

**FEDERAL-PROVINCIAL WORKSHOP:
GROUNDWATER LEVELS AND GROUNDWATER
QUALITY MONITORING NETWORKS**

October 2nd and 3rd , Winnipeg, 2003

MINUTES REPORT

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Executive Summary

Groundwater is one of Canada's most important natural resources, it provides drinking water for 10 million Canadians and is used extensively for agriculture and industry. Groundwater also contributes to the flow to rivers and volume in lakes and plays a pivotal role in sustaining wetlands, freshwater fisheries and other biological resources in Canada. Yet, the groundwater resources of Canada are under-appreciated as judged by the existing knowledge gaps, and the lack of a comprehensive and long-term monitoring of groundwater levels and quality at the national scale.

To encourage discussion of this issue, a federal-provincial workshop on groundwater monitoring was convened on October 2 and 3, 2003 by the Geological Survey of Canada, Saskatchewan Research Council and Manitoba Water. The intent of this workshop was to summarize the current situation of groundwater monitoring in Canada and to sketch a plan to establish an interconnected network of networks of groundwater monitoring across Canada.

Participants from nine provinces and three federal departments presented the status of groundwater monitoring in Canada, both from the provincial and federal perspectives. Four themes were discussed during the workshop: monitoring networks and the possibility of designing a joint network of networks; a national groundwater database; the preparation of a position paper; and the launching of the Canadian Framework for Collaboration on Groundwater.

Much of the focus was placed on discussions relative to the importance of monitoring groundwater and the need to have long-term observation wells coupled with databases and easy access to the data. It was noted that some provinces are already rejuvenating their own networks and that it was up to federal departments to coordinate their efforts to work with the provinces to establish a nation-wide network. However, it was not recommended to develop this concept until clear objectives for a national network are provided and targeted users are identified.

There was considerable degree of consensus to prepare a report with a summary of the groundwater monitoring in Canada as a position paper. It was concluded that such a position paper was needed and could be used to influence decision-makers, which in turn could lead to more funding for GW monitoring. However, the decision was left for a later time until the clear objectives, the outline and the leaders are defined. It was suggested that NRCan takes the lead on this.

There was general support on the idea of establishing a national groundwater database. However, it was said that the provinces were the best agencies to maintain and enhance their own databases. It was suggested that federal government (NRCan), could be able to read the provinces' databases with XML technology. It was noted that the database should go beyond pointers and bring sharing of data to another level, in a national context. To advance this work, there is a need to agree on a set of standards to support groundwater data. It was suggested to use the 1991 work of the federal-provincial working group (Gilliland, 1990), for that purpose.

Finally, a list of actions were set for the coming months and the idea of convening another national workshop in 2004 was left opened.

1.0 Background and Introduction to the Workshop

Groundwater is among the most precious natural resources. Measurements of water levels in wells provide the most fundamental indicator of the status of this resource and are critical to meaningful evaluations of the quantity and quality of groundwater and its interaction with surface water. In Canada, water-level measurements are made by many federal, provincial, municipal and other agencies.

To encourage discussion of this issue by the provincial and federal governments, a Federal-Provincial workshop on groundwater monitoring was convened by the Geological Survey of Canada, Saskatchewan Research Council and Manitoba Water. The intent of this workshop was to summarize the current situation of groundwater monitoring in Canada.

The workshop was held at Radisson Hotel Winnipeg on October 2 and 3, 2003; it immediately followed the Fourth Joint IAH-CNC and CGS Groundwater & Geotechnical Conference also held in Winnipeg the same week. The agenda for the workshop is included as Appendix A and was designed to provide ample time to listen to presentations from the Provinces and from federal departments, as well as for discussions on the many activities going on in Canada relative to groundwater monitoring.

This initiative emerged from two previous national workshops on groundwater, held in Quebec City in 2000 and in Calgary in 2001. Furthermore, this initiative follows one of the recommendations in the *Canadian Framework for Collaboration on Groundwater* (CFCG, Rivera et al., 2003), also a product of the two previous national workshops.

The workshop was one day and a half long. It was mostly a panel discussion, or a roundtable, whereby a quick overview was given by each province. The current federal initiatives were reviewed.

The Objectives of the workshop were to:

1. Summarize the current situation of groundwater monitoring in Canada.
2. Sketch a plan to establish an interconnected network of networks of groundwater monitoring.
3. Discuss ideas and concepts of practical mechanisms to collect, store and share groundwater monitoring data.
4. Plan a more comprehensive, national-wide workshop to be held in 2004 in Quebec City in association with the 5th IAH/CAC – CGS conference.
5. Prepare a position paper.
6. Discuss the idea of a national database on groundwater.

A total of nine provinces and three federal departments participated and the tenth province (NFLD), although not present, also sent a presentation. The participants shared their data, vision and plans and learned from their counter parts in other provinces and federal agencies. At the beginning of the workshop, a summary report of the status of the groundwater monitoring in Canada was distributed to all participants. Attendees at the workshop were provided in advance with a CD-Rom containing all the participants' presentations.

The workshop minutes have been prepared as a record of the meeting and contains the key ideas, comment and concepts that were raised at the workshop. It is a combination of an issue-based record as well as a verbatim record. The minutes report should be read in combination with the CD-Rom of the presentations.

DAY 1

2.0 What Was Said

2.1 Introductory Remarks

Alfonso Rivera (AR) co-chaired the workshop with Harm Maathuis (HM). AR indicated that in Canada, water-level measurements are made by many federal, provincial, municipal and other agencies. He mentioned that the workshop's intent was to summarize the current situation of groundwater monitoring in Canada.

AR: We will look at themes and related elements that are critical to building and sustaining successful programs to :

- promote collaborative efforts,
- explore new and emerging methods and technologies,
- address changing expectations of monitoring,
- ensure data and information comparability, and
- share results and successes.

AR mentioned that groundwater was perhaps the most important resource in Canada and that we have a range of monitoring activities across the country at different levels and by different agencies. He concluded that we need to share resources and data.

AR: We will hear first-hand from our colleagues across the ten provinces, as well as from other agencies, on the status of their respective monitoring programs but also a little bit of history and most importantly the future of this vital activity.

He went on presenting the detailed objectives of the workshop and its outline:

1. Summarize the current situation of groundwater monitoring in Canada.
2. Sketch a plan to establish an interconnected network of networks of groundwater monitoring.
3. Discuss ideas and concepts of practical mechanisms to collect, store and share groundwater monitoring data.
4. Plan a more comprehensive, nation-wide workshop to be held in 2004 in Quebec City in association with the 5th IAH/CAC – CGS conference.
5. Prepare a position paper.

