Groundwater Extraction and Ecosystem Protection in Canada: Permitting, Planning, and Collaboration

Workshop Report

Program on Water Governance

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Background

The Walter and Duncan Gordon Foundation (the Gordon Foundation) has long been interested in protecting Canada's freshwater resources for the benefit of future generations. One of the critical areas it has focused on in its work is groundwater. It is fair to say that groundwater is both one of Canada's most important natural resources and one of its least understood. Millions of Canadians rely on groundwater for domestic use, industrial processing and agriculture. Groundwater is a vital contributor to the health of our streams, rivers, lakes and wetlands. And yet, we know very little about how much of the resource we have, who uses it, or whether it is being used in a sustainable manner.

To improve our understanding of groundwater management, in March 2005 the Gordon Foundation released *Buried Treasure: Groundwater Permitting and Pricing in Canada*, which for the first time examined and compared groundwater licensing and permitting practices across the country. As a follow up to the report, the Foundation hosted a one-day Groundwater Workshop on Provincial Permitting Systems in Canada in January 20, 2006.[1] At that workshop, experts from across the country shared information on recent initiatives related to groundwater permitting and discussed how permitting could be improved. Post-workshop surveys of participants indicated that most in attendance supported the idea of a second workshop that would focus on ecosystem needs and how they can be addressed in groundwater permitting.

Accordingly, the Gordon Foundation agreed to hold a second workshop on groundwater in partnership with the Program on Water Governance at the University of British Columbia (UBC). This Report has been prepared by Workshop Facilitator, Joanna Kidd of Kidd Consulting to communicate the ideas, comments and concerns that were raised at the workshop. These are presented without attribution. It is not intended to be a verbatim report, but rather is intended to convey the major themes and ideas brought forward. Any errors or omissions are the work of the author.

Workshop Outline

The workshop was held on May14, 2007 at the Institute for Resources, Environment and Sustainability at UBC. The purpose of workshop was to explore how groundwater permitting systems can address ecosystem needs and how partnerships can further the protection of groundwater resources. A total of 49 participants attended representing a broad range of interests – regulators, agency representatives, consultants, scientists, law, academics and non-governmental organizations with an interest in groundwater.

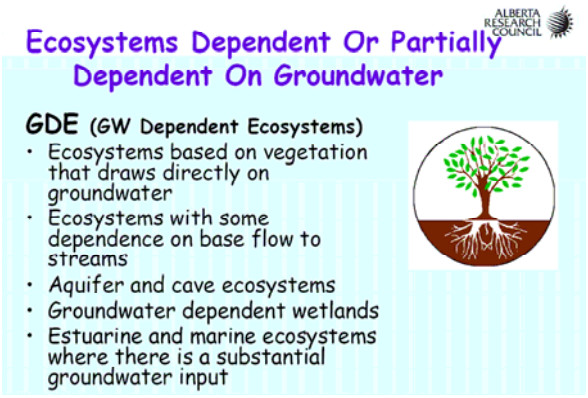
[1] The *Buried Treasure* report and the Workshop Report can be accessed at http://www.gordonfn.org/FW-pubs&links.cfm

The workshop was opened by organizer, Linda Nowlan, Faculty Research Associate, Program on Water Governance and UBC, who welcomed participants, referenced the *Buried Treasure* report and acknowledged the presence in the room of many of the people who had contributed to the development of the report. She noted that the workshop was a direct outcome of the January 2006 workshop, and was designed to further discussion and dialogue on groundwater issues relating to protecting the environment and partnerships.

Sue Gordon from the Alberta Resource Council then gave the keynote address, which was followed by a panel that focused on Accounting for Ecosystem Needs in Groundwater Permitting Systems. In the afternoon, a second panel focused on partnership to protect Groundwater Resources. The workshop finished off with a discussion on Enhancing Consideration of Ecosystem Needs in Groundwater Management. The Agenda for the day is included as Appendix A and the list of participants is included as Appendix B.

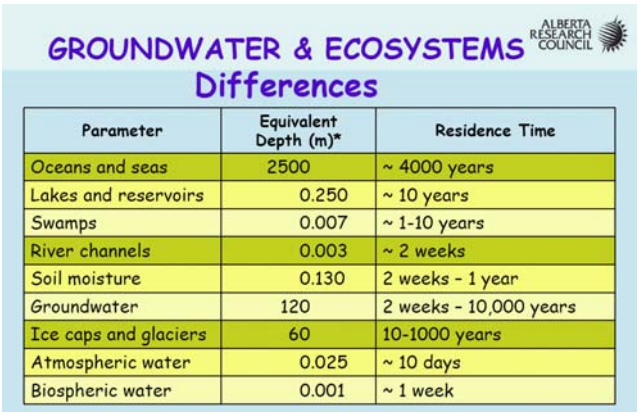
The Role of Groundwater Resource Studies in Water and Ecosystem Management

Sue Gordon, Groundwater Program Leader at the Alberta Research Council gave the keynote presentation on The Role of Groundwater Resource Studies in Water and Ecosystem Management. Her presentation set the stage for the day's discussion. She began by reviewing her background as a biologist, geologist and hydrogeologist and her experience as a scientist, consultant, regulator and researcher.



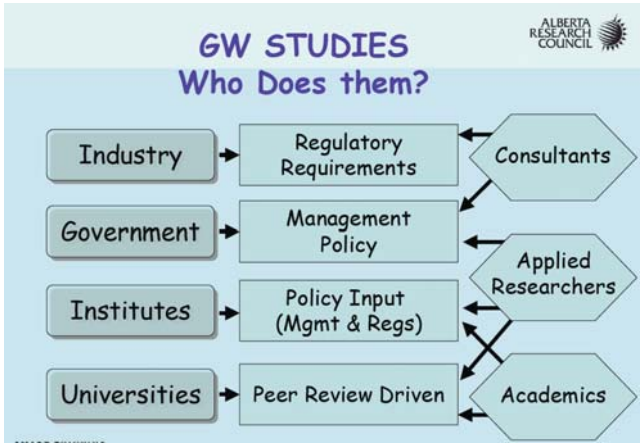
Gordon then provided participants with background on the integration of groundwater and ecosystems. She suggested that there is a new management approach emerging in Canada right now, one that is transferring the knowledge gained from years of studying groundwater to policymaking. Groundwater science is built upon the understanding of geology. In Alberta all the aquifers are not mapped. There is, however, information available from groundwater wells and Ecological Land Classification maps. Standard groundwater studies typically look at scale (the amount of groundwater that can be produced) and the physical and chemical characteristics of groundwater, and usually deal with saturated flow systems. While these studies assess effects on neighbouring wells, they do not consider how broader systems might be affected. Gordon suggested that more comprehensive studies should begin with the identification of recharge and discharge areas and Groundwater Dependent Ecosystems.

Gordon noted that it is challenging for hydrogeology to deal with unsaturated zones where recharge takes place, but that these are the critical places where major storage for groundwater for plants and ecosystems takes place. The physics of the recharge zone is complex, and it is difficult to quantify water storage. In areas where groundwater is discharging, geochemistry is complex and flows are variable, for example varying seasonally. She noted that the residence time for groundwater is very different than for other sorts of freshwater, such as that found in rivers or the atmosphere. Residence time for groundwater can vary from 2 weeks to 10,000 years. Groundwater flow takes place at three different scales – local (on the scale of weeks), intermediate (on the scale of years) and regional (on the scale of centuries).



