ALBERTA ENVIRONMENT

COALBED METHANE/NATURAL GAS IN COAL WATER WORKING GROUP

FINAL REPORT
TO MULTI-STAKEHOLDER ADVISORY COMMITTEE

FEB. 2, 2005

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EXECUTIVE SUMMARY

The Water Working Group (WWG or Group) was one of the four working groups established under the Multi-stakeholder Advisory Committee to address potential issues and make recommendations associated with the development of coalbed methane (CBM) in Alberta. The WWG noted high public concern about water issues, particularly those related to the protection of water supplies and the conservation of water resources for other uses. A majority of the recommendations are unique to CBM development in this province.

The WWG began by reviewing available information about CBM development, including technical information and input from public meetings. CBM development outside of Alberta has been associated with a range of production characteristics and a range of potential impacts that have garnered public attention. However, the WWG noted that guidelines for CBM approval and groundwater monitoring exist in Alberta, and that the characteristics of the coal seams in Alberta are not necessarily the same as those in other jurisdictions where public concerns have been raised.

Concerns about impacts on non-saline water (less than or equal to 4000 mg/L total dissolved solids) are the focus of this report

The WWG noted that some coals in Alberta will contain non-saline groundwater, although the majority of CBM wells drilled in this province to date have been in dry (little or no water produced) coal seams or seams containing saline groundwater. The WWG believes it is imperative to have an appropriate regulatory framework in place to ensure that the potential production of non-saline groundwater, associated with future CBM development, does not impact Alberta's water resources. The Group noted there are existing regulations that describe strict guidelines related to the disposal of saline groundwater.

While the WWG observed that development of CBM is similar to conventional gas, they noted that some production or operational practices may differ. The Group noted that CBM could uniquely affect Alberta's water resources. Concerns about CBM development include the following:

- Water resources may be impacted if non-saline groundwater is produced to achieve reservoir de-pressurization during CBM production.
- There is a need to manage produced non-saline groundwater for beneficial purposes, due to general concerns about water availability.
- There is a lack of scientific information on aquifers in Alberta that may be affected by CBM development.

The potential effect on groundwater supplies in Alberta is not fully understood at this time. The Group therefore feels it is essential for regulators and industry to contribute to an enhanced database so effects on non-saline aquifers can be better assessed.

Recommendations (Detailed on Pages 11-20)

The WWG recommends a risk-based approach to managing CBM development in this province. They want to see current requirements strengthened to employ a precautionary principle, which will reduce the risk to Alberta's useable water supplies. This risk-based approach is illustrated in the report as a "decision tree" and its success will require effective coordination between Alberta Environment and the Alberta Energy and Utilities Board (EUB), as well as active support from the CBM industry and other stakeholders. It is essential that Alberta Environment have the staff, training and resources required for approvals and monitoring of the potentially high volume of CBM projects expected in Alberta.

Improvements to the Regulatory Process

The WWG believes that the document entitled "*Alberta Environment Guidelines for Groundwater Diversion for Coalbed Methane/Natural Gas in Coal Development* (April 2004) " (the *Guidelines*) is a good basis for regulating CBM development. However, the WWG recommends Alberta Environment (AENV) improve these guidelines by making the requirements for approval and monitoring of CBM activities (that could affect non-saline groundwater) more comprehensive. The EUB should review the CBM application process to enhance and encourage project-based planning and disclosure. The Group also believes that co-ordination between EUB and AENV regarding applications, approvals and appeals should be improved when there is a potential for non-saline groundwater diversion.

Improved Scientific Information

It is essential that AENV, other government agencies and stakeholders cooperate to identify *priority areas*[1] where groundwater protection is most urgent (because of the potential for CBM activity to affect other water users). Beginning with such areas, AENV should assemble improved groundwater data and ensure appropriate monitoring of groundwater. At the same time, provincial regulators and industry should investigate the potential for unintended effects on surrounding aquifers as a result of CBM activity.

Best Practices

Industry, government and other stakeholders must work together to ensure that best practices for CBM operations are developed immediately. As CBM projects proceed, there must be greater emphasis on sharing data and best technical practices among all parties, and on informing Albertans about the efforts to protect groundwater resources.

One year and three year review

As these ideas are implemented, it is essential they be reviewed within one year to assess progress in achieving the recommendations. A second review, within 3 years, should include an assessment of (1) the effectiveness of the recommendations, (2) new issues or information, and (3) an assessment as to whether additional recommendations are needed.

[1] The definition of priority areas should be determined with stakeholders and may include criteria such as: water short areas; locations where high concentrations of CBM development are expected; and potential for impacts on other users.

The WWG believes that immediate implementation of the recommended changes is necessary to ensure the protection of Alberta's groundwater resources. Regulatory changes should apply to all new CBM applications; existing CBM diversion approvals should be revisited once the new regulatory requirements are established. The WWG recognizes, however, that operators will require a transition period to develop, learn and implement best practices on an industry-wide basis.

INTRODUCTION

In November 2003, Alberta established the Coalbed Methane/Natural Gas in Coal (CBM/NGC) Multi-stakeholder Advisory Committee (MAC) to provide advice about the future management of Coalbed Methane/Natural Gas in Coal exploration and development in the province. In this report, these activities are referred to simply as CBM development.

Purpose of the Water Working Group

Under the auspices of MAC, a multi-stakeholder Water Working Group (WWG or "Group") was established in March 2004 to review technical water issues associated with CBM development, and to provide findings, advice and recommendations about policies and practices that will protect the province's water resources while supporting responsible CBM development. Alberta Environment (AENV) led and supported the activities of the WWG.

The Group's Terms of Reference (see Attachment 1) directed their focus to issues related to the potential impacts on water resources and identification of any opportunities associated with CBM development. The terms included both groundwater and surface water considerations, although groundwater issues were the main focus.

Membership

The WWG included representatives from the oil and gas industry, agricultural organizations, environmental organizations, landowner groups, academia, provincial and municipal government, and other stakeholder groups. Attachment 2 lists the names and affiliation of WWG members, and identifies the Group's support staff.

Approach and scope

The WWG identified potential issues that should be addressed within their Terms of Reference and then reviewed available information relating to those issues. The Group considered issues raised at public information sessions held from March to May 2004, as well as issues raised by its own members. The WWG members raised ideas and options, and discussed the nature and probability of concerns before developing potential recommendations. While diverse views were raised throughout the discussion, the WWG members achieved consensus about this report.

The WWG considered current policies, regulations, approval processes, data and knowledge. The scope of the discussions did not include surface access or air issues (which are being addressed by other working groups); nor did it include general issues related to the oil and gas industry unless those issues were related to water resource effects of CBM development.

Primary differences in water production from CBM and conventional gas developments

A conventional gas well typically produces gas at its highest rate initially. The volume of the associated water production is variable but may increase with time. Conventional gas development in Alberta has occurred for decades and has generally not been associated with impacts on non-saline groundwater. This gas production has occurred mainly at depths below the Base of Groundwater Protection[2] (BGWP), predominantly involving saline groundwater. This saline groundwater is normally disposed via deep wells. However, a recent trend toward development of shallower conventional gas zones could potentially result in the production of non-saline groundwater. This trend means that efforts to protect non-saline groundwater may be applicable to shallow conventional gas development, as well as CBM.

A distinguishing feature of CBM development is that some water may need to be withdrawn to initiate gas production. When a CBM well produces water, it typically produces higher volumes initially, with minimum gas. The water volumes may decrease with time as the gas rate increases.