AR ended his introductory remarks by asking the attendees to reflect on the following questions during the workshop:

- What is our capacity to monitor groundwater?
- What are the monitoring programs?
- What do we do with the data we collect?
- How do we instrument our monitoring stations?
- What do we do with abandoned wells (i.e. first nations)?

2.2 Launching of the Canadian Framework for Collaboration on Groundwater

Cam Baker (CB) from Ontario Geological Survey, presents an overview of the **Canadian Framework for Collaboration on Groundwater** as a way of its official launching given its recent publication.

CB:

- The document may be downloaded from the GSC-Quebec Division website (www.nrcan.gc.ca/cgsi)
- Evolution
 - 1st national workshop on groundwater
 - Ad-hoc committee of provincial and federal reps
 - Framework needed to address
 - groundwater as a strategic resource
 - relationship with economic growth
 - lack of assessment
- Framework should promote cooperation between:
 - Government
 - Universities and research agencies
 - Stakeholders
 - Industry and consultants
- Framework must be based on science
- Goals
 - Acquire data
 - Improve communication
 - Provide a resource for developing policy
- Need to set up:
 - Groundwater advisory council
 - National coordinated network
 - Communication
 - Training and accreditation
- May establish working groups in advisory council
- Identified programs:
 - National inventory of resources
 - Application of expertise and technology
 - Specific scientific research
 - Access to information
 - Support training
- What the framework is not:
 - Transfer of responsibility
 - Policy setting
 - Guarantee of funding
- Requirements for success
 - Champion(s)
 - Clear goals
 - Work plan (meet client needs)
 - Commitment (from partners)
 - Performance measures (access value)

- Challenges ahead
 - Jurisdictions have:
 - Adopted hardware and software combinations
 - Reluctance to abandon current systems
 - Differences in reporting standards/methods
 - Different policies on data distribution
 - Data available
 - Paper vs digital
 - Fees
 - Problems with different agencies
 - Conflicting mandates
 - Variable amounts of communications
 - Different priorities
 - Abilities to contribute money and manpower variable
 - Different levels of expertise

The next steps following the Canadian Framework for Collaboration on Groundwater is to form the *Canadian Groundwater Advisory Council* and the *Federal-Provincial Committee on Groundwater*. Cooperative programs recommended in the Framework will be implemented with time. One example of this, is the Earth Sciences Sector Groundwater Program whose design followed the Framework's concepts and vision and some of its recommended programs at the national scale.

2.3 Groundwater level observation well networks in Canada

Harm Maathuis (HM) from Saskatchewan Research Council, presents the draft report: "***Current groundwater level observation networks in Canada***".

HM:

- Last map produced in 1978 (Hydrology Atlas of Canada)
- Objective:
 - Provide a review of provincial groundwater level observation networks
- Layout
 - History
 - When and why
 - Site selection criteria
 - Data collection/processing
 - Map of old and current wells
 - Database requirements
 - Anthropogenic effects considered
- Provincial breakdown presented
 - Number of wells
 - Number of wells with records greater than 25 years
 - Number of wells affected by anthropogenic effects

- Observations
 - Western Canada wells not as affected by cutbacks in funding
 - Processing data highly variable
 - Some well data is missing
 - No observation wells in northwestern Ontario or northern Canada
 - Limited long-term wells (none east of Manitoba)
- Questions
 - Is there a need for a common approach?
 - What tools should be used for hydrographic analysis?
 - Do we need to examine ties between observation wells and streamflow measurements?
 - Do we need to have pumping records/do these records exist?
 - What are the objectives of a Canadian network?

AR raised the following issues :

- How does Canada compare to other countries?
- We have very few observation wells.
- The comparison of groundwater use in the NAFTA countries is 30% groundwater dependency in Canada, versus 50% in USA, and 66% in Mexico.
- 1 400 observation wells in Canada versus 42 000 in USA, and 15 000 in Mexico.

2.4 Presentations from the Provinces

Provincial representatives provided an overview of the current situation regarding monitoring of groundwater levels and quality as well as the historical perspective and, in some cases, future venues.

Each presentation is described in bullet form as well as the verbatim discussion that followed.

Mike Wei (MW), from WLAP, British Columbia

- BC's Observation well and ambient groundwater quality monitoring networks.
- History, rationale, objectives and operation.
- Relevance of the networks.
- Issues & initiatives.
- Observation Wells classified into three categories:
 - Monitoring groundwater levels in developed aquifers,
 - Specific engineering and research projects, and
 - Monitoring for forecasting and baseline data.
- Since 1960, 350 observation wells have been established. Today, there are 163 active observation wells in the Network; some Observation Wells have close to 50 years of record.
- Reporting of ten key observation wells is done in the Snow Survey Bulletin
- Access to month-end data on the ministry web site : Web site: <http://wlapwww.gov.bc.ca/wat/gws/obswell/wellindex.html>.
- Monitoring groundwater has allowed a better understanding of various processes (temporal and spatial levels decline, pumping behaviour, recharge from precipitation, N03-N distribution, etc.)

- Data collection
 - Semi-annual to annual sampling (depends on budget)
- Importance of networks in understanding human and natural impacts on aquifers and developing policies to manage and protect them.
- Issues: data assurance, storage, access and analysis and reporting; new business needs, staff training. Initiatives: Technological upgrades to data collection, water reporting strategy, apply water quality index and objectives to aquifers, and partnerships.

BB: Anthropogenic impacts are predominantly local. What is the interpretation of limited spacing sampling?

MW: The network provides an ongoing indication of these impacts.

GVK: Are pumping rates monitored?

MW: Pumping rates are not under the jurisdiction of my department (nor are pumping rates monitored by other provincial government agencies. Pumping rates are recorded by owners of major wells).

GVK: What is a thalimedes?

MW: A float and pulley type groundwater level monitoring device where the water level is recorded digitally on a potentiometer.

Q: Were alpha and beta decay measured?

MW: These measurements are not a priority. We are mostly interested in agricultural (NPS) contaminants.

Q: Are temperatures measured?

MW: No.

