly what is being used, it is not possible to know if the resource is being over-allocated. Detailed information on current use is also necessary to help determine future demands.

4.2.1 Reporting of Surface Water Licensed Withdrawals

When Alberta Environment issues a water licence they require the licence holder to keep records of the actual amount of water that is withdrawn and, in the case of large allocations, to submit reports of water used. Alberta Environment does not currently maintain an up-to-date province-wide database on the volumes of water actually withdrawn, although this type of data is available in some locations, such as the Ft. McMurray region.

The failure to track the actual volume of water withdrawals could create problems in some parts of the province. First, we do not know what the impact would be if the full licensed quantity of water were to be withdrawn. There may be no apparent impacts at the present, but it is possible that impacts could occur if all licence holders in an area were to withdraw their full licensed allocations. Secondly, without adequate information on current withdrawals, it is difficult to predict what future demand will be. It is thus important to fully track the amounts of current allocations that are being withdrawn.

4.2.2 Reporting of Groundwater Licensed Withdrawals

It is also important to have accurate records of groundwater withdrawals to monitor the proportion of a licence allocation that is actually being used. This will help ensure that water is effectively and appropriately allocated and that new licences for withdrawal are not issued that could lead to over-allocation of the resource.

4.2.2.1 Withdrawals of Groundwater

Some withdrawals of groundwater are reported to Alberta Environment and some records are kept by the Alberta Energy and Utilities Board, but, because of limitations in the reporting, "neither source likely

[90] Alberta Environment, 1990, *Ground Water Allocation for Oilfield Injection Announced,* News Release and Fact Sheet, March 27.

provides a complete and accurate picture."[91] The EUB is the agency responsible for regulating and monitoring the use of saline groundwater. It keeps records of water diverted from wells, but does not specifically distinguish between fresh and saline water (see Section 2.5, above). It is important to have accurate records on both the volumes of fresh and saline water that are withdrawn, as this assists good management. It is then possible to set targets for reductions in the use of fresh water and to monitor the progress in meeting those targets.

4.2.2.2 Dewatering of Groundwater

In addition to issuing licences for the use of groundwater, Alberta Environment also issues approvals under the Water Act for the drainage of surface water, where this water would hinder a project. Companies mining oilsands usually require dewatering of the muskeg before undertaking operations, and may need to divert (depressurize) basal aquifer groundwater for the life of the project to prevent mine pit flooding. While a company will estimate the volumes of water that will be removed through dewatering and depressurization, and may record the amount drained, the approval does not require them to report the actual amount of water that is drained. The volume of water removed by dewatering is not included in the figures for surface water allocations, except where a company plans to use the water in their process or retain it on their site. In that case, the water use must be licensed. In all other cases, all water that is removed through dewatering is returned to the basin. However, given the potential impacts to both surface water bodies and to groundwater reserves, the actual amount that is drained should be reported.

4.2.3 Monitoring of Groundwater

A document published as background to the Water Strategy for Alberta states, "Although we suspect Alberta has large amounts of groundwater, we currently do not have data that indicates exactly where, and how much groundwater is available."[92] Alberta Environment has approximately 200 wells across the province that monitor water depth, but does not analyze the long-term trends in water levels in those wells or determine to what extent changes in water level are due to drought or to withdrawals of water for industrial or other uses. In 2001 the department analyzed the trend in water levels in only about 30 wells, most of which were in the central and southern parts of the province.[93] In almost three-quarters of the wells analyzed, the groundwater level was below or much-below normal levels, including several deep wells. In some areas it is known that groundwater levels have been declining for a long time, as farmers and landowners have to drill deeper to access water for their needs. A more widespread analysis of long-term data is needed and the government should use this information to help make wise decisions with respect to water management in the future.