Some coal seams are above the BGWP. Therefore, some produced water could be non-saline, a fact which is generating public concern about potential impacts to Alberta's water resources. There is limited information on both the potential impacts to aquifers and the quality of non-saline groundwater produced by CBM wells in Alberta. This is due to the fact that there has been minimal development of CBM associated with non-saline groundwater to date; the industry prefers to concentrate on development efforts on dry CBM or coal containing saline groundwater.

THE BASIS FOR RECOMMENDATIONS

The WWG reviewed available information about CBM resources and exploration in Alberta (from the Alberta Geological Survey, Alberta Environment, Alberta Energy and Utilities Board, and others such as industry). The Group concluded that, due to the early stage of CBM development, there is insufficient information currently available to make definitive long-term predictions about the potential effects on Alberta's water resources.

Consultation with Albertans

The Government of Alberta began a consultation process to review the existing legislation, regulations and policies governing CBM development and to determine whether they are sufficient to protect the environment, while allowing responsible development of this natural resource.

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[2] "Base of Groundwater Protection" refers to the approximate depth at which saline groundwater could be encountered.

Issues and concerns related to water were identified by Albertans attending information sessions, held in eight communities, from March to May 2004, and noted in position papers from stakeholders (including the Canadian Association of Petroleum Producers (September 2003) and the Pembina Institute (June 2003)). The following list summarizes the issues and concerns identified:

- Sustainability of non-saline aquifers (particularly shallow aquifers that may support water users).
- The need for baseline information on groundwater quality and quantity.
- The cumulative impacts of removing non-saline groundwater from coalbed aquifers.
- Potential non-saline aquifer contamination through the use of poor quality water during drilling and well completion.
- Potential for co-mingling of different quality waters between aquifers during drilling and production.
- Potential for gas migration into water wells as a result of drilling and production.
- Use and/or disposal of produced saline and non-saline groundwater.
- Applicability of the *Water Act* to CBM development issues.
- Clarification of the roles of the Energy and Utilities Board, Alberta Environment, and Agriculture, Food and Rural Development in relation to protection of water during CBM development.
- Abandonment and reclamation of CBM wells, and liabilities related to water.

Current legislation and policies associated with CBM development

WWG members reviewed the existing legislation, regulations, and guidelines that currently protect the environment. While most current CBM development occurs in "dry" coals (little or no water produced), non-saline groundwater or saline[3] groundwater may be produced from certain coals. The following section briefly describes the key legislation, regulations and policies currently associated with CBM development in Alberta, and the different requirements for the diversion and disposal of saline versus non-saline groundwaters.

Environmental Protection and Enhancement Act

The *Environmental Protection and Enhancement Act* (EPEA) is provincial legislation administered by AENV. It takes an integrated approach to the protection of air, land and water. EPEA contains numerous provisions regarding the release of substances into the environment and, for certain defined activities, an approval must be obtained from Alberta Environment.

Water Act

The *Water Act* is provincial legislation administered by AENV and governs the diversion, use and disposal of both groundwater and surface water. The *Water Act* applies to all water in Alberta regardless of its chemical composition. However, the *Water (Ministerial) Regulation* contains a specific exemption (from the requirement to obtain a licence) when there is a diversion of *saline groundwater*.

According to Alberta's *Water Act*, all industrial, municipal, large agricultural, and other water users must apply to AENV for a licence to divert and use (or dispose) an annual allocation of water. Water licences are not prioritized on the basis of intended use, but allocated on the principle of *first-in-time, first-in-right* for both surface and groundwater. Household water use is considered to be a statutory right, does not require an authorization and has the highest priority of all water diversions.

The protection of aquifers, the safeguard of existing household, traditional agriculture and licensed water users, and the protection of the aquatic environment are the foremost factors considered during the review of a licence application.

Diversion and disposal of non-saline groundwater for CBM

An authorization from AENV is required for the diversion of non-saline groundwater. Therefore, if the diversion of non-saline groundwater is anticipated during CBM development, the operator must obtain an authorization under the Water Act from AENV, in addition to the required Alberta Energy and Utilities Board (EUB) approvals.

[3] Saline groundwater is defined in the *Water (Ministerial) Regulation* as water that has total dissolved solids (TDS) exceeding 4000 milligrams per litre (mg/L). (By deduction, non-saline water is considered water having less than or equal to 4000 mg/L TDS).

Prior to an authorization being granted by AENV, the operator must submit technical evidence to show that the proposed diversion and use (or disposal) of non-saline groundwater:

- will not damage the source aquifer or other non-saline aquifers,
- will not unreasonably impact the water supply of nearby users,
- will not negatively impact the environment in general, and
- will be a beneficial use.

These requirements are outlined in the document entitled "*Alberta Environment Guidelines for Groundwater Diversion for Coalbed Methane/Natural Gas in Coal Development*, (April 2004)" (the *Guidelines*).

AENV also developed the *Surface Water Quality Guidelines for Use in Alberta*. The guidelines are used to assess ambient conditions, to identify areas with existing or potential water quality concerns, and to assist in setting limits for wastewater discharges to surface water bodies. In the case of CBM wells, the proponent and regulating agencies could use these guidelines to jointly evaluate options for the release of produced groundwater to surface waters.

Additional review and scientific criteria must be established before large-scale land surface discharges of produced non-saline groundwater could be considered. The *Surface Water Quality Guidelines for Use in Alberta* can generally be used to assess water suitability for irrigation use. However, they may not be fully applicable to the assessment of produced water from CBM development until more comprehensive water quality characterization of such waters has been completed.

Diversion and disposal of saline groundwater for CBM

Diversion of saline groundwater is exempt from the requirement for a licence (under Schedule 3, section 1(e) of the *Water (Ministerial) Regulation*). This exemption is partially due to the fact that saline groundwater is often very deep and its production is not likely to have an impact on non-saline aquifers. Since saline groundwater historically has been associated with conventional oil and gas operations, the disposal of saline groundwater falls under EUB regulations.

The *Water (Ministerial) Regulation* specifies the requirements for the drilling, completion, and production of water wells. These regulations were developed prior to the advent of the CBM industry with its associated potential for non-saline water production. However, since they are pertinent to production of non-saline groundwater from CBM wells, CBM operators are currently required to comply. For example, the *Regulation* does not permit multiple aquifer completions:

- Section 43(1) (b) advises that the inter-mixing of saline and non-saline groundwater is not allowed within the wellbore. Individual CBM wells may be completed in target coal zones either above or below the Base of Groundwater Protection but not in both.

- Sections 47(g) (i) and (ii) advises that wells must be constructed in a manner that maintains the current water quality standards by preventing the inter-mixing (co-mingling) of groundwater from different aquifers by limiting the completion interval to 7.62 m (unless a distinct aquifer unit of greater thickness is present).

Energy Resources Conservation Act

Under the *Energy Resources Conservation Act*, the EUB reviews energy development projects to ensure proposals are in the public interest, having regard for social, economic and environmental impacts.

Oil and Gas Conservation Act and Regulations

The EUB regulates the drilling, completion, operation and abandonment of all petroleum industry wells. The EUB also regulates CBM and water disposal wells in consultation with AENV. The regulations address groundwater protection through requirements for wellbore integrity (cemented casing through the zone of non-saline aquifers), and for the prevention of leaks and surface spills.

All water produced in conjunction with oil and gas production is referred to as *produced water*. The EUB's legislation governing produced water requires that it be safely handled, stored and disposed by industry. Current EUB policy requires produced water to be returned to the zone of origin—if below the Base of Groundwater Protection (BGWP)—or a deeper zone. Disposal of produced water above the BGWP or on the surface of the land or surface water bodies is not allowed. This policy is in place because produced water is typically very saline and could cause serious environmental damage if discharged to the surface or injected into non-saline aquifers. If non-saline produced groundwater is encountered, the developer must follow the *Alberta Environment Guidelines for Groundwater Diversion for CBM/NGC Development (April 2004).*

Groundwater characteristics and related issues of coal seams in Alberta

The subsurface distribution of those coal resources with potential for CBM development is shown on Figure 1.