Robert George (RG), from Alberta Environment

- Main measured parameter is head
 - 95 continuous measurements using chart loggers
 - 60 continuous measurements using digital data loggers
 - 40 discontinuous measurements
- Manual levels taken 4-12 times per year
- Chart recorders are hand digitized
- Also collect temperature and chemical data
- Uses:
 - Forecasting
 - Municipal, industrial and agricultural studies
 - Management
 - Modeling
 - Contaminant risk studies
- Quality monitoring well network is different from level network in some cases
 - 200 deep wells (some shared with level network)
 - 100 shallow wells
 - Monitoring for quality, especially long-term changes

- Routine analysis:
 - Major ions
 - Nitrate
 - pH
 - Electrical conductivity
 - Trace metals
- Special analysis
 - DOC
 - TOC
 - Ammonia
 - Turbidity
- Data flow well defined from field staff to drought monitoring and public
- Data warehouse project under way for surface water and groundwater
- Alberta Health collects chemical data but this is not available to Alberta Environment due to privacy concerns
- Data dissemination in several media

BB: Does database provide names?

RG: Names are OK but addresses are not. The data given can only be used for a given. purpose

MW: Is action published?

RG: Not yet.

GVK: Is pumping monitored?

RG: There is some pumping data but only on paper.

Harm Maathuis (HM), from Saskatchewan Research Council

- Two networks in Saskatchewan:
 - Saskatchewan Research Council
 - Started in 1964
 - 54 wells
 - 3 surface water stations
 - Saskatchewan Watershed Authority
 - Started in 1994
 - 18 wells
- Also have Riverhurst and Weyburn networks which are independent of SRC and SWSA
- SRC objective: measure natural groundwater level variations in known environments not affected by man and relate to climate
- SWSA objective: measure groundwater levels in stressed systems
- SRC monitoring started with analog recorders but began switching to Thalimedes recorders in 1988
- Data processing:
 - Determine monthly median water level for SRC
 - SWSA records daily max and min water levels
 - Problem of data reduction exists
 - Median loses spikes but not overall trend

- Types of aquifers
 - Unconfined
 - Confined sand and gravel (intertill)
 - Sand and gravel in channels
- Issues:
 - Aging wells
 - Started retrofits in 1999
 - Install smaller diameter casings in existing wells
 - Data availability
 - Water quality
 - No program in place other than project that ended 10 years ago
 - Funding

MW: Do you own wells?

HM: SRC owns all wells but not properties.

Q: What is the purpose of retrofits?

HM: 5-7" steel casing with telescoping screens have a 30-40 year lifespan. We installed a new screen inside the existing screen and 2-3" PVC pipe in the casing and filled the annulus with grout or cement.

Q: Are you comfortable with retrofits? How are the wells designated for retrofits? Is this based on construction records or televiwer?

HM: Retrofits are done based on observations and availability of funds.

Q: Are wells affected by man?

HM: About 40% have been.

Q: Were casings leaking in older wells.

HM: In about 1 or 2 cases. This is not the criteria for replacing wells.

Graham Phipps (GP), from Manitoba Conservation

- There are many fingers in the pie in Manitoba
 - Water Branch of Manitoba Conservation
 - Industry, Trade and Mines
 - Intergovernmental Affairs (water services board)
- GWDrill database
 - 95000 logs
 - Chemical data (field and lab)
 - Original logs retains
 - Little quality assurance
 - UTM by centre of quarter section in most cases
 - Search engine in place
 - Data retrieval a problem (e.g. township and range vs. river lots)
 - Log info
 - Location
 - Dates
 - Use
 - Driller
 - Stratigraphy
 - Completion
 - Basic pump test
 - Remarks

- HyDATA
 - Temporal database
 - Water level
 - Temperature
 - Chemistry
 - Also has surface water and meteorological data
- Manual entry for GWDrill
- Analogy records manually entered, transducers imported
- Many limitations for GWDrill
 - Location
 - Non-uniform descriptors
 - Entry errors
 - Text conversion errors
 - Limited search capabilities
 - Currently Oracle database
 - Additional data as text
 - Designed as data storage system
- Currently ~600 monitoring wells, rain gages and soil moisture tubes in Manitoba
 - Most concentrated in certain areas
- Chemistry
 - Scheduled for select wells
 - Single or occasional analyses for others
- Most wells have Stevens recorders
- Currently checking reliability of transducers
- Initiatives
 - Maintenance
 - Expansion?
 - Specific quality initiatives
 - Agricultural
 - Rural
 - Specific aquifer management
 - Drinking water office
 - Well inspectors

Q: What is the basis for locating wells?

GP: New wells installed for various projects or to monitor usage.

MW: Lab chemistry can be imported but must it be matched to the well manually?

GP: Yes, a technician must do this.

Dajana Grgic (DG), from Ontario Ministry of the Environment

- Program overview
 - Network is a partnership between 38 conservation authorities and 10 municipalities
 - Information on ambient groundwater levels and quality
 - 360 monitoring wells
 - Central data management system
 - Signed agreement with conservation authorities
 - Review of existing information

- Review of hydrogeologic mapping
- Monitoring area / well selection examined
- Well assessments performed
- Instrumentation
 - Level loggers
 - Barometric loggers
- Quality parameters for initial monitoring established
- Both manual and satellite systems
- Quality assurance
 - Data correction
 - Well construction standards
- Interested in:
 - Water budgets
 - Drought response
 - Cumulative impacts
 - Environmental assessments
 - Source management

Q: Is access to the database restricted?

DG: Access currently restricted but will be available in the future.

BB: Why is cooperation required given that the province owns the water ?

DG: Network is a watershed based and province wide and it would be too much commitment for the province to handle the establishment/ enhancement and maintenance of the network requirements.

MW: Did Ontario used to have a monitoring network?

DG: Yes, a network of monitoring wells existed in Ontario between 1946 and 1979.

GVK: What is the plan for rain gauges?

DG: Raingauge network to be established within the existing monitoring network to obtain the info on the local precipitation in the areas where groundwater interacts with surface water. Information collected to complement to the stream gauge network information.

BB: Does the initial analysis include pesticides?

DG: Yes and the initial analysis will be used to determine long-term monitoring locations.

Pat Lapcevic (PL), from Grand River Conservation Authority, Ontario

- Grand River is the largest river in southern Ontario
 - 93% rural land use within the watershed
- Conservation authority is for watershed amangement
- 60% of water comes from bedrock aquifers
- 70% of municipal water supply is groundwater
- 50000 L/d is cutoff for licensing
 - ~900 users in the watershed
 - Agricultural
 - Industrial/commercial
 - Remediation (e.g. pump and treat)
- Groundwater is important to ~60% of streams in the area
 - Ecological impacts
 - Economic impacts (e.g. fishing)

- Objectives
 - Response to stresses
 - Quality trends
 - Data for models
 - Conditions in regional aquifers and shallow flow systems (surface water interactions)
- Network in development stage
- Drilling program planned
- Telemetric systems
 - Measure water level and temperature continuously
- Quality
 - All monitoring wells sampled at least once
- Lots of other monitoring programs
 - RM of Waterloo has 100's of monitoring wells
 - Private monitoring for environmental impacts
- Challenges
 - Insufficient number of monitoring wells
 - Quality vs. quantity of data
 - Approach to situate wells
 - Resources (capital and operation)
 - Integration of networks

BB: Is there a central database for all programs in Ontario?