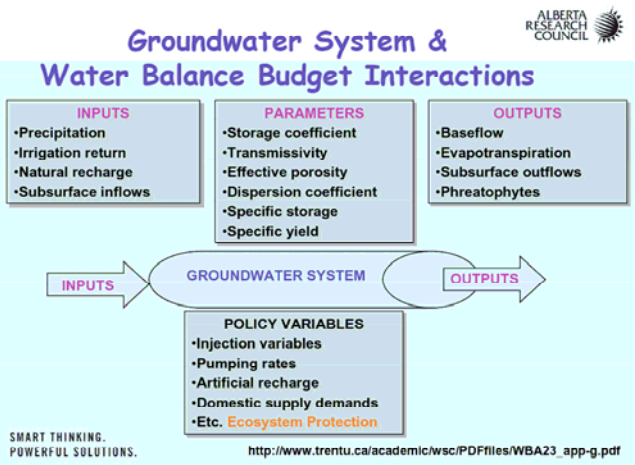
Parameter	Equivalent Depth (m)*	Residence Time
Oceans and seas	2500	~ 4000 years
Lakes and reservoirs	0.250	~ 10 years
Swamps	0.007	~ 1-10 years
River channels	0.003	~ 2 weeks
Soil moisture	0.130	2 weeks - 1 year
Groundwater	120	2 weeks - 10,000 years
Ice caps and glaciers	60	10-1000 years
Atmospheric water	0.025	~ 10 days
Biospheric water	0.001	~ 1 week

Gordon then went on to talk about Groundwater Studies. In Alberta, studies done by government are usually related to management policy, studies done by industry are usually related to regulatory requirements, studies at universities are driven by peer review, and studies done by institutes usually provide input to management and regulations. She went on to give some examples. Groundwater studies done to satisfy regulatory requirements include those to gain approval to divert groundwater for Coal Bed Methane extraction and Environmental Impact Assessments that might be done on oil sands projects. Neither of these really considers impacts on ecosystems. Phase 1 of the Research and Knowledge Strategy for Groundwater in Alberta is an example of a groundwater study that will influence policy. Hydrological studies being carried out by Dr. John Gibson and Dr. Cathy Ryan are examples of groundwater studies that are peer reviewed and will provide policy input. Dr. Gibson is studying acid deposition in the Muskeg Mountains near Fort McMurray, and his research is related to Steam Assisted Gravity Drainage for oil recovery. His research is funded by the Cumulative Environmental Management Association (CEMA) and industry. Dr. Ryan is exploring the theory that Sylvan Lake is fed by groundwater, and her research is funded by a local watershed stewardship group. In both cases, the studies are showing a link between groundwater and ecosystems, but that is not the primary focus of the research.



In terms of improving the integration of groundwater studies into ecosystem protection, Gordon began by stressing the importance of having biologists working jointly with hydrogeologists and resource managers. “We need to link up those people doing groundwater studies with the people who are studying ecosystem protection and management”. She went on describe the Provincial Water Research Strategy that had emerged from the provincial Water for Life process. The Alberta Science Research Authority has been charged with developing the strategy, and the provincial government has allocated $30 million to begin the first two years of implementation. One of the shortcomings of the Research Strategy is the lack of links from the science to practical policy issues.

Gordon noted that the Alberta Ingenuity Centre for Water Research and the Alberta Water Council had recently released "Sustaining Our Resource: A Research and Knowledge Strategy for Groundwater in Alberta." This report contains recommendations on how to improve knowledge of groundwater in Alberta. It notes that some jurisdictions including Australia are already estimating ecosystem needs through strategic research or the application of local knowledge. She noted that conceptual models for biological systems could be developed with the same parameters that are used for physical groundwater systems.



Gordon summarized her remarks by saying:

- There has been a lot of work done by many different groups on groundwater – we need to integrate this knowledge into groundwater management regimes.
- We need to develop peer-reviewed research that implements the high level research strategy that has been developed for groundwater.
- As a key research area, we need to focus on the science of how groundwater systems interact with ecosystems.
- We need to ensure that our value decisions regarding ecosystems are better supported by science.
- Resource management needs to be better supported by science.

Discussion

A number of points were made in response to the presentation. These are categorized and provided below.

Groundwater research

- Public concern or public intervention is also a trigger for carrying out groundwater research and should be acknowledged as such.
- There are significant linkages between academic institutions s and government in groundwater research.
- Aquifer systems need to be studied at a regional scale, not on a local scale (i.e., on single wells.).

Integrating ecosystem considerations

- We do not have the science yet to bring consideration of ecosystem effects into groundwater management.

- Ecosystem linkages are already being made in terms of protecting streams for salmon, especially with respect to temperature.

- In Ontario, there has been a systematic attempt to eliminate ecosystem requirements from consideration in the Source Water Protection process, largely because of its financial implications. The scope of the Source Water Protection process has recently been narrowed to protect only water sources that are used for drinking water. There is a concern about "sterilizing" developable land by protecting recharge areas that aren't tied into a drinking water supply.

- It is difficult to model living systems that adapt, such as aquatic ecosystems in streams. One of the problems seen in municipal water taking initiatives is the lack of follow up monitoring over time to see if there are adverse impacts.

- In BC there are over 900 developed aquifers, but regional studies have been done on only a few of them. Decisions to take water are nevertheless being made all the time, in the absence of issues that might trigger more detailed studies.

- Ecosystems are not well defined as a resource, and their needs are not well understood.

- Sustainability plans for groundwater should include all users, including ecosystems.

Governance

- Even with perfect science, value judgments are still made in the process of developing regulations and policies.

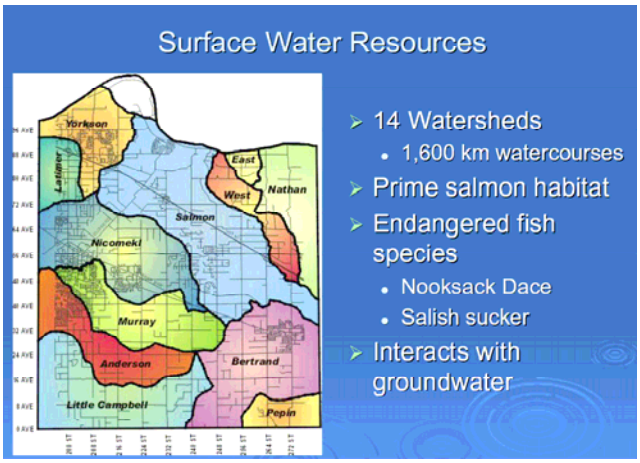
- There is a "disconnect" between science and decision-making. Policy makers take science into account, but also consider economics, social issues and political lobbying. Science does not result in good policy unless there is a strong linkage.

- In a practical sense, we are playing catch up. Aquifer studies are being done after the fact, so that in many cases we don't have good baseline data to assess impacts after water taking begins.

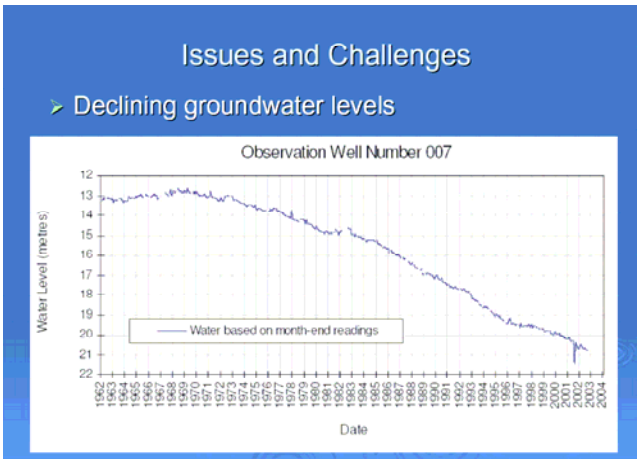
Accounting for Ecosystem Needs in Provincial Groundwater Permits and Watershed Plans

Township of Langley, BC's First Water Management Plan

Antigone Dixon-Warren, from the Township of Langley in BC gave a presentation on the Township's First Water Management Plan. Langley is the first community in BC to develop a water management plan, and its pilot project is being closely watched by other communities around the province. Langley is located between Surrey and Abbotsford and is part of the Greater Vancouver Regional District (GVRD). About 75% of Langley is within the GVRD's Agricultural Land Reserve. The Township includes 14 watersheds totaling 1,600 km of watercourses. Many of the creeks are prime salmon habitat and some include populations of two endangered species – the Nooksack dace and the Salish sucker. Of the 100,000 residents in the Township, about 80% are serviced by municipal supplies with the remainder being on private wells of which there are about 5,000. Groundwater provides about half of the municipal water supply. Dixon-Warren noted that supply of groundwater allows the municipality to be self reliant, and is cost-effective source of drinking water, being about one third the cost of source of water from the GVRD. In 2005, the Township carried out a groundwater modeling study in which the aquifers in the area were re-mapped.