- Saline groundwater is produced from the Mannville Group, the deepest coal zone being investigated as a potential source of CBM. Near Fort Assiniboine, the groundwater produced from this coal zone has a total dissolved solids (TDS) content of approximately 40,000 mg/L. Mannville development occurs at depths greater than 800 metres, and the Mannville is separated from overlying strata containing non-saline water by 400+ metres of the vertically and laterally continuous Colorado Group shales. The saline water produced must be disposed in accordance with EUB guidelines, and is re-injected into a wet Mannville or deeper zone. The Mannville Group has also been the source of much of the conventional oil, gas, and associated water production in the province.

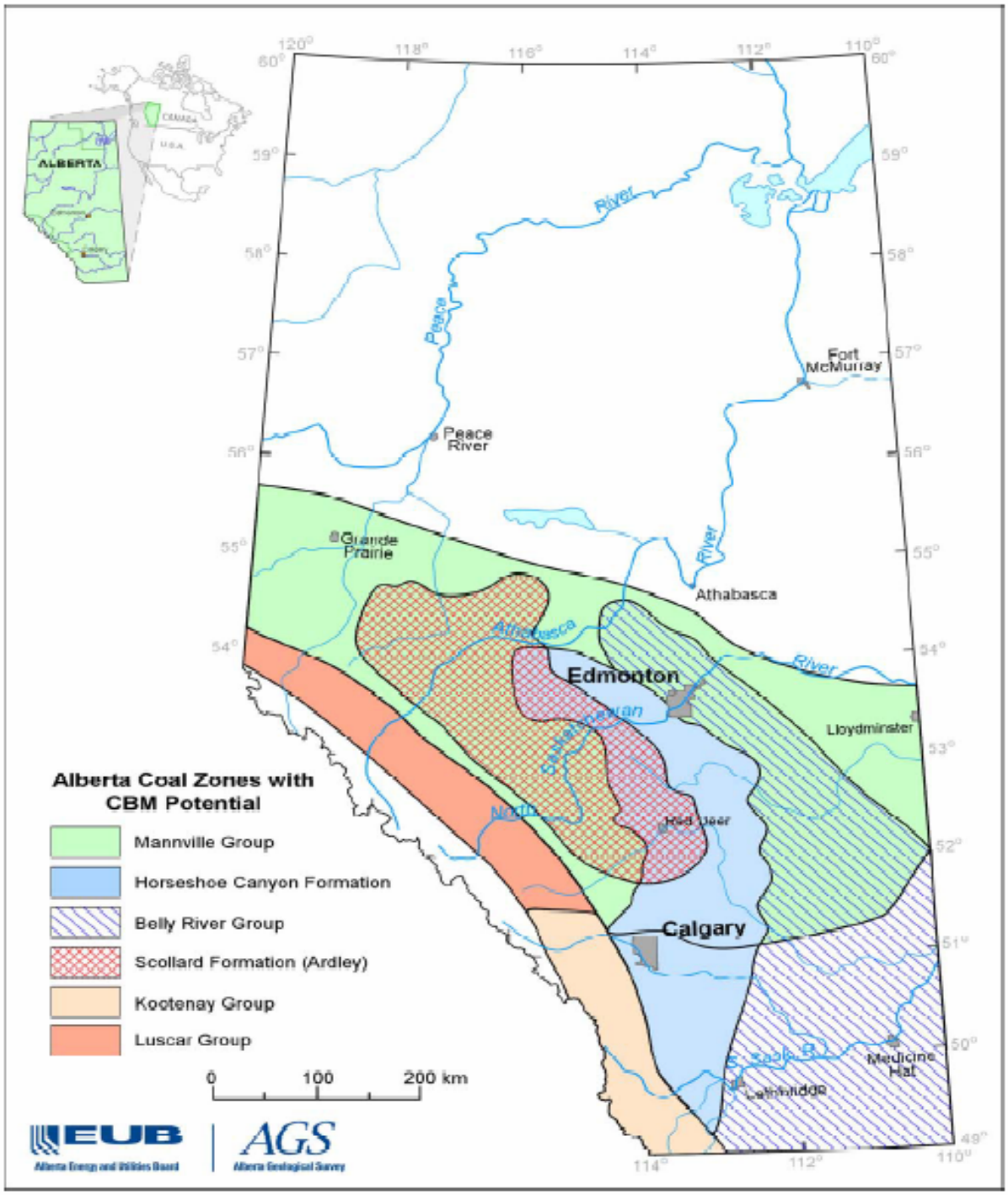
- Coal zones in the Belly River Group (McKay, Taber and Lethbridge coal zones) and Horseshoe Canyon Formation (Drumheller and Carbon Thompson coal zones) and Scollard (Ardley) formation are separated from the deeper Mannville Group by the impermeable shales of the Colorado Group. Coal seams of the Belly River and Horseshoe Canyon are generally numerous, thin, and separated by shales and sandstones that may also contain gas. Current CBM developments in these zones have produced little or no water. There are however, shallow coals in these strata that could produce non-saline water. *Note: Water wells completed in the shallow portion of Belly River and Horseshoe Canyon may be associated with naturally occurring methane.*

- The Scollard Formation contains the Upper and Lower Ardley coal zones and is the most laterally extensive coal zone which may contain non-saline groundwater. Area residents have expressed concerns that the production of non-saline groundwater from this zone may affect their water supplies.

- CBM investigations in the Foothills areas have been of a limited nature because of the complicated geology. Recent investigations north of the Town of Blairmore encountered saline groundwater in the Kootenay Group coals.

In summary, the available groundwater production and quality information indicates the coal zone characteristics in Alberta are different from those of other jurisdictions where CBM development has occurred. For instance, Alberta coal zones generally have less permeability, are thinner and contain less water than those in some U.S. basins (e.g., the Powder River Basin in Wyoming). The WWG noted that the regulatory requirements in Alberta specifically control the disposal methods of produced water to prevent environmental damage. By contrast, rules in other jurisdictions may permit produced water to be disposed on the land surface, including dugouts, causing environmental problems in some cases.

Figure 1: Coal Zone Distribution with CBM Potential



Current situation

- At present, the most efficient way to gain information about water in coal seams and surrounding aquifers is to have industry gather and submit the necessary information as they proceed with development of CBM resources. AENV and the EUB continue to participate in the data collection and analysis process.

- To date, CBM investigations conducted in Alberta (mostly in Horseshoe Canyon and Belly River, with limited exploration in the Mannville Group and Ardley Formation) have encountered coals containing little or no groundwater. Dry coals are presently the most economic to develop. Current regulations, concerns surrounding potential groundwater impacts, and increased operating costs have limited CBM development in seams containing non-saline groundwater to pilot projects. However, in the future, there may be more development pressure in coal seams containing non-saline groundwater.

- The major impact to groundwater resources from CBM development will be related to the completion of wells and the potential production of non-saline groundwater from coal seams.

- AENV released the *Alberta Environment Guidelines for Groundwater Diversion for CBM/NGC Development* (April 2004). The *Guidelines* outlines the current regulatory requirements for diverting non-saline groundwater associated with CBM development. Any authorization issued for the diversion of non-saline groundwater associated with CBM development has a term of two years.

- The drilling of wells through non-saline aquifers has been raised by the public as a potential risk to groundwater resources. However, all conventional oil and gas wells are drilled through aquifers. According to the EUB, there have been few proven incidences of impact on aquifers resulting from oil and gas well drilling in Alberta.