4.3 No data base of complaints

The public may report problems with water wells and other impacts from oil and gas activity on water to Alberta Environment, Alberta Agriculture, Food and Rural Development, the Farmers' Advocate, the EUB and perhaps other departments or agencies. However, according to the Canadian Association of

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[91] Canadian Association of Petroleum Producers, 2002, *Use of Water by Alberta's Upstream Oil and Gas Industry*, p. 5-8; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317

[92] Albert Environment, 2002, *Water for Life: Facts and Information on Water in Alberta*, p. 9; http://www.waterforlife.gov.ab.ca

[93] Alberta Environment, 2001, *Mountain Snow Conditions and Water Supply Forecasts for Alberta*, September 2001; http://www3.gov.ab.ca/env/water/ws/watersupply/historical/SEP01.pdf. In 9 of the 30 wells studied, the groundwater level was below normal and in an additional 13 wells the level was much-below normal. The definition of much-below average is that the reading is in the lower 15% of recorded values; for below average, the reading is between the lower 15% and 35% of recorded values.

Petroleum Producers, "although several government agencies reportedly receive complaints from members of the community, no database has been kept."[94]

While some complaints may be localized due to geophysical activity (seismic shots) to locate mineral resources, others may be related to dewatering operations and impact a wide area. Complaints may also arise due to the migration of gas into freshwater aquifers.

[94] Canadian Association of Petroleum Producers, 2002*, Use of Water by Alberta's Upstream Oil and Gas Industry*, p. 8-2; http://www.capp.ca/default.asp?V_DOC_ID=763&PubID=38317

5. Recommendations

As indicated at the beginning of this report, the Alberta government is seeking public input on its draft water strategy, *Water for Life: Alberta's Strategy for Sustainability.* Some of the recommendations in this paper are consistent with those being proposed in the draft strategy, while others are new. The Pembina Institute hopes that our proposals will contribute to the ongoing discussions on the water strategy for the province and lead to improved water conservation and management.

RECOMMENDATIONS

To ensure the conservation and wise use of water, the Pembina Institute recommends that the government

1. **Record the amount of water withdrawn under licences and approvals**

   Knowing the actual volume of water used is essential for wise management. This database should be publicly available.

2. **Reduce the use of fresh water by the oil and gas industry**

   Fresh water is a finite resource so policies, including targets, are needed to encourage the use of alternatives.

3. **Introduce a charge for the industrial use of water**

   Putting a price on water is the most effective way to promote conservation.

4. **Revise regulations relating to the management of fresh water in coalbed methane extraction**

   The unique risks posed by some CBM operations require special regulation.

5. **Track and report complaints about water**

   A central, public database of complaints is needed, to identify areas where there are problems with water supply and quality.

6. **Review grandfathered industrial water licences and approvals**

   To ensure the wise use of water, industrial and large-scale commercial water licences and approvals that were issued for an indefinite period should be reviewed and converted to term licences, similar to licences issued under the Water Act.

RECOMMENDATIONS cont'd.

7. **Tailor water industrial licences and approvals to actual needs**

Licences and approvals for industrial and large scale commercial uses should be phased to reflect the actual needs for a particular stage of development in a project, rather than providing for the maximum requirements throughout the life of a project.

8. **Dramatically enhance research and monitoring of groundwater resources**

More information is needed on freshwater aquifers in Alberta, to ensure that they are not over-allocated or contaminated.

9. **Legislate the protection of wetlands**

There is currently no effective regulatory protection of wetlands in Alberta, yet wetlands are important for replenishing groundwater reserves, as well as for providing habitat for various plant and wildlife species.

10. **Develop water basin management plans for all Alberta**

Proactive, forward-looking management plans are urgently needed for water basins across the province.

5.1 Record the amount of water withdrawn under licences and approvals

A prerequisite for good water management and planning is to have good statistics on current water use. Better data will improve Alberta Environment's ability to

- assess the current situation with respect to water withdrawals in the province.
- determine whether the resources are sufficient to make further allocations.
- estimate future demands and availability, which will help in long-term and water management planning.
- monitor the changes in the use of fresh water and saline water by oil and gas companies, and take any additional action required to meet the targets.
- ensure that companies are in compliance with their licensed withdrawals.