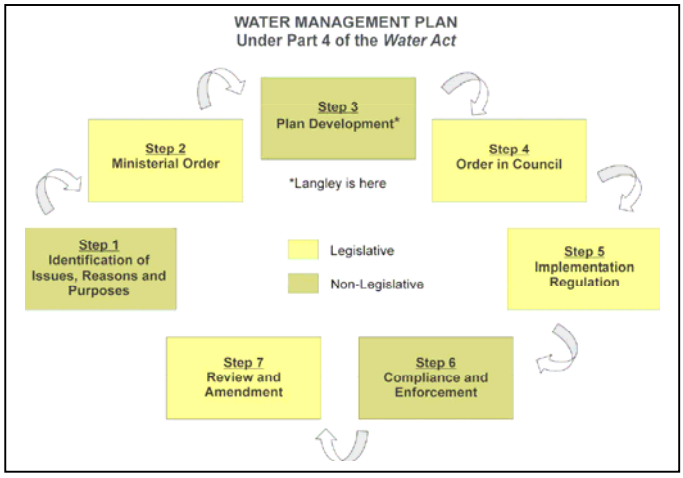
The Township of Langley is facing many water challenges. The first of these, said Dixon-Warren, is increasing demand for treated water as the population grows. Peak water use is very high in the summer months, with about 40% of water being used for lawn watering and irrigation. There are no firm numbers on how much groundwater is used in private wells, but it is estimated to be about twice the amount pumped for the municipal supply. Coupled with this increasing demand is a decline in groundwater levels. Dixon-Warren noted that some of the Langley aquifers are also vulnerable to contamination, and local occurrences of poor water quality have been seen. The final challenge is the impact of intensifying land use as development takes place. The cumulative effect of these factors is that baseflows in area streams have dropped by as much as 35% since 1961. An additional challenge faced by the Township is the uncertain effect of global warming. In reviewing the relevant water regulations, she noted that water quantity is largely unregulated and water quality regulations are mainly reactive.



To address these water issues, the Township developed a Water Resources Management Strategy, which is a 20-year action plan. The Strategy includes an extensive outreach and education component focusing on water conservation and involving private well owners in the

protection of groundwater. Comprehensive groundwater modeling has been done and policies have been developed to drive water conservation and protection, including rigorous stormwater management practices. Most recently, Dixon-Warren noted that the Township is developing a Water Demand Management Strategy to reduce overall water use and peak use. This will likely lead to universal water metering.

The next step for Langley is the development of a Water Management Plan under Part 4 of the BC *Water Act*, which is currently under way. Such plans are designed to help communities address local water issues including risks to water quality, conflicts among users and conflicts between human uses and in-stream requirements. The development of the Plan will include a Stakeholder Advisory Committee and broader public consultation. The Plan, once developed, will be legislated by Cabinet. The Plan may include the following:



- protection of the quantity of groundwater supplies through permitting, licensing and enhanced water conservation;
- protection and enhancement of recharge areas through land development practices and wetland protection;
- protection of aquifers from contamination through nutrient management and pesticide by-laws; and
- protection of baseflow for the benefit of fisheries.

Dixon-Warren finished by noting that the Township has a goal of 30% reduction in groundwater demand in the next 5 to 10 years, and hopes that this will allow water levels in aquifers to rebound and stabilize.

Source Protection under the New Ontario *Clean Water Act*

Don Ford from the Toronto and Region Conservation Authority (TRCA) gave a presentation entitled "Water Management: An Ecosystem Approach". He began by describing Ontario's conservation authorities, which are local environmental agencies that work with municipalities, stakeholders and the public to protect and enhance the natural environment. Conservation authorities are watershed-based, and work in partnership with municipalities and provincial agencies to manage natural resources, including flood risk and erosion. TRCA's jurisdiction includes 9 watersheds that cover 2,500 km^2 and include three regions (Peel, York and Durham), the City of Toronto, and 3 lower tier municipalities.

Ford then went on to describe the regulatory framework for water management in Ontario. The *Ontario Water Resources Act* is the major act dealing with water taking and permits to take water. The Act protects "existing uses" and requires that the environmental and human impacts of water taking be considered in the permitting process. Notwithstanding this, many stream systems are stressed and over-allocated.

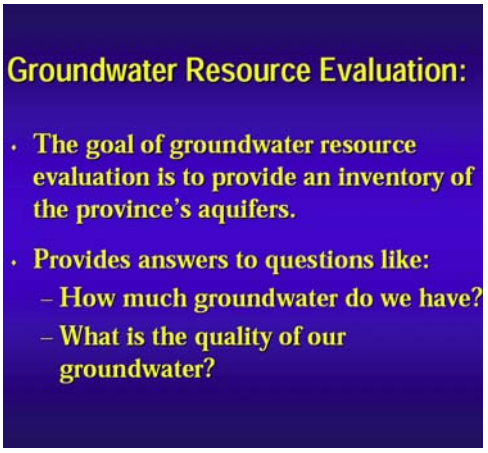
Ontario's new *Clean Water Act* received Royal Assent in October 2006 and will be promulgated in July 2007. Ford noted that one of the first regulations to come out of the Act will be that which establishes 19 Source Protection Regions across the province. Led by conservation authorities, these Source Protection Regions will develop Source Water Protection Plans to protect current and future sources of drinking water from potential contamination and overuse. Source protection is considered the first barrier in a multi-barrier approach to protecting the quality of drinking water. These plans will include the characterization of the watersheds in each Source Protection Region, the calculation of water budgets, the identification of threats to drinking water supplies, the development of plans to manage these risks, and the institution of long-term comprehensive monitoring.

Ford went on to discuss groundwater and surface water interactions in the TRCA jurisdiction, noting the importance of the gravelly Oak Ridges Moraine, which collects rainwater and forms the headwaters of the rivers in the area. TRCA now has a good understanding of where baseflow is largely dependent on groundwater and where sensitive fish populations (such as brook trout and redside dace) are found. He noted the importance of protecting recharge areas.

Ford noted that there is a shared responsibility for protecting water resources in Ontario with some jurisdictional overlap. In the Source Water Protection Plan process, for example, municipalities have prime responsibility within wellhead areas and conservation authorities have prime responsibility outside of them. He cited a recent example (York Region's 16th Avenue Sewer Project) in which de-watering to allow construction of a sewer trunk was drawing down a confined aquifer by up to 40 metres. This was affecting over 80 private wells in the area and resulting in 20 L/sec discharge into a local stream, Robinson Creek. TRCA brought the Region, provincial agencies and the Department of Fisheries and Ocean (DFO) together to address the issue. Ultimately, advanced mitigation measures were adopted including dispersed outfalls, heating or cooling of discharge water, artificial recharge for losing reaches of the creek and targets for baseflow. The major lessons learned from this, noted Ford, was that more work needed to be done at the environmental assessment stage, review agencies needed to work together better, and ecosystem needs must be acknowledged and managed in such projects.

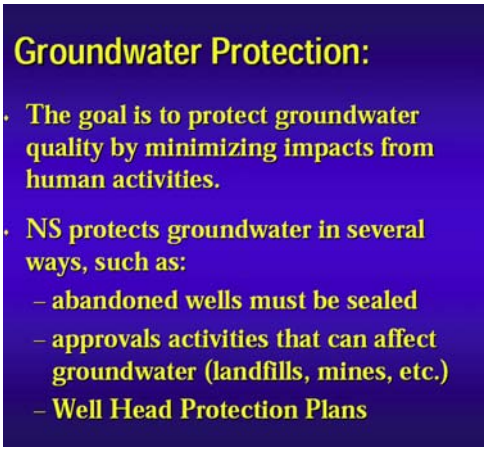
Nova Scotia's Approach to Groundwater Protection

John Drage, Hydrogeologist with Nova Scotia Environment and Labour presented a paper on "Groundwater Pumping and Ecosystem Protection in Nova Scotia". He began by acknowledging the importance of groundwater in the province. There are approximately 150,000 water wells in Nova Scotia and half of the population relies on groundwater (40% using private wells and 10% being serviced by municipally-supplied groundwater). In total, 37 of 82 municipal water supplies in the province use groundwater, and it is used by an additional 1,600 registered users such as schools and restaurants. There are also 1,100 wells serving industrial, commercial and agricultural interests.



Drage noted that the goal of the province is to protect groundwater and ensure that it is used in a sustainable manner. To achieve this, the province uses a combination of regulations and management programs. Under the *Environment Act*, the province owns groundwater, allocates groundwater resources, promotes sustainable management of water resources, and promotes the health and integrity of aquatic ecosystems. There are regulations under the Act that address well construction, groundwater allocation, approvals and drinking water guidelines.