POTENTIAL ISSUES

The WWG reviewed the outcomes of public information meetings held in 2004 regarding the development of the CBM industry in Alberta. They noted that many of the issues raised could be generalized to oil and gas exploration and well development. However, the WWG addressed several unique issues regarding changes in water quantity and quality that they felt could be a specific consideration as CBM exploration, well development and completion proceeds in the province. Coals that potentially contain non-saline water are the most urgent concern, since current EUB regulations require that most of the water be deep well disposed during completion and operation of the CBM wells.

ISSUE 1: Groundwater and surface water resources may be impacted by CBM well drilling, completion and production activities.

The withdrawal of water from shallow coal seams could impact ecosystems or aquifers if adequate precautions are not taken. Do current approval and monitoring processes pay sufficient attention to the need to protect Alberta's water supplies over the next several decades as a significant number of CBM wells are developed?

ISSUE 2: Disposal of all produced waters from CBM activities could result in a loss of useable water.

Disposal operations must be regulated to minimize risk to aquifers. Produced water must be managed so that it is used in a beneficial manner. Opportunities to use non-saline water in a way that helps household and agricultural users should be explored. Produced saline groundwater should be used to replace non-saline water in underground injection activities wherever possible.

ISSUE 3: Other non-saline aquifers could be affected by the release of methane after CBM production commences.

When a coalbed is de-pressurized, there could be unintended releases of methane into connected aquifers, and water wells could be affected.

ISSUE 4: Improved public information about CBM development is needed.

Both government and industry must increase efforts to make information available to Albertans who may be concerned about the effects of CBM exploration and development on their water supplies. If adequate information is not readily available, the public may anticipate negative impacts to water supplies, such as those documented in Wyoming and Montana, despite the fundamental differences in geologic and hydrogeologic characteristics and existing legislation.

FINDINGS (BY ISSUE)

This section of the report describes the issues addressed by the WWG, along with the recommendations the Group is forwarding to MAC. As these ideas are implemented, it is essential they be reviewed within one year to assess progress in achieving the recommendations. A second review, within 3 years, should include an assessment of (1) the effectiveness of the recommendations, (2) new issues or information, and (3) whether additional recommendations are needed.

ISSUE 1: Groundwater and surface water resources may be impacted by CBM well drilling, completion and production activities.

Recommendation 1.1 - Strengthen the approval process for CBM by implementing a risk-based, decision tree process that will ensure protection of aquifers and water supplies, considering the potential for both direct and cumulative effects, and taking appropriate precautionary measures.

Background:

Albertans have expressed concerns about the loss of useable groundwater if CBM development is allowed in coal zones containing non-saline groundwater. These concerns were highlighted by recent requests for a moratorium on such developments. As surface water becomes scarce in some basins in the province, non-saline groundwater will become increasingly more important. The removal of non-saline groundwater during coalbed methane development could be a significant local or regional concern.

The withdrawal of water from coal could impact ecosystems and aquifers. In some situations, aquifers (and current or future water wells) could be affected even if they are many kilometres away. Surface waters, such as wetlands, could be affected if they are hydraulically connected to an affected aquifer.

The public has raised concerns that increased well density associated with CBM developments could pose additional risks to aquifers. They also raised questions regarding the adequacy of current application reviews and monitoring.

Do the current approvals and monitoring processes pay sufficient attention to the need to protect Alberta's water supplies in areas where a significant number of CBM wells may be developed? Some Albertans have expressed concern that pumping water from coals will draw water from other aquifers.

The current *Alberta Environment Guidelines for Groundwater Diversion for Coalbed Methane/Natural Gas in Coal Development (April 2004)* are applied only when the water being removed is non-saline. In these cases, the G*uidelines* provide fairly stringent

requirements. If the water being removed is determined to be saline, an authorization from AENV is not required. The WWG felt opportunities to improve the use of produced water, possibly including incentives for treatment of the water, should be further investigated.

The WWG noted the *precautionary principle*. There is considerable uncertainty about the characteristics of the aquifers that underlie Alberta. The precautionary principle states "where there are threats of serious or irreversible damage, the lack of scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation"[4]. This principle was endorsed by Canada and Alberta in the Canada-wide environmental standards sub-agreement of the Harmonization Accord.[4]

The WWG felt the existing guidelines provide a solid basis for regulating CBM development, but support the following list of improvements:

Note: To assist the reader, a glossary providing definitions of terms used in CBM development is included as Attachment 3.

Recommended actions to improve the approval process:

a) AENV and the EUB should develop a "decision tree" approach for reviewing CBM applications. This approach should address the level of risk (to aquifers and users) by considering factors such as hydrogeological setting, existing users, salinity and expected volumes of water produced. It should also include the establishment of a threshold volume of produced non-saline groundwater below which a simplified *Water Act* approval process could apply. The decision tree should be developed with stakeholder input. A conceptual draft of a decision tree was developed by the WWG and is illustrated in Figure 2.

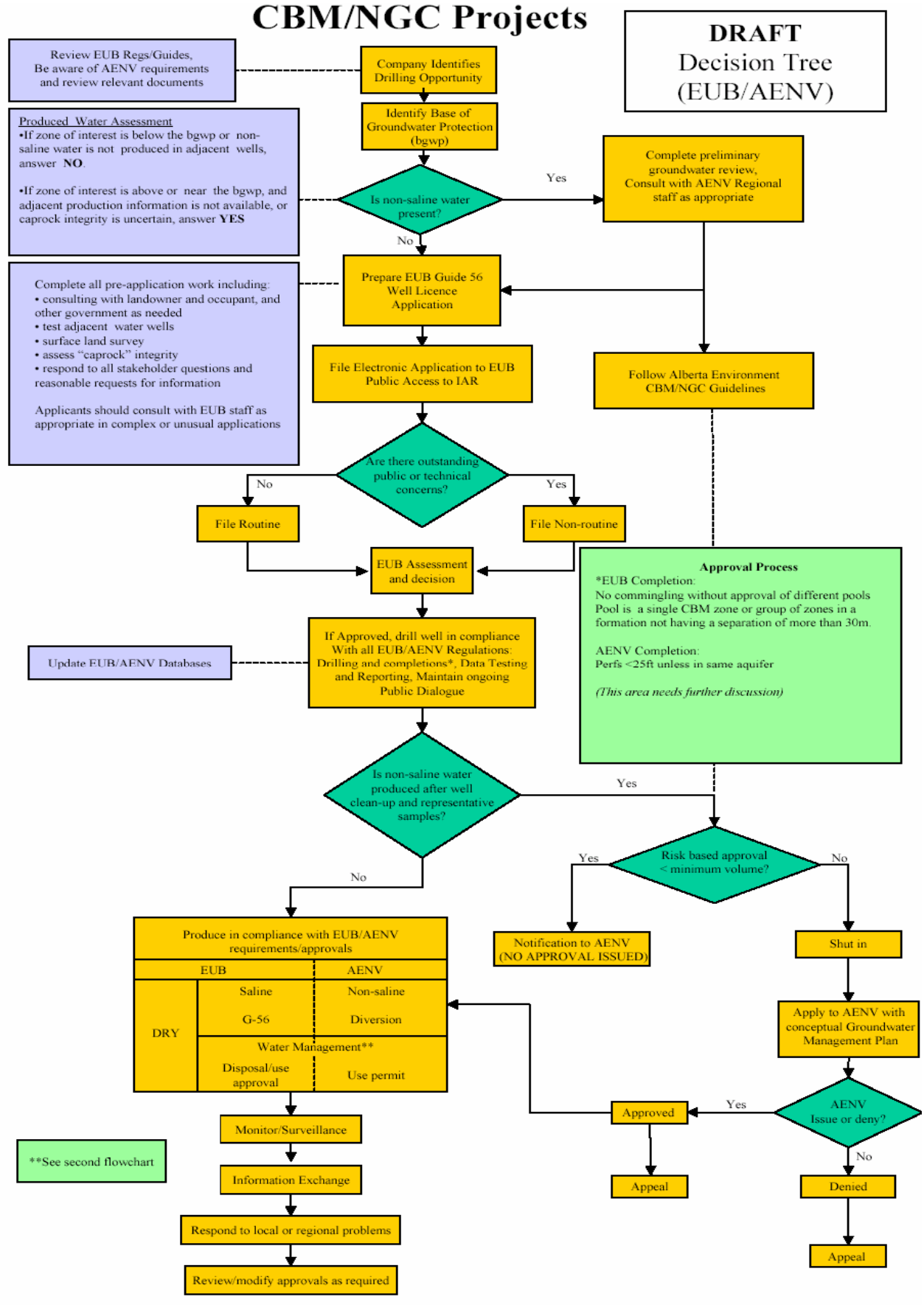
   The greater the risk of effects on aquifers, the greater the need for hydrogeologic and environmental information and impact assessment.