Alberta Environment should keep a record of the amount of fresh water that is actually withdrawn each year under each water licence and approval, for both surface water and groundwater. This would include recording the volumes removed for dewatering. They should also record the volume of saline water used. Alberta Environment and the EUB should coordinate their activities to ensure the necessary data can be reported and compiled, without causing duplication.[95] Where a company currently reports on the use of

[95] The EUB already collects some data, but the data collection system should be upgraded to distinguish between potable, useable and non-useable water. It would be helpful to record the volumes of water used that are potentially potable (less than 1,000 milligrams of dissolved solids per litre) treatable (between 1,000 and 4,000 milligrams of

groundwater to the EUB they will need to indicate whether they are using fresh or saline water. The EUB can forward this information to Alberta Environment, to enable them to monitor the use of fresh and saline water. The system should also distinguish between the water used for conventional oil and gas, heavy oilsands, and CBM extraction.

Regional figures on water use (as well as water allocations) should be reported to the public at least annually, and more detailed information showing the volume of fresh and saline water used by each company should be available, if required. There should also be an inspection and auditing system in place to ensure that companies are accurately reporting their water use.

While reporting and monitoring is needed, other measures must be taken at once to encourage conservation.

5.2 Reduce the use of fresh water by the oil and gas industry

Fresh water is a finite resource and there are sometimes alternatives to its use. Targets should be developed to reduce the amount of fresh water used by industry. A mechanism to achieve this could follow the highly successful model developed by the multistakeholder Clean Air Strategic Alliance and implemented by the EUB that has been the basis for significant reductions in the volumes of solution gas flaring in the province.[96]

Initial actions by industry to achieve reduction targets could be voluntary. If trends to reduce the use of fresh water (by switching to saline or through conservation) were insufficient, further measures would be needed.

A key step in facilitating reduction in the use of fresh water by the oil and gas industry is to amend the Alberta Environment policy on *Ground Water Allocation for Oilfield Injection* so that it applies to the Green Area, as well as the White Area, of the province. This would require all companies to look at the potential to use non-potable sources of water before applying for a water licence. Some companies already do this. At a later stage, this policy should be reviewed to determine whether it should be mandatory.

Removal of fresh water from the hydrologic cycle is a special concern. Alberta Environment must ensure that companies applying for water licences use the latest technologies to optimize the efficient use of water and to use saline water over fresh water wherever possible. In the oilsands this may also involve encouraging greater use of solvents, instead of steam by in situ operations to extract bitumen.[97] With conventional oilwells, a company could consider using natural gas liquids or CO_2 to enhance oil recovery as an alternative to water.[98]

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dissolved solids per litre) and saline (where the salinity exceeds 4,000 milligrams and it is unlikely that the water would be required for treatment).

[96] Clean Air Strategic Alliance, 2002, *Gas Flaring and Venting in Alberta: Report and Recommendations for the Upstream Petroleum Industry by the Flaring/Venting Project Team;* http://www.casahome.org/uploads/FVPTRptANDRecsFinalVersionJUN-21-2002.pdf. This mechanism sets province-wide reduction targets and requires companies to assess the potential for reducing flaring activity, the results of which are publicly reported on an annual basis. See also EUB Guide 60, *Upstream Petroleum Industry Flaring, Incinerating, and Venting;* http://www.eub.gov.ab.ca/BBS/requirements/Guides/g60.htm

[97] Alberta Energy Research Institute, 2002, VAPEX Process Engineering and Economics, in *Energy Horizons,* Vol. 1, Issue 1, October, p. 5; http://www.aeri.ab.ca/sec/new_res/docs/e_news/issue_01.pdf

[98] While CO_2 may be an alternative to the use of water for enhanced oil recovery, there are various concerns to be addressed before considering the widespread storage of CO_2 underground as a means of reducing the amount of CO_2 in the atmosphere. It is not yet known what the risks of leaks are from different types of geological strata and how