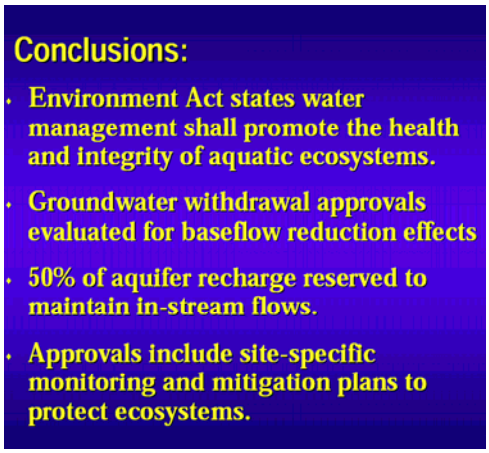
Drage noted that the Nova Scotia groundwater management program has 4 major components: resource evaluation, groundwater allocation, groundwater protection and monitoring. The goal of groundwater evaluation is to provide an inventory of the province's aquifers. The goal of groundwater allocation is to ensure that pumping does not exceed the sustainable yield of the province's aquifers. Approvals are required for groundwater withdrawals greater than 23 m^3/day. A Hydrogeological Study is required to apply for an approval to withdraw groundwater. The applicant must assess sustainable yield, water quality effects, seawater intrusion, well interferences and ground/surface water interactions. The goal of groundwater protection is to protect groundwater quality by minimizing impacts from human activities. In terms of monitoring, the province has a Groundwater Observation Well Network that was established in 1965. The Network includes 24 wells that are used to measure groundwater levels hourly and for chemical testing (general water chemistry, metals, VOCs, pesticides, tritium and perchlorate). Drage showed a slide of groundwater elevations over 40 years at one of the Network monitoring wells: levels have remained constant over that period.



With respect to ecological protection, Drage noted that for applications to withdraw groundwater, sustainable aquifer yields are set at 50% of the aquifer recharge rate. Applicants must evaluate baseflow reduction if the proposed well is located within 60 metres of surface water. Maintenance flow requirements set by the Department of Fisheries and Oceans must be met. For other activities such as landfills or industrial facilities, the province reviews proposals for potential ground/surface water effects. Approvals for such activities contain specific requirements for mitigation and monitoring.

As a case study, Drage described a proposed open pit quartz mine in which the two open pits would extend below the water table and would require de-watering. The proposed mine was

near the Clyde River and several wetlands. The Environmental Assessment Report concluded that baseflow in the river would be reduced by 30% to 40%. Ultimately, the project was approved with a number of conditions including requirements for:

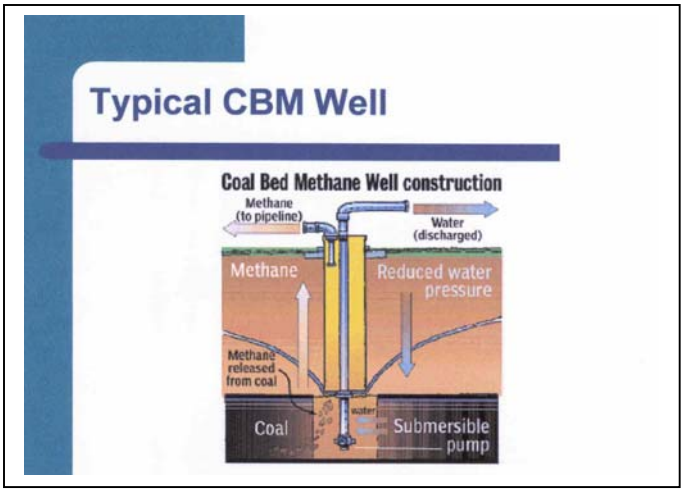


- groundwater monitoring;
- surface water monitoring;
- biological monitoring of fish, fish habitat, aquatic invertebrates and vegetation in the river and wetlands;
- statistical evaluation of monitoring data;
- a contingency plan to alter mine operations if significant changes occur; and
- an $85,000 bond to acquire land in the event that the mine causes unacceptable environmental effects on the wilderness area.

Drage concluded by saying the province is planning to develop a comprehensive plan by 2010 to address all water resources and that he hoped ecological needs would be included in the plan.

Groundwater in Coalbed Methane Development and Oilfield Injection Projects

Nga de la Cruz from Alberta Environment gave a presentation on "Groundwater in Coalbed Methane Development and Oilfield Injection Projects in Alberta". She began by describing a typical Coalbed Methane (CBM) well. In some cases, these are dry and it is much easier to extract the natural gas. Where there is water present (either fresh or saline), it is pumped out to increase the pressure on the rock formation so that the methane is released from the coal. She noted that many of the coal formations with potential for CBM are in the southern part of Alberta, and that industry tends to go first to areas without groundwater, so they do not have to get licenses for pumping groundwater.



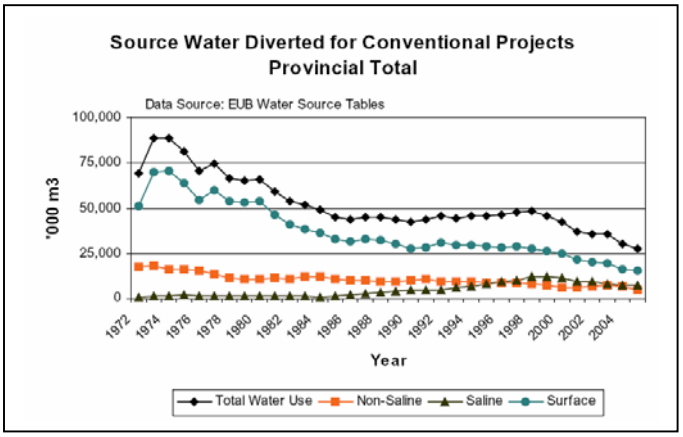
CBM extraction is subject to the Alberta *Water Act*. Where groundwater is fresh, its diversion and disposal Alberta Environment is regulated by Alberta Environment. Where groundwater is saline, diversion and disposal is regulated by the Alberta Energy and Utilities Board (EUB). Applications under the *Water Act* go through a process of technical review to assess the impact of the proposed project on the aquifer, people and surface water interactions. This is followed by a public notice, public input and decision-making. After that, a license is issued or denied, and there is an opportunity to appeal. In practice, de la Cruz noted that licenses are rarely denied and the appeal now takes the form of a hearing. She also noted that the assessing the impacts on surface water was added due to public concern.

n 2004, Alberta Environment released a Guideline for Groundwater Diversion for Coalbed Methane Development. This requires that the applicant:

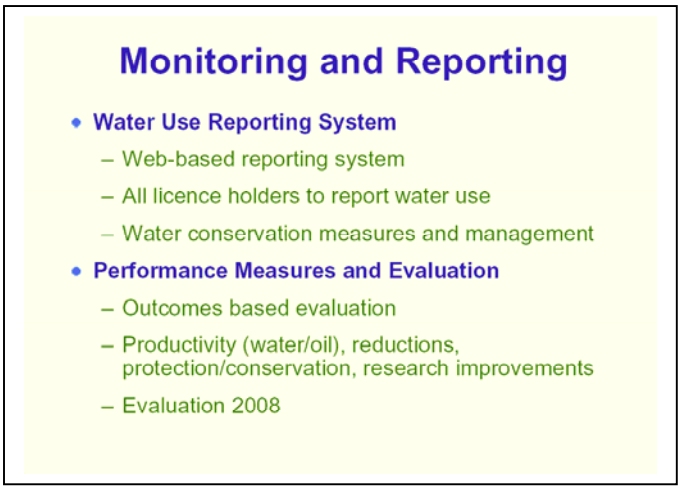
- conduct a preliminary groundwater assessment;
- provide geological cross-sections showing other wells and proximity to surface water bodies;
- provide a technical report that assesses the cumulative impact on ground and surface water and includes a water management plan and monitoring plan; and
- provide baseline data on water wells with a 600-metre radius of the proposed CBM well.

The applicant also needs to address the disposal of the groundwater that is pumped out. Saline groundwater is typically disposed by deep well disposal or oilfield injection.

De la Cruz then went on to discuss oilfield injection. In oilfield injection, water is pumped into an oilfield to more oil towards producing wells. This can be done with surface water, or saline or fresh groundwater. Over the last 35 years, the amount of surface water and fresh groundwater used for oilfield injection has declined, and the amount of saline groundwater used has increased slightly. (In total, groundwater makes up only 2.9% of the total water allocated in Alberta).



In 2006, the Province released a Water Conservation and Allocation Policy for Oilfield Injection. The Policy is aimed at enhancing the conservation and protection of the water resource and reducing or eliminating the use of fresh water resources for oilfield injection. Under the Policy, the province has a Guideline or Allocation Framework that assesses the impacts of oilfield injection proposals on the drinking water supply, aquatic ecosystems and water quality. The Guideline also requires applicants to prepare a water conservation plan for each 5-year term renewal application and to evaluate the cumulative effects of the proposed water use and other water users in the area. The Water Conservation and Allocation Policy for Oilfield Injection is supported by a Water Use Reporting System and Performance Measures and Evaluation. These are used to evaluate and report on progress in water conservation.