b) *Alberta Environment Guidelines for Groundwater Diversion for CBM//NGC Development (April 2004)* should be enhanced and included in the above "decision tree" approach. This revision should also identify standard minimum conditions for approvals and ensure that the components of the *Field-verified Survey* are appropriate and effective (see Attachment 5).

   This review is intended to make the approval conditions more consistent across the province. This does not limit the Director from imposing additional conditions in specific situations. The WWG preferred placing consistent conditions in the Guidelines rather than in a Code of Practice.

[4] Quoted from An Emissions Management Framework for the Alberta Electricity Sector Report to Stakeholders, Clean Air Strategic Alliance (CASA), November 2003.

Figure 2: Conceptual Draft of a Decision Tree (For discussion only)



c) Existing CBM wells should be reviewed and evaluated with respect to the revised *Guidelines*. If there is evidence that revised *Guidelines* conditions have not been met, appropriate action should be taken. Any company producing non-saline water from a CBM well without a diversion authorization should immediately terminate operations and notify provincial regulators to initiate the authorization process.

This responds to a concern that some companies may already divert non-saline water without the review required in the Guidelines.

d) The revised *Alberta Environment Guidelines for Groundwater Diversion for CBM//NGC Development (April 2004)* should clarify how much drawdown is allowed during CBM de-pressurization by specifying that in a non-saline aquifer, the pressure must be maintained so the water level does not drop below the top of the aquifer.

This was discussed and agreed upon by the Group because industry noted that the lack of clarity within the current Guidelines might pose a significant development restriction in some situations.

e) CBM operators should be required to obtain baseline data prior to drilling and production. Ongoing water quality, flow and water level data are also required to fully characterize aquifers. In lower risk cases, there may be fewer requirements for information.

f) AENV should work with the environmental service industry to identify, develop and adopt standard procedures for the sampling and analysis of water (quality and flow) produced from CBM wells, and from water wells that may be affected by CBM projects. These procedures should include appropriate quality assurance and quality control measures.

g) AENV should work with other agencies and stakeholders to identify and characterize *priority areas* where CBM approval requirements should be more rigorous (because of concerns about impacts to non-saline aquifers and other water users, intensity of CBM activities, etc.). In priority areas, AENV, in collaboration with key stakeholders, should establish a monitoring network and data management system. Maps of these areas should be made available to regulators, applicants and stakeholders.

h) AENV must have the resources to address the high number of CBM well applications anticipated (where non-saline water is involved). The department must also have staff, training and technical resources to manage and analyse data and information gathered during CBM applications and development.

i) In order to better understand the impact of CBM development, the EUB should review the CBM application process to enhance and encourage project-based planning and disclosure. This would allow full “project” disclosure, improved community consultation, impact assessment and definition of project developments.

In the development phase, proponents should fully disclose the potential number of wells intended within the described area in their application, including well spacing and potential cumulative effects on groundwater. AENV and EUB should address this in their review, and this information should be provided to the community.

This responds to a concern that affected residents are not given a full description of the number and spacing of wells. The WWG recognize that there are practical limitations (e.g., the operator may not initially have all the information).

j) The EUB should review public input opportunities and guidelines to ensure they are appropriate for CBM development.

The concern is that the current interpretation of "directly affected" status (see glossary) may be inadequate for these kinds of developments.

k) Improve coordination between EUB and AENV regarding CBM applications, approvals and appeals where there is a potential for non-saline water diversion.

Improved coordination should have the purpose of improving regulatory effectiveness and efficiency. For instance, there is a concern that there is inadequate sharing of information between AENV and the EUB.

Recommendation 1.2 - There is an immediate need for improved scientific information (including geological setting, groundwater quality and quantity, hydraulic conductivity) to assure protection of Alberta's water resources as CBM activities proceed.

Background:

The Water Working Group learned that the current AENV groundwater monitoring program alone could not adequately monitor the potential impact caused by projected CBM activities (see Attachment 6). The program has been reduced over the past ten years due to restricted budgets. Recently, some funds have been allocated to strengthen the groundwater monitoring program. The WWG also learned that data and information are collected separately by AENV, EUB and others (primarily operators).

The WWG noted that expanded baseline and performance data collection is required to provide the information needed to support water resource management decision-making related to CBM activity. It is urgent that improved groundwater data be assembled in areas where aquifers may be affected and CBM development activity is likely to be high; or where there is evidence coal seams could produce water that could affect regional water supplies.

The Working Group noted that alternative recovery technology research requirements should be communicated to Alberta Energy Research Institute for inclusion under their Energy Innovation Network (INet) Program.

Recommended actions to improve scientific information about water resources associated with CBM:

a) AENV (in cooperation with others) should complete an inventory of groundwater in the province, including the completion of the Base of Groundwater Protection (BGWP) mapping project, and by focusing on priority areas.

b) There is insufficient information about groundwater recharge rates. AENV must have sufficient resources to gather baseline data on recharge rates, particularly in priority areas. AENV must analyze the data periodically to improve the understanding of recharge rates in order to guide decisions about groundwater diversions.

c) Provincial regulators and industry should investigate the potential for unintended effects upon surrounding aquifers.

Recommendation 1.3 - Industry, government and other stakeholders must work together to ensure that best practices for CBM operations are developed and implemented immediately.

Background:

There are separate regulations for water wells and gas wells. They separately include different types of groundwater protection requirements. However, CBM development has triggered the need to examine the technical details and process to ensure regulations are parallel, but suitable for the purpose of CBM development.

Some current practices are preferred and viewed as "responsible" within the oil and gas industry. No effort has yet been made to inventory and rank these practices. Industry has expressed an interest in assembling shared "best practices." These best practices will benefit not only the companies, but also other stakeholders such as landowners.

Recommended actions to improve best practices:

a) Regulators should conduct a review of CBM development activities to ensure we gain the benefit of studies and experience elsewhere (e.g., Report entitled: Coalbed Methane Best Management Practices- A Handbook, Western Governors Association, USA. 2004)

b) Operators should be asked to develop and document beneficial practices (e.g. CO_2 use, best uses of produced water, fracturing) in cooperation with the EUB and AENV.

c) Review drilling and completion practices for water and energy wells, ensuring regulations are appropriate for the purpose of the well. Topics to be addressed could include drilling fluid, wellbore integrity/aquifer isolation, casing types, and length of completion intervals, etc

ISSUE 2: Disposal of all produced waters from CBM activities could result in a loss of useable water.