PL: MOE has quality. Aggregate industry monitors for compliance. Water bottlers must have groundwater level records. Pumping information comes from municipalities. There is no central database.

BB: Is there no more a longer-term groundwater level monitoring? From the 1960's?

PL: The province stopped in the early 1990's. 30 years of records are in London, showing where old monitoring wells exist but these are not currently used. Andrew Piggot has done some work estimating water levels in the gaps.

Q: Is there sufficient data to establish whether there are different heads at different depths?

PL: This is dependent on hydrogeology.

Comment(CB): Problems encountered in Ontario will be an indicator of what may happen in the rest of Canada in the future.

Michel Ouellet (MO), from Minsitère de l'Environnement, Québec

- Quebec Environment began monitoring groundwater in selected locations in the 1960s
 - Project and site specific problem driven
- Watershed inventory program in the 1970s
- Monitoring frequency was sparse and for only short periods of time in some cases
- Number of observation wells peaked at about 200 but monitoring ceased in 1984
- Majority of wells handed over to local authorities
- Hydrogeologic mapping in 2 regions in 1996 resulted in the installation of 15 new wells
- In 2000, 12 monitoring wells were installed at the Mercier site

- 27 current wells
- Two engagements
 - 1. Inventory of major aquifers
 - 2. Expand monitoring well network

Q: To monitor hydraulic connections with the Chateaugay River, how many locations were measured?

MO: We need more measurements. The convergence to one monitoring well was noted and this well was the only one to show this response to the river. Other wells showed responses typical of deeper wells.

Q: Are there municipal networks?

MO: Yes, but these are small and mainly concerned with specific contaminants.

GVK: The old records are very important and should be saved.

MO: This data has been saved in many cases.

Comment (AR): The regulations in Quebec are available at this workshop.

Daryl Pupek (DP), from New Brunswick Science and Reporting Branch

- Air and water monitoring is done by Science and Reporting Branch
 - Includes water science
- 1978-1992: 30 original sites for water levels
- 1992-2001: no data
- 2001-2002: 4 new sites established
- 10 New Brunswick sites, 2 USGS sites and 1 independent site
- Data capture in real time
- All new wells require chemical samples
- Municipal well sampling program has ~2500 new wells per year
- 6 new water officers
- Potential uses of time series data outlined
- Water quantity website
 - Hydrographs
 - Link to water survey of Canada
 - Streamflow data

Discussion:

YJ: Are the hydrometeorologic stations operated by regional or national government?

DP: It is a federal-provincial partnership.

Q: Can data be exchanged from the website?

DP: In some cases.

Q: What about the USGS wells?

DP: They belong to the State of Maine and there is only a loose agreement, but exchange of data has occurred through the web.

John Drage (JD), from Env. & Labor, Nova Scotia

- NSDEL is the lead Department in Nova Scotia
- Responsibilities
 - Ensure appropriate management
 - Allocation of water
 - Public education
 - Mandate does not specifically mention groundwater monitoring
- Groundwater monitoring
 - Levels since 1965
 - Up to 40 wells
 - Little chemistry data
 - Stevens recorders at first but replaced with data loggers during 1990's
 - Only published report of groundwater levels in 1984
 - Now only 11 monitoring wells
 - Gaps in the data
 - 3 new monitoring wells planned
 - telemetric
 - record every 4 hours, download weekly
- Groundwater quality data
 - No dedicated monitoring network
 - Case by case basis
 - Databases maintained by municipal supplies
 - Data is biased because of case by case basis of collection
- Current quality programs
 - Annual nitrate monitoring program (~ 150 wells)
 - Radionuclides program (181 schools)
 - Digital/GIS database
- Other data
 - Pump test database (700 tests in spreadsheet format)
 - Well log database (~ 93000 logs from 1940-2002 in MS Access)
 - Regional groundwater resource studies
 - Cover about 50% of province
 - Results published in reports
 - Recent groundwater studies
 - GSC Carboniferous basin
 - GSC Annapolis Valley
- Management
 - Well construction regulations
 - Allocation approval needed for users greater than 23000 L/d
 - Application, interference and saltwater intrusion considered
 - Public drinking water systems must have chemistry tested every 2 years
 - Municipal water supplies must go through approvals renewal process

Discussion:

MW: Are pump tests required for 72 hours?

JD: Only for industrial wells. Others need a capacity test.

Q: What about non-domestic users below 23000 L/d?

JD: They are required, but some variance is allowed.

Yefang Jiang (YJ), from PEI Fisheries, Aquaculture and Environment

- FAE oversees groundwater in PEI
- 13 long-term monitoring wells with transducers
- Network is integrated with hydrometric and water quality monitoring
- Monitoring is concentrated in index basins
- Monitoring wells
 - Depths between 15 and 36 metres
 - Ages from 2 to 40 years
 - 4 water levels and temperatures per day
- Major characteristics of water level regime
 - Rapid response to recharge stress
 - Spring is major recharge time
 - Recession in summer and fall
 - Second recharge in October and November
 - No long-term trend
- Groundwater for 100% of drinking water
- Quality affected by geology and land-use
- 5 permanent quality stations plus 13 municipal wells
- ~ 3000 samples from private wells per year, mainly inorganic chemistry
- key issues
 - Nitrate
 - Saltwater intrusion
 - Metals
 - Pesticides
- Targeted sampling for specific contaminants
- Heavy reliance on data from private wells
- Pros:
 - Sample density
 - Reduced effort and cost
- Cons:
 - Time series analysis not possible
 - Poor georeferencing
- 20 years of pesticide monitoring
 - related to fish kills
- Extraction permits required for well with pumping rate of greater than 4 L/s
 - Maximum instantaneous rates, does not account for seasonal variations
- Key issues
 - Extraction
 - Well field protection
 - Nitrate
 - Pesticides
 - Climate change

Discussion :

BB: Why is temperature important?

YJ: It is simply a capability of our equipment.