Discussion

Langley Water Management Plan

Q: Is the removal of land from the agricultural reserve an issue?
A: It is not a great issue in our Township.

Q: Why does the Township want to reduce use of groundwater in the future?
A: Because of dropping aquifer levels and reductions in baseflow to area streams. The Plan will be adaptive, with the first monitoring point 5 years after it is in place.

Nova Scotia Groundwater Management

Q: Is there a biological basis for having 50% of recharge reserved for in-stream flow?
A: The province worked with DFO to arrive at the number. It is based on studies in the US and New Brunswick.

Q: How long is DFO asking for monitoring to be done to assess whether loss of baseflow is a problem?
A: With respect to the quartz mine, monitoring will continue for as long as the mine operates. Monitoring is monthly for chemistry and twice annually for biological systems.

Eliminating Thresholds for Licensing Groundwater Withdrawals

Q: Can we eliminate the thresholds for groundwater withdrawal licenses to better account for environmental impacts of water taking?

A: In Ontario, the threshold is 50,000 L/day. Removing the threshold would bog down the system and perhaps lead to illegal water takings.

A The threshold in Nova Scotia is 23 m^3/day. It would be impractical to eliminate it. It is enough work to deal with licensing at this threshold. Nova Scotia monitors all withdrawals to assess cumulative impact of all water takings.

Consideration of Climate Change Impacts

Q: Are regulators in Canada considering the impacts of climate change on groundwater?

A: In Ontario, some of the watershed plans (for example for the Rouge and Humber Rivers) do look at climate change scenarios, and the impacts of climate change have been modeled.

Groundwater Monitoring

Q: What is the rough number of groundwater monitoring wells in your region?

A: In the TRCA jurisdiction, TRCA has 22 monitoring wells for the 2,500 km^2 area. TRCA's partners have additional wells.

A: Nova Scotia has 25 for the whole province.

A: The Township of Langley has 5 MOE monitoring wells and its own production wells.

A: Alberta has 200 for the province, which is 662,000 km^2 in size.

Abandoned Wells

Q: How do you enforce the sealing of abandoned wells?

A: In Nova Scotia, we have a compliance division that acts mostly on the basis of complaints. We are considering an auditing program.

A: The Ontario Source Water Protection process addresses the sealing of abandoned wells.

Agricultural Impacts

Q: What are you doing in terms of agricultural impacts on the quality and quantity of groundwater?

A: Non-point source contamination of groundwater is an issue in Alberta, but the agricultural sector receives some favouritism. Feedlots are covered by regulations.

A: The province of Ontario has a new *Nutrient Management Act*. Agricultural impacts will also be considered in the Source Water Protection process, especially in wellhead areas. It should be noted that agricultural groundwater takings are exempt from the 50,000 L/day limit.

A: In Nova Scotia, the most intensive agricultural areas mostly use surface water, but will probably switch to groundwater over time. They are subject to the same approval process as other groundwater users, but are exempt from fees. We also have Farm Management Plans that address the nitrate problem.

A: In Manitoba, agricultural users are licensed. The exemption in Manitoba is 50,000 L/day. Form experience, it appears that livestock users use less water than this.

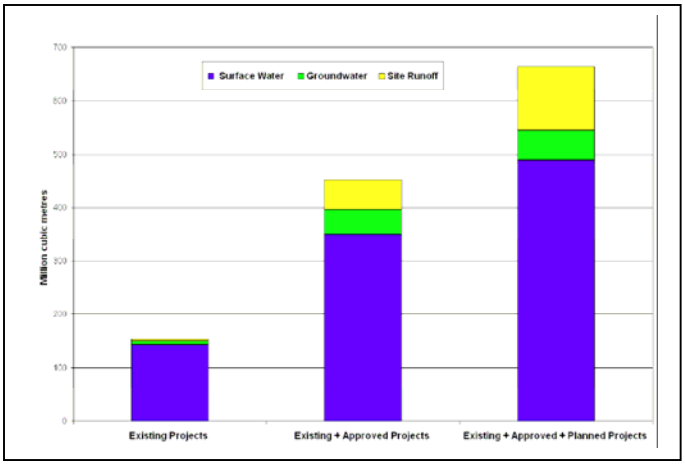
Partnerships to Protect Groundwater Resources

Water and Oil Sands Development in Alberta

Mary Griffiths from the Pembina Institute gave a presentation on “Oil Sands Development and Groundwater in Alberta: Developing Partnerships”. She began her presentation by describing the Pembina Institute, which was formed in 1985 in response to the sour gas issue. Now with 50 staff in 6 offices across the country, the Institute focuses on sustainable energy solutions. In 2006, the Institute released “Troubled Waters, Troubling Trends”, which examined the impact of the oil sands industry on water. The Institute’s most recent report on the issue is entitled “Protecting Water, Producing Gas”. Both reports are available on the Institute’s website at http://www.pembina.org/

Griffiths noted that the oil sands cover about 1/5 of Alberta. Although much attention has been focused on the mining of bitumen (heavy crude oil), only 7% of the province’s bitumen is shallow enough to be mined. Most of the bitumen lies deep within the ground and must be extracted by pumping water or steam into the ground.

Oil sands mining has many impacts on surface water, and has relatively little impact on groundwater. The major impacts on groundwater take place when the overburden, which is peatlands or woodlands, is removed to allow mining to take place. Extensive amounts of surface water from the Athabasca River are used for oil sands mining, and this will increase tremendously when approved and planned projects are brought on line.

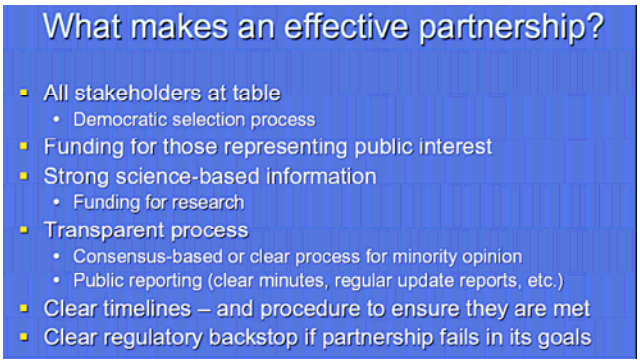


In the future, oil sands operations will use increasing amounts of fresh groundwater, up to 2/3 of the future water supply. Griffiths showed the vast extent of Alberta's bitumen reserves in the oil sands and how little had been recovered to date. Total production to date is about 790 million m^3 of crude bitumen, and Alberta may have as much as 50,000 million m^3 of recoverable crude bitumen, more than exists in Saudi Arabia.

Griffiths suggested that water partnerships in Alberta began with the Alberta "Water for Life" Strategy. As part of the Strategy, the province created the Alberta Water Council, which is a multi-stakeholder body with representation from industry and government. The province has also created 9 Watershed Planning and Advisory Councils (WPACs), which focus on surface water but do consider groundwater, and Watershed Stewardship Groups. To date, however, there is only one WPAC in the oil sands area, the Cold Lake-Beaver River Basin Advisory Committee, which includes representatives of local residents and First Nations. The province has led the way with the science for the Cold Lake-Beaver River WPAC, has developed State of the Basin reports on groundwater quality and groundwater quantity and has developed a Water Management Plan. Griffiths described this process as "devolution of government power up to a point" and suggested that the Advisory Committee seems to be moving in the right direction, although it is still early days for the initiative.

In the Athabasca River watershed, the province has established the Cumulative Environmental Management Association (CEMA) that focuses on the oil sands and impacts on the Athabasca River. Griffiths noted that CEMA has a Surface Water Working Group, but nothing similar for groundwater, despite the impacts of oil sands mining on groundwater. Recently, however, ten companies in the area have joined together to examine the groundwater issue and have retained a consultant to look at cumulative impacts. Griffiths commented that this was an encouraging action. Although the government is involved to some degree and there is some public involvement, she noted that it is not a proper partnership.

Griffiths went on to describe the elements of an effective partnership. This begins with having all the stakeholders at the table with equal players and equal powers and a democratic selection process. Funding for those participating is also needed, in part to guard against burnout. The process needs to have a strong base of scientific information. The process needs to be transparent and should aim for consensus if possible. There should be clear timelines and the Province needs to provide a clear regulatory backstop in case the process fails.



Griffiths raised the question of who represents the public. She suggested that ENGOs do not represent the general public and cannot speak for them. The general public must be provided with the opportunity to have input. First Nations need to be fully represented. The public must the able to participate as equal partners at the table with industry and government.