5.3 Introduce a charge for the industrial use of water

The current system in Alberta provides almost no incentive to conserve or increase efficiency in the use of water. The single most effective mechanism to influence conservation and efficient use of any resource is achieved through a pricing signal. The need to charge a realistic price for water has been recognized at both national and international levels.[99, 100]

The fact that water is a scarce resource requiring wise use by Albertans means that it is time to begin to charge for its use for industrial and commercial[101] purposes. The scale of use by industry and the continued dramatic growth in industrial development in the province make it necessary to introduce such a charge. Initially the charge could be modest, so as to allow for adjustment and provide time to implement long-term reduction plans. It would need to be understood that, over time, the charge would increase as a reflection of the resource's value and to spur more intensive conservation efforts. As an incentive for industry to switch from fresh water, there should be no charge for the use of saline water.

The amount of the charge should depend on the use to which water is put. Charges on water permanently removed from the hydrologic cycle (e.g., oilfield injection) should be higher than those applied to activities that only make temporary use of the resource. Uses that result in discharges that are more polluted than the water intake could potentially result in a higher charge than those that return the water close to its natural state (although this might be better dealt with by applying a discharge fee, rather than in the pricing of water).

The broader application of charges on water to non-industrial sectors of the economy is outside the scope of this paper but should be carefully considered in consultation with stakeholders.

5.4 Revise regulations relating to the management of fresh water in CBM extraction

The first CBM projects being developed in Alberta are being regulated under current legislation that applies to conventional gas. While the dewatering of fresh water and disposal of saline groundwater are already regulated, it is important to revise the regulations to ensure that the potential environmental impacts associated with the extraction of CBM are fully assessed and properly managed.

5.4.1 Provide for Broad Public Participation

The depressuring of freshwater bearing coal seams prior to the extraction of CBM may impact the water resources of an area. It is possible that with extensive CBM operations the public over a wide area may be affected by the cumulative impacts. It is thus essential that a company not only notify the local landowners, but also provide public notification through an advertisement in the media. There must be an

long the CO_2 will remain underground. The Pembina Institute is also concerned that attention to underground storage of CO_2 should not divert resources away from the development of renewable energy, which is a known way of reducing greenhouse gas emissions.

[99] Organization for Economic Cooperation and Development, 2003. *OECD Observer*, "Pricing Water," March 19; http://www.oecdobserver.org/news/fullstory.php/aid/939/Pricing_water.html

[100] Environment Canada, 1987, *Federal Water Policy, Strategy 1: Water Pricing;* http://www.ec.gc.ca/water/en/info/pubs/fedpol/e_fedpol.htm#5.1

[101] Under Alberta Environment's classification of water licences (used for Figure 1) commercial includes operations such as petrochemical plants, power plants, pulp and paper mills and all large scale users that require a separate licence or approval. It does not include commercial operations within a municipality that draw their water from the municipal water supply.

opportunity for all affected publics to participate in regulatory decision making on an equal legal basis to be able to fully provide their input, not only with respect to impacts on groundwater and the way in which fresh water is used or discharged, but also on the broader range of concerns associated with CBM.[102]

5.4.2 Ensure Environmental Assessments

Since it is highly probable that there will be a considerable number of CBM wells, at densities of between 2 and 8 wells per section, when the dewatering of a freshwater aquifer is required a review of the regional impacts is essential. If test wells show the potential for widespread effects on freshwater aquifers as a result of dewatering, then, as input to a decision on whether to allow the operation to proceed, basin-wide/watershed studies should be conducted to provide a baseline and evaluate any potential impacts. For large-scale CBM operations or regions where several CBM operations are proposed a full regional Environmental Impact Assessment should be required, to examine not only issues relating to water but the full range of environmental impacts.[103]

5.4.3 Report Dewatering of Aquifers

Accurate recording and reporting of the volume of fresh and saline water removed from CBM seams is essential. As indicated in Recommendation #1, Alberta Environment licenses dewatering of fresh water and they should require the reporting of the actual volume of water removed. They should also obtain copies of information of the removal of saline water that companies report to the EUB. While the EUB is responsible for having effective inspection and enforcement mechanisms to ensure the safe handling of the saline water, Alberta Environment should know where these activities are underway, so they have an integrated view of dewatering activities and can ensure that this does not create any environmental problems.