BB: Are there barium issues in PEI?

YJ: Barium concentrations were found close to drinking water guidelines in some samples. We are considering add Barium as a tested compound in routine chemical analysis.

MW: What are the impacts when streamflow is depleted? Do water levels go down?

YJ: Significant stream flow reductions were observed in some intensively developed basins. More data are required to assess the impacts on fish populations. Only wells adjacent to intensively pumping areas have experience low heads

RG: Are monitoring wells integrated with hydrometric stations?

YJ: Monitoring wells are integrated with hydrometric stations in the index basins. Establishing index basins in PEI is a federal-provincial partnership.

2.5 Review of federal involvement and interest

Alfonso Rivera presents a perspective from a Federal Department (NRCan) point of view. He reviews current interest of federal involvement on groundwater monitoring. The highlights of his talk are:

- National inventory and monitoring networks are linked
- Specific scientific research (fractured media, surface water interaction, etc.)
- Accessibility to information
- Training and accreditation
- Relevance use of data from observation wells
- Why are data from monitoring wells useful?
 - To derive hydrogeologic parameters (K , S_y , S_s , f)
 - To assess groundwater flow and direction
 - To assess groundwater storage
 - To assess aquifer recharge
 - To evaluate the effects of groundwater pumping
 - To calibrate numerical models
 - To assess climate changes
 - To assess linkages on weather conditions and stream discharge interactions
 - To establish groundwater baseline quality
 - To assess GW quality deterioration
 - For forecasting
- Groundwater sustains surface water supplies and ecosystems
- Frequency of measurements should be dependent on aquifer conditions
 - The frequency of measurement is one of the most important considerations in the design of a water-level monitoring program.
 - The development of a plan for water-level monitoring in a network is dependent on the objectives of the program and the intended use and level of analysis required of the data
 - The frequency of measurement should be adequate to detect short-term and seasonal GW-level fluctuations of interest and to discriminate between the effects of short and long-term hydrologic stresses.

- Interest in monitoring currently exists in Canada
 - The MSC – Water Quantity, St-John’s Oct. 8, 2002: Groundwater was brought up to the table by participants.
 - The MSC Water Survey Branch: National Hydrometric Program Administrator’s Meeting in Yellowknife, Oct. 6-8, 2003: Groundwater is in their agenda as a full issue to discuss.
 - NRCan (GSC/GC) Groundwater Program (2003+-2006): Regional assessments, National GW Database, and GW Monitoring.
- GSC maintains many monitoring wells across Canada, associated with various projects
- Applications of data
 - Trends in precipitation
 - Recharge
 - Etc.

2.6 Other Initiatives (CCME)

Allan Crowe (AC), from Environment Canada presents complementary initiatives conducted by the CCME (Canadian Council of Ministers of Environment).

- CCME recognizes that the protection of surface and groundwater quality is a priority of all jurisdictions
- In May of 2001, CCME Ministers agreed to link existing federal, provincial and territorial water quality monitoring networks to ensure Canadians have access to comprehensive information
- Need to promote Canada-wide consistencies in water quality monitoring and reporting
- CCME experts workshop held: “Linking water science to policy” workshops
 - statements and reports on various issues
- Current picture
 - Fragmented programs
 - Coverage of key issues and stresses deficient
 - Limited synthesis of an integrated Canada-wide picture
- CCME created an action plan
 - Subgroups created (**CCME Water Quality Monitoring Subgroup**)
 - Canada-wide inventory to be created
 - Global review of techniques
 - Framework for monitoring
- No distinction between surface and groundwater
- Web-based Canada-Wide Water Quality Data Reference Network created
 - search engine, data summaries, GIS-based mapping, statistical analyses
 - Initiative led by Environment Canada (NWRI)
 - inclusive of all water quality monitoring activities
 - currently only surface water; but groundwater is being added to system
 - all partners maintain their own databases (no central database)
 - partners release all information or selected data
 - Summaries will be available to public (not yet for public release)

- Hydat
 - Website has river stations available
 - Joint federal-provincial agreement for data sharing

Q: Is water from taps and surface water the only data available?

A(AC): Only surface water is currently available.

Q(SG): What data will be available or information will be made available to the public?

A(AC): Only summaries and contacts will be available.

3.0 Discussion by breakout groups

Five questions were designed to encourage discussion among the attendees, and to seek a degree of consensus on the issue of monitoring networks. Five groups were formed and each group discussed each question independently in breakout sessions.

3.1 Question analyzed

QUESTION 1

Can we sketch a plan to establish an interconnected network of networks for groundwater monitoring?

- Discuss the pros and cons, the legal aspects, the possibilities of sharing monitoring data with Canada
- Discuss the idea of making data accessible to the public at large...

QUESTION 2

What are the most practical mechanisms to collect, store and share groundwater monitoring data?

- Discuss and make suggestions based on your experience...
- Discuss and suggest an "ideal" situation...

QUESTION 3

What would be the objectives (and interests) of a Canadian network? How would such a network be established and who should/could fund it?

QUESTION 4

If a position paper is prepared and is ready by the time of the Québec City workshop in October 2004, what would you suggest that the overall content be?

- Who could prepare this position paper?
- Make suggestions...

QUESTION 5

How do you see the role (if any) of federal departments (EC, NRCan, AAFC) in the development of groundwater monitoring programs in support of regional groundwater assessments?

Examples that could be analyzed:

- Expand the federal/provincial hydrographic agreement to include groundwater monitoring...
- A new, more groundwater-focused agreement?
- As an element of the current CCME's "Source-to-Tap" water protection agenda?
- Others?

3.2 Overview of breakout groups discussions

Question 1: reported by John Falhman (JF).

- Would it be a connection platform or would it comprise interpreted data?
- Identify users
- No problem with sharing data as long as there is no cost
- With regards to the public at large, privacy legislation may apply, data would need to be explained. Maybe safer to redirect to the data provider
- Who is this for?

- National users.
- What are the pros, cons and legality of sharing data?
 - OK as long as it doesn't cost the provinces anything.
 - What is in it for the provinces?
- Should data be available to the public?
 - Privacy issues to be addressed
 - Need to have a disclaimer

AR: Do you mean what is your benefit as a province?

JF: Yes. None. What do I care about Newfoundland's data?