Griffiths also raised the question of who takes final responsibility for partnership decision-making, suggesting that government has the ultimate responsibility to make decisions if partnerships fail, and that these decisions must be based on sound science. She ended by saying that concept of partnerships in oil sands development and groundwater is a work in progress.

Groundwater and Ecosystem Needs: Fish Collaboration in the Nicola Valley

Craig Orr from the Watershed Watch Salmon Society (WWSS) gave a presentation on "Groundwater and Salmon Interactions". He began by affirming the need for partnerships to address groundwater and salmon issues. He noted that salmon love to live in rivers that are found in arid, interior habitats and such areas are much more productive than coastal areas. The Nicola Watershed, a tributary of the Fraser River, is such a river. In it is found the endangered Fraser coho, Upper Fraser Chinook during the spring and summer, and the prized Thompson River steelhead among other species. Water quantity and temperature are key factors in the survival of salmon in such areas.

Orr went on to stress that groundwater is vital for all the life stages of interior dwelling salmon. In the summer low flow period, influent groundwater provides localized cooling that allows juveniles and adults to survive. For juveniles, these upwellings of cold groundwater provide refuge from daytime and nighttime temperatures and fry and parr may burrow into the sediment in these areas. In the summer, staging adults may become confined to the areas that are cooled by groundwater. If temperatures get above 25 Celsius, the fish die. Orr noted that groundwater is important in the low flow period in the winter as well. In the winter, influent groundwater counters the formation of anchor ice, eggs are maintained at stable temperatures in the gravel, and provides a stable environment for rearing. The selection of redd (nest) sites in the winter may be driven by the presence of groundwater.

Orr listed a number of factors that affect salmon in the Nicola Valley. The first of these is climate change. He noted that the past 7 to 9 years have been the warmest on record in the Fraser River, which is one of the reasons for the disappearance of sockeye salmon. High temperatures have triggered a reaction to a parasite that is naturally carried by salmon. The Nicola watershed is also suffering from development impacts. Surface water in the desert-like area is overallocated, and groundwater (which is not regulated) is being increasingly withdrawn. Overfishing has also had an impact, and has led to reduced adaptive capacity and a shrunken gene pool. Lack of funding has meant that there is less money available for stewardship programs, research and monitoring. The watershed is also experiencing competition for water from ranchers and other users and adverse impacts on the refugia.

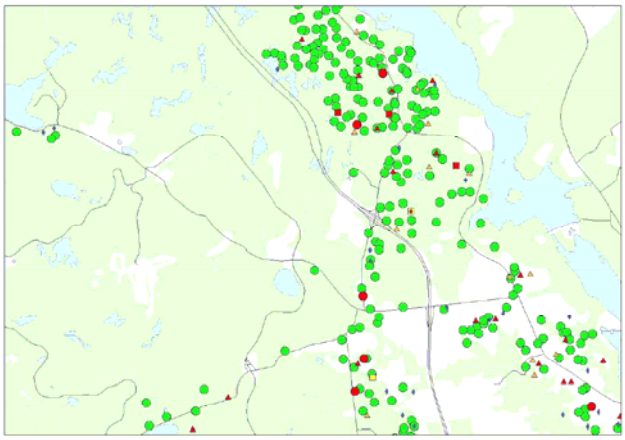
To address these issues, the Nicola Water Use Management Plan (WUMP) is being developed. This is a community initiated and led multi-stakeholder process designed to ensure that the future water supply will be divided equitably among all water users balancing the community's social, economic and ecological values. The consensus-based process began in 2004 and will be completed in 2007 at a cost of $1.3 million. Information on the Nicola WUMP can be obtained at their website http://www.nicolawump.ca/index.htm.

Orr finished his presentation by acknowledging the many challenges facing the WUMP process in the Nicola Watershed. He noted that the Province of BC is currently trying to upgrade its groundwater legislation, which right now doesn't recognize fisheries as an important social and economic component. Through the WUMP process, the stakeholders will be exploring different governance models to try to "break the pathology of regional resource management", which is to maintain the status quo. Orr finished by observing that "one of the drivers of changes is crisis, and I suspect that we haven't had enough of a crisis yet with climate change."

Citizen Participation in Groundwater Management in Chelsea, Quebec

Patrick Henry from H_2O Chelsea gave a presentation on "The H_2O Chelsea Project: A Partnership to Protect Water Resources". He began by describing the Project as a partnership between the Municipality of Chelsea, the University of Ottawa's Institute for the Environment and a local ENGO, Action Chelsea for the Respect of the Environment. About 100 volunteers are involved in the project. The Municipality of Chelsea is characterized by largely low-density housing built on the Precambrian Shield in the Gatineau Hills. Because of the geology, all residences are on wells and septic systems. There are some development pressures in the southern part of the municipality.

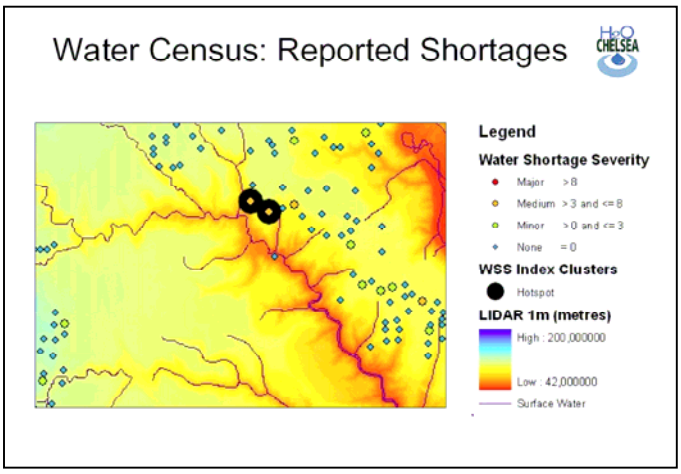
Henry noted that the H_2O Chelsea Project was proactive. Instead of reacting to a groundwater problem, the community is trying to avoid one. The Municipality of Chelsea is already an environmental leader and many of its environmental initiatives go beyond what is required by provincial or federal laws. The municipality was the second in Canada to ban the aesthetic use of pesticides in 1998. The municipality also has a Septic Tank Emptying Program developed in 1991 and a Wetland Protection By-Law. It has set a minimum lot size of 1 to 2 acres to minimize well and septic density, and requires a hydrogeological study for developments on parcels of land greater than 10 acres.


Mesure bactériologique / Bacterial Analysis - 2005

The H_2O Chelsea Project includes components that address lakes, streams, well water quality, well water quantity, and community education. In the Well Water Quantity Program, H_2O Chelsea acts as an intermediary between residents and laboratories. Through the program, residents can

have their well water sampled for about 1/3 the cost of commercial rates. H_2O Chelsea keeps a copy of the results to identify any issues of concern such as septic bed leakage or road salt. Results are then mapped.

Henry noted that the Well Water Quantity Program is more complex and attempts to answer the question “Is the current and projected rate of groundwater use sustainable”. H_2O Chelsea is tackling this in three ways. A Static Level Program measures the height of water in wells, but is limited in the number of wells that have been measured. Early on the project, a Water Questionnaire was sent to all residents of the municipality to see if they had experienced any problems with their wells. This generated an idea of which areas were experiencing water shortages. H_2O Chelsea followed up the Questionnaire with a 12-page Water Census that was sent to all residents to elicit more detailed information about the location and nature of water shortages. In areas where shortages have been identified, the Municipality will be following up with additional research on the static levels of groundwater.



H_2O Chelsea releases an annual report each year on their findings and progress. The report also includes recommendations for action and research for the following year. Henry noted that the project has had many successes. It has led to cattle being removed from Gatineau Park, and has gotten funding for engineered septic systems for groups of houses. The partnership of municipality, residents and university has paved the way for increased funding because it demonstrates broad community support for groundwater protection initiatives.

Henry ended his presentation by noting that H_2O Chelsea is working to publicize and transfer its research, monitoring and education resources to other interested communities. They have received some funding from Natural Resources Canada (NRCan) to develop a mapping portal. Monitoring protocols, datasheets, databases and training materials are available at their website http://www.h2ochelsea.ca/introduction.htm

Accounting for Ecosystem Needs in Land Use Planning in Oliver, BC

Murray Journeay from the Geological Survey of Canada at Natural Resources Canada gave a presentation on “Pathways Toward Groundwater Protection Planning”. He began by acknowledging the many partners in the project from agencies, academic institutions, non-profit organizations, local governments and the private sector.