Recommendation 2.1 - Regulations and best management practices must promote wise use and conservation of water.

Background:

Albertans have expressed concerns about the loss of good-quality groundwater if CBM development is allowed in coal zones containing non-saline groundwater. These concerns were highlighted by requests for a moratorium on such developments. As surface water becomes scarce in some basins in the province, non-saline groundwater will increasingly become more important. The public has also expressed concerns about the deep-well disposal of usable non-saline water during CBM activities. This was considered a long-term loss of usable groundwater and conservation should be practiced wherever possible.

Recommended actions for beneficial use of produced water:

a) AENV should establish appropriate guidelines for protection and use of non-saline groundwater within the decision-tree approval process proposed by WWG.

b) There must be guidelines for the beneficial use of marginally saline, produced water. The potential for treatment and use of water that is somewhat above the 4,000 mg/L threshold should be investigated, as the WWG noted that in the future these marginally useable waters may become more valuable, particularly in fully allocated basins. Pending the results of this investigation, AENV/EUB may review situations where produced water quality is above a TDS of 4000 mg/L, but has a reasonable potential for re-use. The WWG supports the use of produced water for other applications, whenever possible.

c) Authorized diversions of non-saline water for industrial use should be revisited when CBM developments create new sources of water in the area.

   There may be potential for lower quality water to be used to replace higher quality water for industrial applications, including oilfield injection (i.e. the WWG feels that regulators should require adjacent industrial projects using non-saline water to review their water source if new sources of lower quality water become available). Also, if an injection operation requires additional water, then new alternate sources of lower quality water must be considered.

d) When produced water is non-saline, a beneficial use assessment must be part of the application review process. If non-saline water is not suitable for other uses, deep-well disposal could be considered as a possible disposal option. Alberta Environment must establish criteria for acceptable use of non-saline produced water.

ISSUE 3: Other non-saline aquifers could be affected by the release of methane after CBM production commences.

Recommendation 3.1 - The Alberta government and CBM producers must investigate the potential for methane migration into water wells.

Background:

Public concern has been expressed that methane could migrate into local water supplies. The process of de-pressuring coal seams through water production liberates methane, and the public is concerned that aquifers might be affected by methane migration within, or from, the coal seam.

Some aquifers naturally contain methane and some water wells already produce associated methane. If a water well is completed in the same coal seam, or in an aquifer hydraulically connected to the coal seam, then de-pressurization could lead to a greater potential for methane migration into the completed water well. The effects of CBM de-pressurization need to be clearly understood, and impacts on water well users prevented.

Recommended actions to assess potential methane release into aquifers:

a) Investigate the potential for methane migration or release to water wells as a result of CBM de-pressurization.
   - A review of literature in other CBM-producing regions should be undertaken.
   - Objectives and potential outcomes from any sampling program must be clear.
   - Evaluate tracking methods such as isotopic and geochemical indicators, as well as “pressure front” tracking.
   - Numerical simulation of potential vertical/horizontal flow.

b) Implement appropriate prevention, monitoring and mitigation measures if necessary.

ISSUE 4: Improved public information about CBM development is needed.

Recommendation 4.1 - Develop a public database on CBM development, subject to normal provisions of confidentiality. This database should include information such as well location, coal formation, production interval, volume of groundwater withdrawn, and monitoring data.

Background:

Because CBM development is new to Alberta, significant effort is required from members of the public to gather relevant information. Albertans generally are not well informed about the industry's requirements and its potential effects (and therefore are concerned about potential unknown effects). Industry and government also need better information to improve the management of the CBM industry.

Actions to improve CBM database and public information:

a) Consolidate CBM data in a publicly accessible (and user-friendly) format, which includes information on wells (e.g., drill logs), applications and approvals. Public data should include adequate chemical analyses and water production rates. *EUB and AENV will be responsible for this task.*

   Note: In some cases, confidentiality issues may limit public access to certain data.

b) Stakeholders should continue to work together to develop and implement a communication plan to provide Albertans with better information on CBM issues including potential effects on water supply. *The WWG assumes that an ongoing multi-stakeholder committee will address this need.*

OTHER CONCERNS

Drilling Fluids

The drilling of any well includes the use of drilling fluids that provide lubrication and sealing as the well bore is drilled. The WWG noted these drilling fluids could potentially introduce substances to aquifers when any well is drilled (including CBM wells). Although this concern is not unique to CBM wells, and there is no scientific evidence that current Alberta drilling fluid practices could result in groundwater contamination, the WWG supported the following as a precautionary measure:

Regulators should provide specific guidance about well drilling fluid constituents and requirements to ensure the fluid does not have deleterious effects on non-saline aquifers.

Background:

Water Used in Drilling: The source, and consequently the quality, of water used in drilling of water wells, and oil and gas wells, has been a contentious issue for a long time.

Section 50 of the *Water (Ministerial) Regulation* (applied to water well drillers) specifies that "No driller shall use a fluid or substance in a drilling operation that may cause an adverse effect on the environment, human health, property or public safety."

The EUB provides guidelines that specify oil and gas drilling practices intended to protect surrounding aquifers from contamination related to drilling fluids. The EUB does not have any documented cases of aquifer contamination caused by drilling.

Currently, all drillers may use water from dugouts, rivers or wells. Companies can drill a water well to provide source water for drilling an oil or a gas well. They can also use privately owned water wells with the well owner's permission. (Companies must obtain a water diversion authorization from AENV for this purpose.)

Recently, water well drillers have been encouraged to use chlorinated water in the drilling of any water well. Unlike energy wells, water from recently drilled household water wells may be immediately produced into the distribution lines and be consumed.

Concerns were expressed that, because oil and gas drillers can currently use dugout water or untreated river water, aquifers could be impacted during drilling. Knowing this, Albertans expressed a fear of potential contamination of non-saline aquifers and suggested treated (drinking-quality) water be used in oil and gas drilling.

Recommended actions to reduce potential for contamination related to drilling fluids:

a) Communicate and reinforce the current requirements for water well and energy sector drillers to protect non-saline aquifers.

b) Investigate whether drilling practices have impacted aquifers, and review regulations to determine whether changes are needed. Consolidate and review studies regarding drilling fluid constituents and related potential for deleterious effects.

c) Industry best practices should identify drilling practices to protect non-saline aquifers.

Attachment 1: Water Working Group Terms of Reference

April 21, 2004

Purpose

Review technical issues associated with CBM/NGC development and provide advice and recommendations about policies and practices that will protect Alberta's water resources while supporting responsible energy development.

Desired Outcomes

1. An improved understanding of the water science and water engineering issues associated with CBM/NGC development.
2. Recommended best practices for industry that ensure protection of the water resource while optimizing the potential for coalbed methane or natural gas in coal development.
3. Advice about the application of existing legislation, policies and regulations to CBM/NGC development. Recommended changes to policy and regulations where warranted.
4. Identification of knowledge gaps and priorities for future research.

Working Group Membership

This is a multi-stakeholder working group.

Tasks

This working group should undertake the following tasks:

1. Identify potential impacts on water resource (issues and opportunities) associated with CBM/NGC.
2. Identify how the *Water Act* and Water (Ministerial) Regulation, the *Water for Life* strategy and existing EUB requirements apply to coalbed methane operations. Assess whether they are adequate. If they are not adequate, recommend changes. Examine relevant federal statutes in the same light.
3. Identify the best ways for the provincial government to protect groundwater and surface water resources during CBM/NGC operations (e.g. policy direction, regulations, approvals, monitoring, enforcement). This may also include proposed "best practices" for industry that will protect the groundwater and surface water resources during CBM/NGC operations.
4. Identify requirements for successful coordination among land and resource management agencies (Alberta Energy and Utility Board, Alberta Environment, Alberta Energy, Alberta Sustainable Resource Development, municipal authorities).
5. Review existing information and identify knowledge gaps and priorities for future data collection and research.