Question 2: reported by Mike Wei (MW)

- Partnership with local groups is important.
- The role of the federal government could be to provide assistance regarding monitoring in remote areas, where there are no monitoring sites.
- Provincial and federal participants should establish minimum guidelines.
- Provinces should store and maintain the data. The data could be shared with partners. Summary data could be distributed to the public at large.
- Sharing of data on groundwater levels is less sensitive than quality. Groundwater quality data are more difficult to share because they are more sensitive to the public.
- Must identify benefits for all provinces in sharing data. Sharing with all provinces is not a need as such, a clear objective must be set. Climate Change for example, to provide justification for sharing.
- An index of aquifers (such as in PEI) is a great idea.
- Issue of cost of getting hydrologic data from the federal government
- Why do hydrographs need to be shared?
 - Climate change?
 - Important for federal government to know what is happening
 - Create index aquifers
 - Encourage periodic meetings

Question 3: reported by Richard Fernandes (RF)

- Must identify benefits for all provinces in sharing data. For the federal, one benefit would be to address transboundary aquifers and surface watershed aquifers.
- Must address issues related to consistency, standards, efficiency, coverage and identification of major aquifers.
- Nation-building initiative.
- Funding: Needs more equipment and sites to facilitate consistency. The federal should pay because they want it.
- Issue of jurisdiction
 - Transprovincial aquifers
 - Surface water-aquifer interactions
 - Consistency and efficiency
- Nation building

- Coverage
 - Identify major aquifers and subdivide by subbasin
 - Boundaries of major aquifers?
- Start with water levels (most basic)
- Funding
 - Equipment from federal government (they are the ones who want the data)
 - Provinces get the benefit
- Should they provide maintenance and funding?

Question 4: reported by Miroslav Nastev (MN)

- The introduction or preamble should state that this initiative is an issue of will, not money.
- Chapter 1 should present the current state of networks in the provinces.
- Chapter 2 should define the federal/provincial relationship.
- Address cost-sharing, mention the effort to establish and maintain the network.
- Technical questions addressed in the position paper:
 - What should be measured (minimal information). Standards of data collection (frequency, format)
 - Which data could be made available (quantity, quality). Questions relative to the legality of data, disclaimer with regards to ownership of the data, in what context should it be used.
 - Raw data should be distributed on websites. Interpreted data for a second phase.
- NRCan should coordinate the preparation of the position paper with input from the provinces, universities, private sector.
- The objectives of the position paper would be to provide guidelines and standards concerning a network of networks

Discussion:

Q: Should Environment Canada be involved?

AR: Sleep on it.

AC: Two issues here, quantity and quality. NRCan has the federal lead w.r.t. to groundwater quantity; Environment Canada has the federal lead w.r.t. groundwater quality.

AR: If a position paper is presented, NRCan could do this in coordination with the provinces. NRCan and Environment Canada need input.

CB: Provincial sign-off would be difficult.

Question 5: reported by Pat Lapcevic (PL)

- Only provincial people in this discussion group
- Federal government could fund instrumentation or provide research funding. The role of the federal government is to fund components of the network.
- Assess the interest of provinces to access data from other provinces
- What accessibility of data is necessary? Is it necessary for provinces to see each others data?

Discussion:

AR: Most federal departments are involved with the provinces already. NRCan has an excellent relationship with many of the provinces. This provides a reference for collaboration. We leave GSC wells for the provinces and cost sharing has occurred for monitoring. GSC has good working agreements with PEI, Quebec and BC.

DAY 2

4.0 Additional Plenary Discussion from Day 1

AR makes a synthesis of discussions from Day 1:

- Provinces reorganizing monitoring well networks
- Monitoring groundwater levels and quality are both important
- Some regulations and strategies are in place or are being planned
- Some agreements between different levels of government (e.g., Ontario)
- The watershed-scale approach seems to be the preferred approach in some provinces
- Majority of monitoring wells are west of Ontario, eastern Canada currently reacting
- There are between 1500 and 2000 observation wells in the whole of Canada
- Comparisons with other countries are relative
- At least 3 federal departments interested in groundwater monitoring; we heard from NRCan (GSC), AAFC and EC (CCME)
- GSC installs monitoring wells as an element of regional-scale assessments and then turn them over to the province where the assessment takes place
- No agreement but there is cooperation between the federal government and provinces
- The 18 jurisdictions on the Hydrometric Agreement are considering Groundwater monitoring for the first time since 1975
- Discussed specific questions
- 5 objectives outlined by HM

Detailed discussion on the themes of DAY 1:

AC: What is the objective of the position paper?

AR: Information is basic. I believe that in order to plan something we need to know where we are. A position paper could help with this. I prefer monitoring for long-term and regional assessment. The purpose of the paper is to have information and know current status of monitoring.

Q: Do we need a paper? Based on the response of this workshop should we be writing a paper yet?

PFRA: There has to be thought given to other federal departments. We must seek input from these other departments because there may be further sources of funding and they may be able to breathe more life into this project.

Q: The position paper is part of this process but what is it for?

RG: The paper is to influence the governments and to encourage more monitoring and establish why we monitor. The issue of sustainability must be addressed.

Q: What is the purpose of data sharing?

Q (CB): What about CCME?

AC: CCME may wish to share groundwater information but they may not. We are unsure. Their Canada-Wide Water Quality Data Referencing System is set up to handle quality information for any kind of water, including groundwater.

MW: We are here as provinces because of the national focus. Provinces already monitor so why am I here? It has been suggested that we are working towards a network of networks, a national focus.

PFRA: National focus is important. We are living in a global environment. Agriculture is dependent on groundwater in every province. This is part of the big picture.

DP: New Brunswick has more interaction with the federal government. The hydrometric agreement has worked towards a goal of measuring surface water flow and levels. The NAPS agreement to provide air quality monitoring is in place. The CCME initiative to talk to the minister of the environment about the need for Canadians to know water quality and water quality indexing is beginning. The GSC does regional aquifer assessments. Index basins is in place in PEI and BC has an inventory and classification system for aquifers. Ontario has water authorities. The GSC has a process of negotiating cooperation with the provinces on various levels. NRCan and Environment Canada have an agreement over quantity and quality. AgCanada and PFRA have a national water expansion plan than New Brunswick has already tapped into. The horse has left the barn already and we are left in a catch-up phase. Monitoring is part of everybody's strategy and we need to get back to a level playing field. Confusion exists.

AR: Groundwater monitoring is an element of many things. This workshop's objective is to figure out where we are. We want to plan for the future.

DP: There seems to be some scarcity in getting involved with groundwater monitoring.

CB: Forestry has data sharing and this may serve as a useful model.

YJ: Monitoring wells for regional assessment, models, and contaminants, this should be the focus of the position paper. We should also look to the USGS for examples.