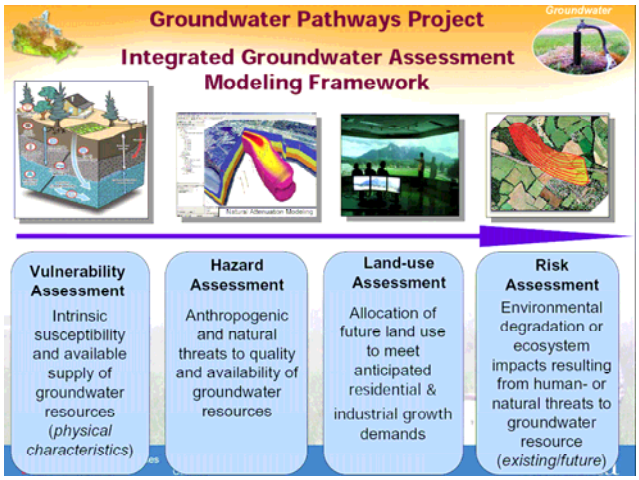
The aim of the Groundwater Pathways Project is to improve science and policy linkages within a framework of the community planning process. If we can characterize groundwater resources and identify where and why then are vulnerable, said Journeay, then we can identify where it is ‘safe’ for human settlement and agricultural land use, and we can define limits of growth and development. The desired outcomes of the Project are to help achieve sustainable use of groundwater resources and to encourage partnerships that integrate hydrogeological expertise and information in decision-making.

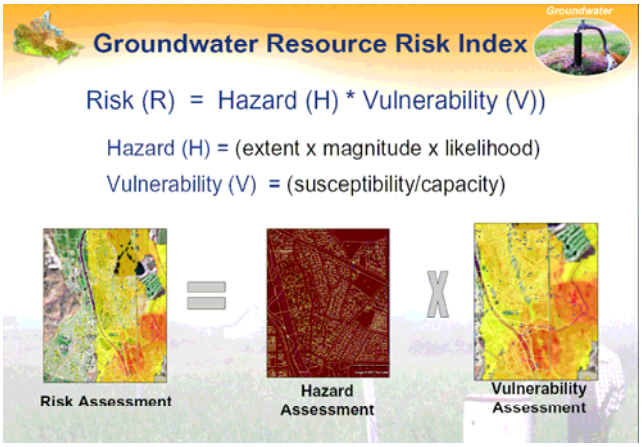
The Groundwater Pathways Project has developed a draft framework and methodology for integrating conventional groundwater resource assessment and comprehensive community planning. It uses well-established techniques of vulnerability and risk assessment to evaluate potential impacts of existing and future settlement patterns. It also uses Multi-Criteria Decision Analysis and Scenario-Based Modeling that complement existing planning and protection tools such as wellhead protection and aquifer vulnerability assessment.

To date, the Groundwater Pathways Project has focused on two areas in BC – the South Okanagan Regional District and the Gulf Islands. In the Okanagan, the Region is developing a regional growth strategy, and within the Region, the municipality of Oliver is reviewing its Official Plan. Journeay noted that the Okanagan was selected because of the opportunity to work with governments at different levels in an area where there already were strong partnerships interested in ground and surface water.

The Groundwater Pathways Project linked up with the community planning process that was unfolding at the local level in Oliver. This planning process – "Smart Growth on the Ground" – was itself a partnership involving the region, the municipality, and a local NGO. The Smart Growth process involved looking at growth in the 20 to 40 year time frame. Through an extensive community consultation process, Smart Growth set priorities, indicators and targets for growth, examined a number of potential future growth scenarios, and eventually developed a concept plan for the future of the municipality of Oliver.

The modeling framework for the Groundwater Pathways Project involved a vulnerability assessment on groundwater in the Oliver area, conducting a hazard assessment to identify threats to the quality and quantity of groundwater, theoretical allocation of land to meet anticipated residential and industrial growth, and then assessing the risk to groundwater from that growth. In terms of groundwater vulnerability, Journeay noted that the Groundwater Pathways Project looks at both water quality and water quantity. For water quality, this involves assessing the physical characteristics of groundwater aquifers and the potential for surface contamination over time. For water quantity, this involves determining the capacity of surface and groundwater supplies to balance environmental and human needs over the long term planning horizon of 10 to 40 years.





The Project defines "risk" as equaling "hazard" times "vulnerability". Journeay noted that the Groundwater Pathways Project is still evaluating a number of models for doing formal risk assessment, and they are still several years away from completing the work.

Journeay finished by noting that most groundwater assessment methodologies focus on existing conditions, but we need to look at future states. The Groundwater Pathways Project was designed to help communities visualize potential community plans and evaluate whether they would be sustainable in terms of groundwater resources.

Discussion

Septic Tank Emptying Program

Q: Did the Municipality of Chelsea get much resistance from landowners for their septic tank emptying program?

A: There are always some people who show up at council meetings upset, and sometimes a lot of discussion is needed. Overall, most homeowners are interested in saving money and protecting and property values.

Groundwater Pathways Project

Q: Would NRCan be interested in carrying out similar Groundwater Pathways projects in Alberta?

A: Yes, we are interested in building partnerships to improve the use of science in decision-making.

Q: Does NRCan have a comprehensive groundwater database for the Gulf Islands?

A: No, although there is some similarity among the islands, especially the southern ones. We have been working with the Gulf Islands Trust to show how the outputs from the Groundwater Pathways Project could be used in developing Official Community Plans (OCPs). We have also been involved in an OCP taking place on Pender Island. We have learned that the specific outputs are less important than the development of frameworks to embed scientific information in policy documents without having to formally update and review the document.

Q: Are hard copies of the Groundwater Pathways made available?

A: The maps that are developed in the Groundwater Pathways Project process are published. The Gulf Islands Trust use them as part of their planning framework.

Q: How feasible is it to expand the Pathways analysis to a larger scale?

A: The methodology is scalable, but is limited by the availability of information, place-based knowledge and expertise. Beyond the regional level, there are better tools for looking at sustainability.

Water Surveys

Q: H_2O Chelsea mailed out 2400 surveys. What was the quality of the responses?

A: Generally very good. We had people review the design of the survey before we sent it out. The information received was very useful for identifying where and when water shortages occurred.

Q: Was there any reason for the low response – 800 returned?

A: That is actually a very high response. Most surveys get less than 10% response.

Precautionary Principle

Q: You have talked about the need for science-based decision-making in the oil sands and also the lack of science on groundwater. This can lead to either lack of action because of absence of "sound science" or action because of the precautionary principle. Can you comment on the degree to which the precautionary principle is being used in the oil sands, either implicitly or explicitly?

A: I don't see it being used, except when enough people are aware of the issue that they can exert pressure on decision-makers. Part of the precautionary principle is having good baseline data – in this case on groundwater – and in the oil sands area of Alberta, we just don't have that data.

C: There are always uncertainties when we are dealing with complex ecological systems. Such uncertainty is often used by industry as an excuse to maintain the status quo. This is covered well by Gunderson and Holling in their book *Panarchy:Understanding Transformations in Human and Natural Systems* (Island Press, 2002).

Enhancing Consideration of Ecosystem Needs in Groundwater Management

The final part of the workshop was devoted to discussion. Facilitator, Joanna Kidd observed that during the course of the day, participants had provided many examples of innovative approaches for enhancing the consideration of ecosystem needs in groundwater management. She asked participants to suggest concrete ways in which groundwater management could be improved with respect to meeting ecosystem needs. She also asked participants to comment on possible next steps for the Gordon Foundation and the UBC Program on Water Governance in the field of groundwater. The comments are presented below.

The Politics of Groundwater

- We haven't really talked about politics today, and that is where the real decisions are made. If we want better management of groundwater, we have to increase the profile of the groundwater issue and move it up the priority list.

- Watershed groups are becoming increasingly important in terms of focusing attention on issues and encouraging politicians to deal with them.

- In Manitoba, there are some politicians who are leading the way on groundwater issues. There have been examples where the precautionary principle held the day and applications to withdraw groundwater were denied.

- In Alberta, there are increasing numbers of people who are involved in and concerned about groundwater issues. We need to find a way to harness this grassroots energy.

- We need to communicate the importance of protecting our groundwater resources, and communicate that there is no way to "fix" an aquifer that has been contaminated.

- To enhance the profile of groundwater, we need to make it a regional issue, rather than just a local one.

Partnerships

- Some rather unusual groups, such as the BC Real Estate Association are now becoming interested in groundwater issues. They recognize that their constituents have an interest in and care about the issue.

- Partnerships are important in terms of who makes decisions on issues, how issues are framed, and who has the burden of proof.

- The evidence today is that the partnerships that work best are those dealing with science. Should we be pressing forward to get partnership approaches to decision-making?