5.5 Track and report complaints about water

A central register should be established to identify where there are both short- and long-term problems. All complaints about water quantity or quality that are received by government departments and agencies should be forwarded to the central database. Concerns and problems with both groundwater and surface water should be recorded in such a way that the geographical location of any problem areas can be readily identified. The register should record whether the problems are investigated and the outcome of such investigations. The information in this database should be available to the public.

5.6 Review grandfathered industrial water licences and approvals

It is now apparent that water is indeed a scarce and precious resource. As explained in Section 4.1, most licences that predate the current Water Act had no expiry date and were "grandfathered" when the Water Act came into force. The legislation needs to be changed so that all licences for industrial and commercial[104] purposes that were grandfathered from the Water Resources Act, can be reviewed on a

[102] Concerns with CBM are not limited to the dewatering issues discussed in this paper. They also include concerns about land fragmentation, methane leaks, venting and flaring of the methane gas and noise associated with compressors.
[103] The actual geographical extent of operations that would trigger an environmental impact assessment will need to be determined.
[104] Under Alberta Environment's classification of water licences (used for Figure 1) commercial includes operations such as petrochemical plants, pulp and paper mills and all large scale users that require a separate licence or approval. It does not include commercial operations within a municipality that draw their water from the municipal water supply.

regular basis. This would give Alberta Environment an opportunity to determine if the volume of water allocated is actually required for the current operations and whether adjustments need to be made in the allocated volume. Such a review could be done in a fair manner, provided the grandfathered licences could not be adjusted by more than a certain amount at each review, unless the licensee was in agreement. A review would enable Alberta Environment to take into consideration the competing needs for water, including meeting ecological instream flow needs. Adjustments may be necessary to meet instream flows if flows have declined due to climatic or other conditions, while demands for water from new sources might also justify some reallocation of a scarce resource.

5.7 Tailor water licences and approvals to actual needs

Water licences should not allocate companies with more water than that required for their operations (plus a modest allowance to ensure companies can stay in compliance). Traditionally, a company was allocated the volume of water required for start-up operations and also, perhaps, for future expansions. Start-up operations may require considerably more water than is needed for the long-term operation of a facility, once water can be recycled within the process (whether this is in oilfield injection or mining). It would be preferable to issue water licences that describe specific operational aspects of a project and that relate the quantity of water to the varying operational needs. This would prevent "reserving" water for future expansion plans and ensure that proponents are allocated no more water than is needed for a project, while taking into consideration the variations in volumes necessary for different stages of a project. This would ensure that a maximum amount of water remains in the water body, and that water for industrial and commercial[105] purposes can be allocated more effectively.

It is important to make this adjustment to ensure that companies do not have large quantities of surplus water that they can "pass on" to others. While a company cannot sell water to another, they can charge another company for "delivering" water, and thus profit from passing on their surplus water. This is a cause for concern where, for example, agriculture needs more water, but an industrial user with a licence passes on the water they do not require to another industrial user. This is another reason why the grandfathered industrial and commercial licences that give companies indefinite rights to water should be terminated, over an appropriate timeframe, and brought under the mandate of the Water Act (see Section 5.6). Alberta Environment can review allocations at regular intervals and, where necessary, make adjustments to the volume permitted.[106] Of course, temporary reallocations of water from one company to another may be acceptable in some circumstances, as this can promote the efficient use of resources.