AR: Perhaps we need a primer for the objective paper. NRCan recognizes the value of a model but the model must be validated. The position paper is a status paper but not a political document. StatsCan wants to know the status of groundwater.

5.0 Towards a National Groundwater Database

Eric Boisvert (EB), from NRCan makes a presentation on the National Groundwater Database (NGDB), in development in the scope of a project under the ESS Groundwater Program. The NGWD is accessible at: <http://www.gscq.nrcan.gc.ca/BDNES-NGWD>.

Summary of EB's presentation

- The objective of the national groundwater database is to define a series of web services, i.e., to build an architecture and a way to access databases in the provinces.
- The best location for data is near the people collecting and managing them, in this case, the provinces.
- Provinces have various techniques and data standards that must be reconciled.
- The national GW database is not a centralized database but an architecture that allows to extract information from a collection of databases.
- The technology already exists and is known collectively as Web Services. This technology is also supported by larger national initiatives such as CGDI and GeoConnections.
- To make this work, we need to agree on a set of standards to support groundwater data. Ground work has already been done in 1991 by a federal-provincial working group (Gilliland, 1990).
- The Gilliland report (1990) is accessible through the web site of the NGWD. Must be validated in order to provide definition standards used for communication.
- Prototypes are being developed with the provinces of Quebec and Ontario.

Discussion that followed the presentation:

- Trying to create a paradigm shift
- Objective: to define a database and identify it as a required product
- Output
 - A national database architecture
 - An improved decision making
- Workplan already created
- Questionnaires
 - Acquire metrics
 - Small, focused to professors and scientists
 - Discussion on
 - “Please do not tell me what a database is”
- Results
 - Important themes
 - Level of integration
 - State of data
- Data management
 - Scattered
 - Many jurisdictions
 - Many forms and formats
- This project was subject to many drivers and sections (internal and external to NRCan)

- Principles
 - Data is best kept near its source
 - Data creator/owner is best to decide what to make available
 - Provinces have better expertise over area and jurisdiction
- Best option is an interoperable database
- Paradigm shift
 - Let's not agree on how data is stored, let's agree on how it is exchanged (service paradigm)
- Must agree on parameters
- Need standards (e.g. Gilliland, 1990)
- Address information we already have
- Proposed architecture
 - Common format for data between provinces and federal government
- Use XML
 - Uses webserver
 - Don't require hole in firewall
- Prototypes with Quebec, Paskapoo project in Alberta
- Service documentation
 - Can opt out nodes
 - Need some other test for prototypes
 - Other issues
 - Using and publishing modified data
 - Branding
 - Validating themes
 - Establish access rules

Q: All data will remain in their jurisdiction. Will I have to specify how the central database retrieves it?

EB: No.

MO: The standards are communication standards?

EB: It is no more difficult than making a webpage.

RG: Provincial databases aren't the same and get updated from time to time. How would XML support this?

EB: The code would need to be re-programmed but the amount is small.

MW: Who changes the code.

EB: I can provide much of this code. It is generally not difficult due to similarities between databases.

DP: The plan is to link the database but this can't be published and we don't want to make changes in the database.

EB: The database is only read and transmitted to the web.

GP: What about translation to standardize terminology?

EB: This is a science issue and is quite painful. We are working on defining a common language between Canada and the USA and we will be implementing this with time.

6.0 Wrap-up

The remaining of the second-day session was dedicated to a plenary discussion. Verbatim is reproduced below and comments are summarized thematically.

AR: The idea of the database is agreed upon (as presented by EB). The CD with the talks has been prepared and this in addition to HM's report. This is good, but we would like to have a summary perhaps based on HM's report with input from the presentations.

AC: Will HM's report be available on the web?

HM: No, but I can get it to you if you like. After 1 more round of reviews with the provinces the report will be done.

AR: We can't have a network of networks until some issues are resolved. Who? These networks already exist but it could be said that this is a requirement of the federal government and not the provinces. Some federal departments have good relations with the provinces and others don't. Some federal departments don't talk to each other. The federal government is to arrange whether or not something is to be done. The position paper must be done but the objectives must be defined. It should be a recommendation and not a mandate. NRCan could do this in cooperation with other departments but 12 months is not sufficient. I will open these points to discussion and let's decide what's next.

AC: I'm impressed with the amount of information available of the provinces websites. Could we put a link to this?

Comment: The network of networks is not in the form of a central database but links are OK as per Eric Boisvert's idea.

AC: I am only suggesting that we provide links to other agencies.

AR: Eric referred to this as a pointer.

RG: This could also list available datasets, an inventory of groundwater datasets and how to obtain this data.

MW: I think it should go beyond pointers because we need a national framework/context. Otherwise, why are we meeting here?

Comment: We have to be clear. We need to give a message to managers and budgets. It is nation building and knowing what we have. There are about 8 initiatives here and we need to make ourselves understood. We may need a position paper to make our argument. We should capitalize on our spokesman with NRCan.

PFRA: Information is the first point of knowledge management. More than a network of information, this gives us the portal to go forward to manage our resources.

MO: We need to identify which information is needed for quality and quantity. What are the basic data needed?

Comment: Assets that lie in this room are the expertise. We need to share this understanding to address the gap between science and policy. This could create coherence on how to deal with important issues. Eric's idea could work for peer to peer information sharing.

MW: We are riding a wave right now but this could drop. Linking the provincial monitoring networks to national initiatives and objectives can strengthen the mandate of the networks during hard times and minimize the risk of those networks being cut altogether.

AR: We need an executive document to appear as a coherent nation. We need to get a sense of nation building. We knew about knowledge gaps but recognized that no single agency could fill those gaps. The framework document isn't a policy document, just ideas. We are making this work, some provinces are following these ideas. The 1961 GSC report on groundwater is the only national reference with an overall vision. By 2006, NRCan will publish a report based on GSC projects since 1995-1996.

PFRA: We need to work through a 3rd part. It is difficult to get funds from another federal department.

MN: Do we have an exit strategy?

AR: We need to create confidence and trust. Do we need another meeting at Quebec 2004?

RG: It would be useful if we were working towards something.

JC: Should we lay out some ideas and options?

PFRA: Should we engage a smaller number of individuals from this group rather than a 3rd party?

AR: Who do you have in mind for a 3rd party?

PFRA: I'd rather not say.

AR: NRCan has interest in this. Clear actions are in place for long-term research, such as climate change and calibration of models.