- We need to recognize that there is no one agency that has either the mandate or the resources to address groundwater issues. Partnerships are the only answer, and they need to include scientists, policy makers and members of the public. The solution to groundwater issues begins at the local level.

- Senior levels of government need to work with local groups as these are the ones who are doing the work and who understand the local situation.

- There is a difference between developing partnerships with municipalities doing regional planning and developing partnerships with industrial users. In situations like Alberta's oil sands development, the provincial and federal governments need to play a bigger role rather than passing responsibility on to citizens' councils.

- We seem to be concentrating on urban and industrial users of groundwater, but rural users are also important. We need to work with NGOs to reach rural users, and NGOs they need funding to be able to participate.

Governance

- There is no underestimating the importance of governance on the groundwater issue. We currently have a patchwork of regulations and policies.

- In Ontario, we have set up a water network of 24 environmental groups and we are trying to promote consistence across the province in the management of ground and

surface water. The sharing of information allows people to see if their watershed is falling behind.

Future Steps

- The science of groundwater is evolving and we need to continue to share ideas and information. We should consider having a similar forum to this one, but with a broader audience, to help get the word out on groundwater issues. We need to speak with a stronger voice in a more public way.

- The Gordon Foundation could play a role in helping to develop a national policy on groundwater. This could lead to more consistency in how groundwater is managed across the country.

- It would be useful to build bridges to the professional planning community, to see if we can integrate groundwater protection into the land use planning process in a systematic way.

- We also need to address the issue of economic cost because groundwater has value. This sometimes only becomes apparent when the “well runs dry”.

Wrapping Up

Linda Nowlan wrapped up the workshop by observing that it had been a day of fascinating discussion, information exchange and debate. She thanked all the participants for taking part and thanked facilitator, Joanna Kidd and co-organizer, Alice Cohen. She finished by acknowledging the contributions of the workshop sponsors – the Gordon Foundation and Brenda Lucas, the Province of British Columbia, the BC Real Estate Association, and Natural Resources Canada.

Appendix A

UBC Program on Water Governance, Walter and Duncan Gordon Foundation
Groundwater Extraction and Ecosystem Protection in Canada: Permitting, Planning, and Collaboration
UBC Institute for Resources, Environment and Sustainability May 14, 2007

AGENDA

8:30 Welcome and Purpose of the Workshop — Linda Nowlan

8:45 Role of the Facilitator, Agenda and Introductions — Joanna Kidd

9:00 The Role of Groundwater Resource Studies in Water and Ecosystem — Sue Gordon

Sue Gordon, Ph.D., P.Geol., is the Groundwater Program Leader, Alberta Research Council. This presentation will address how the studies of groundwater resources support the policies and regulations of water management that may include ecosystems needs. What kind of baseline information do water managers need about aquifer properties related to groundwater flow paths and rates, recharge and discharge areas and rates, chemistry and vulnerability; groundwater supply in terms of use, quality, and contamination and remediation; and the dynamics of groundwater and surface water interactions and dependence by aquatic and terrestrial species on groundwater? What are the most common gaps in knowledge? How can those gaps be filled? How is this information used to inform a provincial groundwater strategy?

10:00 Coffee

10:30 Panel: Accounting for Ecosystem Needs in Provincial Groundwater Permits and Watershed Plans

Many governments are moving to ecosystem-based management. This panel will explore how provincial groundwater licenses and/or watershed plans account for ecosystem needs, such as relating the contribution of groundwater discharge to in-stream flow needs for aquatic ecosystem health . What methods do provincial regulators use to ensure that permits and plans account for ecosystem needs? How is groundwater integrated with surface water management?

- Antigone Dixon-Warren, Township of Langley BC's First Water Management Plan: *The phased approach of the BC Groundwater Protection Regulation*
- Don Ford, Toronto and Region Conservation Authority: *Source protection under the new Ontario Clean Water Act and the Permit to Take Water Regulation --- an integrated ecosystem based approach to water management*
- John Drage, Nova Scotia: *Nova Scotia's approach to groundwater protection*
- Nga de la Cruz, Alberta: *Groundwater in coalbed methane development and oilfield injection projects*

12:00 Discussion

12:30 Lunch

1:30 Panel: Partnerships to Protect Groundwater Resources

Though the provinces have the lead role in water management, ecosystem-based management will necessarily involve other levels of government, and optimally will involve non-governmental organizations and the private sector. This panel will address different partnerships for groundwater protection with case examples from across Canada that address the impacts of extraction from a number of perspectives.

- Mary Griffiths, Pembina Institute*: Water and oil sands development in Alberta*
  Based on the May 2006 report "Troubled Waters, Troubling Trends", this presentation will discuss the vast amounts of water from rivers and groundwater used by oil sands mining and steam injection to produce oil from bitumen that is too deep to mine, and the potential for collaboration with industry on groundwater protection.

- Craig Orr, Watershed Watch Salmon Society: *Groundwater and Ecosystem Needs – the Case of Fish*
  Collaboration in the Nicola Valley: Fisheries and Oceans Canada, Province of BC, Nicola Valley Water Use Management Plan

- Patrick Henry, H2O Chelsea: *Citizen Participation in Groundwater Management- Monitoring Wells and the Water Census in Chelsea Quebec-*
  Collaboration Between Local Government, NGO and University Research Institute

- Murray Journeay, GSC Natural Resources Canada: *Smart Growth on the Ground in Oliver, BC -- Accounting for Water Ecosystem Needs in Land Use Planning*
  Collaboration between the governments and a partnership involving a university (UBC Design Centre for Sustainability), an NGO (Smart Growth BC), and a professional Association (Real Estate Institute of BC) on land use and watershed plans in the Okanagan

3:30 Coffee

3:45 Discussion
- Recommendations for enhancing consideration of ecosystem needs in groundwater management

4:30 Wrap Up and Adjournment Linda Nowlan

Appendix B

LIST OF WORKSHOP PARTICIPANTS

Abdel-Zaher Abdel-Razek	Newfoundland & Labrador Department of Environment & Conservation
Diana Allen	Simon Fraser University
Paul Allen	Natural Resources Canada
Karen Bakker	IRES, University of British Columbia
Brad Badelt	Township of Langley
Jack Blaney	Commissioner, International Joint Commission
Zita Botelho	BC Ministry of the Environment
Oliver Brandes	Polis Project on Ecological Governance
Randy Christensen	Sierra Legal Defence Fund
Alice Cohen	University of British Columbia
Mary Cooper	Mayne Island Integrated Water Systems Society.
Allan Dakin	Piteau & Associates
Nga de la Cruz	Alberta Ministry of Environment
Antigone Dixon-Warren	Township of Langley
John Drage	Nova Scotia Department of Environment & Labour
Linda Duncan	Environmental Lawyer, Edmonton
John Fahlman	Saskatchewan Watershed Authority
Don Ford	Toronto Region Conservation Authority
Patrick Forest	University of Laval Quebec
Jessica Ginsburg	Canadian Environmental Law Association
Ennis Gordon	Pacific Fisheries Resource Conservation Council
Sue Gordon	Alberta Research Council
Mary Griffiths	Pembina Institute for Appropriate Development
Keith Guzzwell	Newfoundland & Labrador Department of Environment & Conservation
Patrick Henry	H2O Chelsea Quebec
Don Keith	Island-Arc Geological Consulting Ltd., Pender Island
Murray Journeay	Natural Resources Canada
Paul Kariya	Pacific Salmon Foundation
Sylvia Kenny	BC Ministry of the Environment
Joanna Kidd	Kidd Consulting (Facilitator)
Eleanor Kneffel	University of Victoria
Lynn Kriwoken	BC Ministry of Environment
Pat Lapcevic	BC Ministry of Environment
Katherine Levitt	Council of Canadian Academies
Brenda Lucas	Walter and Duncan Gordon Foundation
Rob Matthews	Manitoba Ministry of Water Stewardship
Gevan Mattu	Environment Canada
Melanie Mamosen	University of Victoria
Matt McCandless	International Institute of Sustainable Development
Tim Morris	Sierra Club of Canada
Craig Orr	Watershed Watch Salmon Society
Rick Palmer	Gartner Lee Limited

Appendix B

Susan Rutherford	West Coast Environmental Law Association
Alfonso Rivera	Natural Resources Canada
Marc Saner	Council of Canadian Academies
Owen Saunders	Canadian Institute of Resources Law
Hans Schreier	IRES, University of British Columbia
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Marina Stjepovic	Township of Langley
Sonia Talwar	Natural Resources Canada
Mike Wei	BC Ministry of the Environment