5.8 Dramatically enhance research and monitoring of groundwater resources

Research is needed to find out to what extent declines in groundwater levels are due to changes in precipitation and drought conditions and to what extent they are due to withdrawals of water for agricultural, commercial or industrial purposes. This entails identifying and filling the gaps in the understanding of the hydrogeological and hydrological conditions of a region. Both Alberta Environment and the EUB should ensure that research needs are being identified and carried out.

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[105] Under Alberta Environment's classification of water licences (used for Figure 1) commercial includes operations such as petrochemical plants, pulp and paper mills and all large scale users that require a separate licence or approval. It does not include commercial operations within a municipality that draw their water from the municipal water supply.

[106] The draft water strategy for Alberta also proposes that licensed withdrawals should be reviewed periodically, to ensure that a licence does not exceed the requirements. See draft *Water for Life: Alberta's Strategy for Sustainability*, Alberta Environment, March 2002, p. 39. The difficulty in implanting this measure is that a company may in the short term use more water than it needs to avoid losing its currently licensed amount.

5.9 Legislate the protection of wetlands

Wetlands are important; they collect and filter water that can help replenish groundwater, and they provide habitat for a diverse community of plants, animals and birds. Protection of wetlands becomes increasingly important in times of drought. Legislation is needed to protect wetlands, since the current "no net loss" policy that applies in the White Area of the province is ineffective. This policy requires that, if an area is drained, alternative wetlands should be created to compensate, but the policy cannot be enforced.

Unlike the White Area of the province, there is not a wetlands policy for the Green Area. A no net loss policy should be implemented across the whole province, since important areas of wetlands and peatlands in northern Alberta are threatened by industrial development. These northern wetlands are important, not only for the way in which they regulate run-off to rivers, but from an ecosystem perspective.

Legislation is needed to provide certainty to all stakeholders and ensure that long-term plans and commitments for protection, once established, cannot be arbitrarily changed.[107]

5.10 Develop water basin management plans for all Alberta

To ensure comprehensive water management in a region, the volumes of water that are drained and returned to the basin should be considered together with the amounts that are withdrawn for use. The Water Act makes provision for water management plans in Alberta.[108, 109] Such water basin management plans are being advocated in the draft provincial water strategy,[110] since the issues affecting water management vary from one river basin to another. The development of water basin plans should provide clear opportunities for public input. Decisions made regarding the plans must be transparent and accountable to all interested parties.[111] Plans should include the management of groundwater as well as surface water.[112] Water management plans could allow governments to adapt provincial policies on the use of water by the oil and gas industry to the local situation.

[107] Such a change happened in 2002, when the Ft. McMurray-Athabasca Oil Sands Sub-regional Integrated Resource Plan, which had been previously approved by Cabinet, was amended to allow surface mining in part of the McLelland Lake Wetland Complex where surface mining had previously not been permitted. As a result, True North Energy received EUB approval to destroy part of a rare, patterned fen to access the bitumen beneath.
[108] Water Act, Water Management Plans, section 9; http://www.qp.gov.ab.ca/documents/acts/W03.cfm
[109] Implementation of the first phase of the first water management plan, the South Saskatchewan River Basin Water Management Plan, started in 2002. The North Saskatchewan Watershed Alliance is working on a water management plan, the existing Cold Lake–Beaver River Basin Plan is being updated and new plans are being initiated in the Athabasca River Basin, the Peace River Basin and in a number of sub-basins.
[110] Alberta Environment, 2003. *Water for Life: Alberta's Strategy for Sustainability.* Draft plan released March 27, 2003; http://www.waterforlife.gov.ab.ca
[111] Alberta Environment, Alberta Sustainable Resource Development (Fish and Wildlife Division) and Alberta Agriculture, Food and Rural Development were involved in developing the South Saskatchewan Water Management Plan (see http://www3.gov.ab.ca/env/irm/newslett/oct2002/index.html). In areas where oil and gas projects require considerable amounts of water, Alberta Energy and the EUB should also be involved.
[112] *Water Act*, section 1(1)(fff): "water" means all water on or under the surface of the ground, whether in liquid or solid state.