MO: We need to discuss and identify minimum data requirements and how to obtain them in the position paper. NRCan must assist in building these techniques and infrastructure.

AR: We will spend time and money until March 31 and move forward with phone calls, emails, etc.

(PFRA rep): We can make desirability of participation easier by including multiple objectives. High stewardship issues are good but sidebar stories may help generate interest and let the reader learn about groundwater.

HM: We can start right now. Who will volunteer for the smaller group. We need 3 or 4, just something to keep momentum going.

Comment: We need a leader. I could volunteer but I am very busy. Someone must lead.

HM: We have a leader.

AR: I'm ready to work but not necessarily lead. We need a time frame. Give us a few weeks and let us digest and get the minutes together. The timeline is to get an outline by March. The network of networks remains an open question.

MW: You might have to budget to bring people together. Should this be for input rather than writing? The group should be larger than 4-5 people.

AC: The position paper will require advisors from all jurisdictions.

RG: We need to do work prior to that meeting.

On the Position paper:

- Need to clarify the objectives of the paper. There is a consensus that the paper would be prepared to influence decision makers, which could lead to more funding for more monitoring, would present what we are doing monitoring for, with examples from on-going accomplishments and successful stories on the importance of groundwater, would present the national focus that brought all the provinces to this workshop, convince the political, economic and technical decision makers that we need a national focus, demonstrate the global context, address the gaps between science and policy. It should be a summary document that sets the basis for the future. Should pose problems. Identify the level of information (minimal datasets). To be prepared and used as a primer.
- Information is basic to provide a sense of where we are and what we have (compilation). A nation-building initiative. The provinces didn't show high enthusiasm for a national network (after all, they seemed to be less interested in groundwater conditions in other provinces, as one participant put it "I have enough problems in my province"). The sense was that we need a vision and a message that "CANADA needs a network and that network has both provincial and national benefit, to be successfully and effectively sold to the provinces; and when the provinces can see themselves in this, it will happen". Issues like monitoring to assess climate change, SOE reporting for CANADA might help provinces cooperate with NRCan in this initiative. Information is the first point of knowledge management. Knowledge is crucial to do a better job at what we do.
- Not realistic to expect to have the paper in 12 months. However, the Groundwater program could provide funding to support its preparation, based on the conclusions from this workshop and Harm Maathuis' compilation.
- NRCan should coordinate the effort and involve other federal departments.
- Should comprise a discussion an a series of steps for implementation.
- Should we identify a contractor to produce the discussion paper or should the GSC funds be used for several individuals present to the workshop to get together.

On the GW monitoring Network of networks:

- Do not develop this concept until clear objectives are provided and targeted users are identified.
- Networks already exist, but a national initiative may help save existing networks in the provinces.
- The network of networks is a federal priority. EC, RNCAN and AAFC already have initiatives individually.
- Provinces are already rejuvenating their own networks. It is now up to federal departments to coordinate their efforts to work with the provinces to establish a nation-wide network.

On the National Groundwater Database:

Should go beyond pointers and bring sharing of data to another level – in the national context.

AC: Thanks NRCAN for hosting this event.

AR acknowledges it and closes meeting.

7.0 Next steps

- Prepare and distribute minutes by November 15, 2003.
 - **ACTION** : Alfonso Rivera
- Reply to Harm Maathuis to provide missing information.
 - **ACTION**: Provinces that haven't yet sent the information to Harm
- Comment on the Gilliland report.
 - **ACTION** : Provinces
- By March 31, 2004: define the outline of the position paper, provide clear objectives
 - **ACTION**: Alfonso Rivera and Yves Michaud

References

Gilliland, John, 1990. *Background on a Canadian Groundwater Strategy*: unpublished report, Environment Canada, Conservation and Protection Division, National Hydrology Research Institute, Saskatoon, Saskatchewan, 98 p.

Rivera, A., Crowe, A., Kohut, A., Rudolph, D., Baker, C., Pupek, D., Shaheen, N., Lewis, M., and Parks, K., 2003. Canadian Framework For Collaboration on Groundwater. Government of Canada, 60 p. also accessible on the Internet at: <http://www.cgg-qgc.ca/cgsi>.

APPENDIX A: Workshop Agenda

Thursday, October 2, 2003

- 08:00-08:15 **Welcome and introduction**
Alfonso Rivera, GSC
- 08:15-08:45 **Official Launching of the Canadian Framework for Collaboration on Groundwater**,
Cam Baker (OGS)
- 08:45-09:05 **Current groundwater level observation well networks in Canada**
Harm Maathuis, SRC, Saskatchewan
- 09:05-09:20 **British Columbia**
Mike Wei
- 09:20-09:35 **Alberta**
Robert George, Alberta Environment
- 09:35-09:50 **Saskatchewan**
Harm Maathuis, Saskatchewan Research Council
- 09:50-10:05 **Manitoba**
Graham Phipps, Water Branch
- 10:05-10:30 **COFFEE BREAK**
- Ontario**
10:30-10:45 Dajana Grgic (OME, ON)
10:45-11:00 Pat Lapcevic (CAGR, ON)
- Quebec**
11:00-11:15 Michel Ouellet, Ministère de l'Environnement du Québec
- New Brunswick**
11:15-11:30 Darryl Pupek, Dept. of Environment and Local Government
- Nova Scotia**
11:30-11:45 John Drage, Nova Scotia Department of Environment and Labour
- Prince Edwards Island**
11:45-12:00 Jiang Yefang, Dept. F. A. & E., Watershed Management Section
- 12:00-13:30 **LUNCH**
- 13:30-13:50 **Review of federal involvement and interest in establishing a national groundwater monitoring network**
Alfonso Rivera, GSC
- 13:50-14:10 **Other complementary initiatives (i.e., CCME)**
Allan Crowe, Environnement Canada
- 14:10-15:00 **First series of plenary Discussion -sharing**
All
- 15:00-15:30 **COFFEE BREAK**
- 15:30-16:30 **Discussion: Towards a national network of networks**
Break into self-managed discussion groups
- 16:30-17:30 **Share learnings from discussion groups and wrap-up of the day**

Friday, October 3, 2003

- 08:00-09:00 **Discussion: Towards a national Groundwater Database**
Éric Boisvert, GSC-Quebec
- 09:00-10:00 **Summary of discussions**
Plenary discussion
- 10:00-10:30 **COFFEE BREAK**
- 10:30-12:00 **Next steps / Wrap-up**
Plenary discussion
- 12:00-13:00 **LUNCH**

End of Workshop

APPENDIX B: Lists of Participants

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