Deadline

The Water Working Group must produce and submit a final report by October 1, 2004 Equus Consulting Group will assist them in the drafting and finalizing of this report.
MAC provided additional time to prepare the report. (*On December 6, 2004 a draft version of the report was submitted to MAC for their review and comments.)*

Role of Chair

The chair, from Alberta Environment, will provide direction to the working group and will ensure the group has the information and support needed to complete its tasks. The chair will also inform the working group of any related discussions, policy changes or decisions.

The chair will authorize a facilitator to run the meeting (see below) and then participate in discussions and decisions.

Role of Facilitator

Under the guidance of the chair and co-chairs, the facilitator will prepare agendas, run meetings as authorized by the chair, record discussions and develop draft and final reports that reflect the statements of the working group members in a succinct and unbiased manner.

Media Relations

All media enquiries about the Water Working Group's discussions, draft reports or recommendations are to be directed to the chair for response.

Proposed Schedule of Meetings

The Water Working Group will meet on the following dates in 2004:

- Friday, March 12
- Wednesday, April 21
- Wednesday, May 19
- Wednesday, June 16
- Wednesday, July 14
- Wednesday, Sept. 15: Draft Report review

All meetings will take place in Red Deer unless otherwise noted.

- *Two additional WSG meetings were held on Wednesday, October13 and Wednesday November 24, to review the draft report*

Discussion Process

Open participation is essential to success. The facilitator will invite all working group members to comment during discussions. Members are asked to work together to create proposals by:

- sharing the "air time" and avoiding situations in which only a few members dominate the discussion;
- working together to identify all issues and options (withholding judgement until ideas are "on the table");
- identifying the benefits and costs that should be considered; and
- reflecting on each other's needs and ideas to build proposals that all members can support.

Decision Process

This will be an iterative process. The working group will be asked to identify preferences as the discussions proceed, and the group report will change with each new discussion.

The facilitator will encourage the working group to strive to achieve a consensus[5] on recommendations that emerge from these decisions. The working group will revisit decisions if no consensus emerges during the initial discussions. Techniques such as reframing questions, issues and options; gathering additional information; and allowing time for reflection will be employed.

If no consensus is obvious, then the facilitator will ask working group members to raise their specific views and attempt to consolidate those views into a balanced statement for the report to the Multi-Stakeholder Advisory Committee. The facilitator will write statements that reflect discussions about recommendations and bring those statements to the working group for further discussion.

Documentation

The facilitator will be responsible for documenting all discussions and consolidating those discussions into reports for the Water Working Group. The facilitator will work with the chair and co-chairs to ensure documents are accurate and unbiased, and will facilitate group discussion at the working group to ensure the report reflects the views and expectations of Group members.

Expenses

Working Group members may submit an expense account to cover normal costs incurred as part of their travel to, and attendance at, the Working Group meetings noted in the above schedule.

Sub-Committees

The Chair of the Water Working Group may establish working sub-committees from time to time to prepare reports or propose recommendations to the overall Group. Any interested member may participate in any sub-committee.

[5] "Consensus" in this context refers to a situation in which either unanimous or majority support is apparent to all members. (If the support is not unanimous, then all Committee members are satisfied that the document being submitted recognizes their expectations.)

Attachment 2: Water Working Group Members and Support Staff

David Trew (Chair)	Alberta Environment
James Wuite	Alberta Agriculture, Food and Rural Development
Brenda Austin	Alberta Energy & Utilities Board (EUB)
Sue Gordon	Alberta Research Council
Don Bester	Butte Action Committee
Marc Melnic	(CSUG/CAPP/SEPAC) Enerplus
Kevin Heffernan	(CSUG/CAPP/SEPAC) Trident
Brad Murray	Freehold Petroleum & Natrual Gas Owners Association (Alternate-Else Pederson)
Bernie Schell	Surface Rights Federation
Gerry Haekel	Alberta Sustainable Resource Development
Fred Calverley	Trout Unlimited Canada
Tom Harding	University of Calgary
Richard Chalaturnyk	University of Alberta
Phyllis Kobasiuk	Alberta Association of Municipal Districts & Counties
Brent McBean	Wildrose Agricultural Producers
Morris Maccagno	Environmental Services Association of Alberta
Ian Peace	RAPID- Residents for Accountability in Power Industry Development (Alternate-Mike Queenan)
Bill Brown	WSRAG- Wheatland Surface Rights Action Group (Alternate- Brian Sevick)

Others:
Sharla Rauschning, Alberta Energy (Observer)
Diana Purdy, Alberta Energy (Observer)
Tom Byrnes, EUB (Alternate)

Alberta Environment support staff:
Nga de la Cruz
Stephen Yeung
Glenn Winner
Justin Toner

Facilitator: Bill McMillan, Equus Consulting Group Inc.

Additional Stakeholders who attended WWG meetings:
Andy Etmanski/Rick Ferster, Alberta Coal Association (Mar. 12/Apr. 21/June 16),
Oscar Steiner, Strathcona Energy Exploration Committee (Mar. 12)
Eddy Isaacs, Dr., Alberta Energy Research Institute (Apr. 21)

Attachment 3: CBM Glossary of Terms

Abandonment/reclamation: The permanent dismantlement of a well or facility in the manner prescribed by the regulations and includes any measures required to ensure that the well or facility is left in a permanently safe and secure condition.

Allocation: Is defined by the *Water Act* as the volume, rate, and timing of a diversion of water .

Aquifer: As defined by the *Water Act*, an underground water-bearing formation that is capable of yielding water to wells or springs.

Best management practices: Management practices or techniques recognized to be the most effective and practical means to minimize adverse environmental effects or protect natural resources through more efficient use while still allowing the productive use of resources.

Casing: A series of tubular pipes joined by threads and couplings that line a wellbore to prevent water and rock from entering.

Coal: A black or brownish-black solid combustible substance formed by the partial decomposition of vegetable matter without access to air. The rank of coal, which includes anthracite, bituminous coal, sub-bituminous coal, and lignite, is based on fixed carbon, volatile matter, and heating value.

Coalbed methane (CBM): Natural gas/methane found in coal deposits.

Co-mingling: Mixing of water of different quality from separate aquifers.

Confined aquifer: A confined aquifer is a saturated aquifer whose upper and lower boundaries are impervious layers. Completely impervious layers rarely exist in nature and hence semi-impervious layers commonly bound confined aquifers. In confined aquifers, the pressure of the groundwater is usually higher than that of atmospheric pressure and the water in the well stands above the top of the aquifer.

Conventional natural gas: Natural gas consists of a mixture of hydrocarbon compounds, primarily methane, and small quantities of various non-hydrocarbons that exist in gaseous phase or in solution with crude oil in natural underground reservoirs.

Completion: The process by which a well is prepared to produce water, oil and/or gas, involving such steps as installing, cementing and perforating the casing.

Cumulative effects: Changes to the environment caused by an activity in combination with other past, present, and foreseeable human activities.

Directly and adversely affected party: The EUB uses three criteria to determine who is a directly and adversely affected party. A person must:

- be affected in a different way or to a greater degree than members of the public;

- have a concern related to a property right or other economic interest; and

- be able to show some connection between the proposed activity and the rights and interests that may be affected.

Drilling fluid: The circulating fluid used to bring drilling cuttings out of the well bore, cool the drill bit, and provide hole stability and pressure control. Drilling “mud” includes a number of additives to maintain the mud at desired viscosities and weights. Some additives that may be caustic, toxic, or acidic.

Environmental Protection and Enhancement Act (EPEA): Provincial legislation that takes an integrated approach to the protection of Alberta's air, land, and water. One of the Act's cornerstones is the guarantee of public participation in decisions affecting the environment. Public involvement includes increased access to information, participation in Environmental Assessment and Approval Processes and the right, when directly affected, to appeal certain decisions.

First-in-time, first-in-right: The principle used to prioritize water rights in Alberta. This principle, established in 1894, means that water rights are prioritized according to how senior the licence is, regardless of its use. The older the licence, the higher the priority.

Formation: A designated subsurface layer that is composed throughout of substantially the same kind of rock or rock types.

Fracturing: A method of improving the permeability of a reservoir by pumping fluids such as water or carbon dioxide, nitrogen into the reservoir at sufficient pressure to crack or fracture the rock. Also known as "fracing".

Groundwater: Water that occurs under the surface of the ground.

Household purposes: The use of a maximum of 1250 cubic metres of water per year per household for the purposes of human consumption, sanitation, fire prevention and watering animals, gardens, lawns and trees.

Methane: Commonly known as natural gas (chemical notation: CH_4). The most common hydrocarbon gas.

Multiple aquifer completion: A well is constructed across more than one formation.

Observation well: A non-producing well used to monitor pressure or water level, or to collect water samples.

Operator: The company or individual responsible for managing an exploration, development or production operation.

Outcrop: Bedrock that is exposed at the earth's surface

Perforating: Enhancing gas or fluid flow through the lower portion of a well casing. This is typically achieved by lowering a device with explosive charges into the well create holes through the casing and cement, and into the reservoir.

Permeability: The measure of how easily a fluid can pass through a section of rock. If fluid can pass relatively easily through a given layer, then the permeability is said to be high. However, if a layer effectively blocks fluids, then the layer is considered to be impermeable. Such layers are known as traps.

Pool: A natural underground reservoir containing or appearing to contain an accumulation of oil or gas, or both, separated or appearing to be separated from any other such accumulation.

Porosity: Open spaces within a rock that contain fluids such as water, oil or natural gas.

Produced water: The water extracted from the subsurface along with produced oil and gas. It may include water from the reservoir, water that has been injected into the formation, and any chemicals added during the production/treatment process.

Reservoir: A porous and permeable underground rock formation containing a natural accumulation of crude oil or natural gas that is confined by impermeable rock or water barriers, and is separate from other reservoirs.

Saline groundwater: Water that has total dissolved solids content exceeding 4000 milligrams per litre as defined in the *Water (Ministerial) Regulation*.

Spacing: The distance between wells producing from the same reservoir. Spacing is often expressed in terms of acres, e.g. 40-acre spacing, and is often established by regulatory agencies.

Test hole: A well drilled for the primary purpose of obtaining geological or geophysical information.

Total dissolved solids/TDS (mg/L): A measure of concentration, or how much substance is in a given sample.

Unconfined Aquifer: An aquifer containing water that is not under pressure. The water level in a well completed in an unconfined aquifer is the same as the water level (water table) outside the well.

Water Act: In Alberta, the Water Act is used to protect the quality of water and to manage its distribution. The legislation regulates all development and activities that might affect surface water and groundwater.

Water (Ministerial) Regulation *(WMR):* A regulation under the Water Act.

Water quality: Refers to a set of chemical, physical, or biological characteristics that describe the condition of water in a river, stream, lake, or aquifer.

Water well: An opening in the ground, whether drilled or altered from its natural state, that is used for: (i) the production of groundwater for any purpose, (ii) obtaining data on groundwater, or (iii) recharging an underground formation from which groundwater can be recovered, and includes any related equipment, buildings, structures and appurtenances.

Well density: The concentration of wells on the land surface (per unit area). Less spacing between wells occurs when there is higher well density.

Zone: Any stratum or any sequence of strata that is designated by the EUB as a zone.

Attachment 4: Components of a Field-Verified Survey

The WWG noted that AENV requires a preliminary groundwater assessment as part of their approval for groundwater diversion. For the interest and information of the reader, the requirements are noted below.

The Preliminary Groundwater Assessment requires a field-verified survey of existing water wells, springs and dugouts be conducted within a 1.6 kilometres (one mile) radius of the proposed CBM well site. The survey should include:

- A plan(s) (showing quarter section and section lines) noting the location and ownership of wells, springs and dugouts relative to the proposed CBM well site.
- Tables summarizing details for all wells identified in the survey, as well as dugout size, spring flow rate and the purpose/volume of withdrawal from each source.

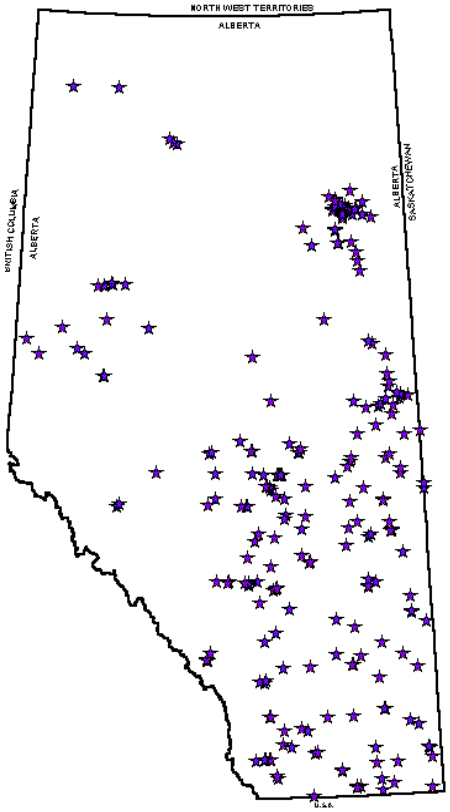
Specific components of the survey include:

1. Legal land location
2. Owner's / lessee's name
3. Type of water source (e.g. well, spring, dugout etc.)
4. Well status (e.g. producing, standby, observation, abandoned, etc.)
5. Well depth (and surface elevation if available)
6. Original non-pumping water level
7. Current non-pumping level
8. Well construction details, completion interval (open-hole, perforated and/or screened interval)
9. Pump intake depth
10. Maximum pumping rate
11. Depth to top of aquifer, amount of available head
12. Distance (approximate) from the proposed CBM well site
13. Purpose and estimated volume of withdrawal
14. Summary of historical chemical analyses

Attachment 5: Baseline Information About Groundwater in Alberta

Alberta Environment is responsible for monitoring groundwater quantity and quality. In the Plains Area, the main bedrock aquifers are sandstones (e.g.) Milk River, Paskapoo and Belly River formations. In Northern Alberta, the main aquifers are sand and gravel present in the glacial materials and in the buried valleys (e.g. Beverly and Helina Channels).
AENV maintains two observation well networks:

1. Alberta Groundwater Observation Well Network (**AGOWN**), and
2. Ambient Groundwater Quality Monitoring Network (**AGQMN**).



The AGOWN network is used primarily to monitor changes in groundwater levels, with some attention to groundwater quality. The second network is used primarily to monitor groundwater quality.

AGOWN well locations in Alberta are shown in the figure on the right.
94 Wells - continuous chart recorders
60 Wells - data loggers (digital recorders)
46 Wells - manual readings several times each year
Approximately 100 shallow wells were constructed specifically for the AGQM in the 1990s.
Groundwater level and quality data will be very important for detecting changes associated with CBM activity. However, the number of monitored wells has been reduced significantly in the past 12 years. Data is collected and stored in several agencies, and may not be in electronic format, making overall analysis and assessment difficult.