

# CANADA - NEWFOUNDLAND AND LABRADOR AGREEMENT FOR THE NATIONAL WATER SUPPLY EXPANSION PROGRAM



## Final Report Real Time Groundwater Level and Water Quality Monitoring of Farming Areas April 2008

**Government of  
Newfoundland and Labrador**

**Near Real Time Groundwater Levels and Water  
Quality of Farming Areas  
in Newfoundland and Labrador**

**Water Resources Management Division  
Department of Environment and Conservation  
April 2008**

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- A Agri-Food Water Quality Index Help Manual
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## Executive Summary

The Department of Environment and Conservation, Water Resources Management Division was successful in obtaining funding under the *Canada – Newfoundland and Labrador Water Supply Expansion Program* administered by Agriculture and Agri-Food Canada.

The contribution agreement, Real Time Groundwater Level and Water Quality Monitoring of Farming Areas, consisted of:

- construction of an observation well in Cormack.
- construction of two observation well huts.
- installation of near real time groundwater monitoring equipment in observation wells at four farming areas in the province located at Brookfield Road near St. John's, Winterland, Wooddale, and Cormack.
- design a water quality index calculator where the groundwater quality in each area can be rated for its suitability for farming purposes.
- provide a web site with information to be accessible to farmers and the general public.
- generation of a report.

All work originally required under the agreement has been done.

### **Acknowledgements**

This project could not have been completed without the involvement of the following people who worked diligently to achieve a successful outcome. Firstly, the Head of Hydrometrics, Environment Canada, Mr. **Howie Wills** was instrumental in setting up the satellite equipment for use before deployment in the field. He also allowed us satellite time on Environment Canada's allotted system time. Howie was a tremendous help in testing equipment before it went in the field. He provided guidance to us any time we needed it.

Those persons who worked on this agreement from Water Resources Management Division, Government of Newfoundland and Labrador were:

**Keith Guzzwell**, Groundwater Resources Manager, provided overall direction for the agreement, tendered the equipment, handled the purse strings, helped with instrument and hut installation, and wrote the final report.

**Bob Lethbridge**, Environmental Scientist, organized the building and installation of the observation well huts, helped supervise the Cormack well construction, was the lead person installing the instrumentation and made sure all the necessary tools and equipment were taken into the field to complete the work.

**Dr. Amir Ali Khan**, Water Resources Management Engineer, designed the agri-food water quality index (AFWQI) for farming areas by adapting an existing drinking water quality index. He supervised the contractual person in the number crunching of the water quality index.

**Kyla Brake**, contractual employee, searched for information on the topic of agriculture water quality index and did the number crushing in adapting the drinking water quality index to be used for agricultural purposes.

**Shibly Rahman**, Water Resources Technician, adapted the water quality index help manual for agricultural purposes, provided guidance to the contractual employee, and modified and tested the calculator to agree with AFWQI.

## 1.0 Overview

The Department of Environment and Conservation, Water Resources Management Division, Government of Newfoundland and Labrador was successful in obtaining a contribution agreement under the *Canada–Newfoundland and Labrador Agreement for the National Water Supply Expansion Program*. The agreement, titled Real Time Groundwater Level and Water Quality Monitoring of Farming Areas, provided for:

- drilling of an observation well at Cormack
- the purchase and installation of groundwater monitoring equipment in four observation wells situated at Brookfield Road, Winterland, Wooddale, and Cormack
- purchase and installation of satellite equipment including a logger, transmitter, and antenna at the four sites
- construction and installation of two observation huts at Brookfield Road and Cormack (provincially funded)
- creation of a water quality index calculator and web site showing real time water levels, groundwater quality data, and the water quality index.

## 2.0 Need for Project

The majority of farms in Newfoundland and Labrador obtain their agricultural water from groundwater sources. Real time water quality testing and water table measurement provide farmers and water resources managers with the information necessary to predict drought and low flow conditions to streams and rivers in areas which are fed in part by groundwater. This long term groundwater level reporting and testing program notifies farmers and regulators of impending water shortages and groundwater quality problems.

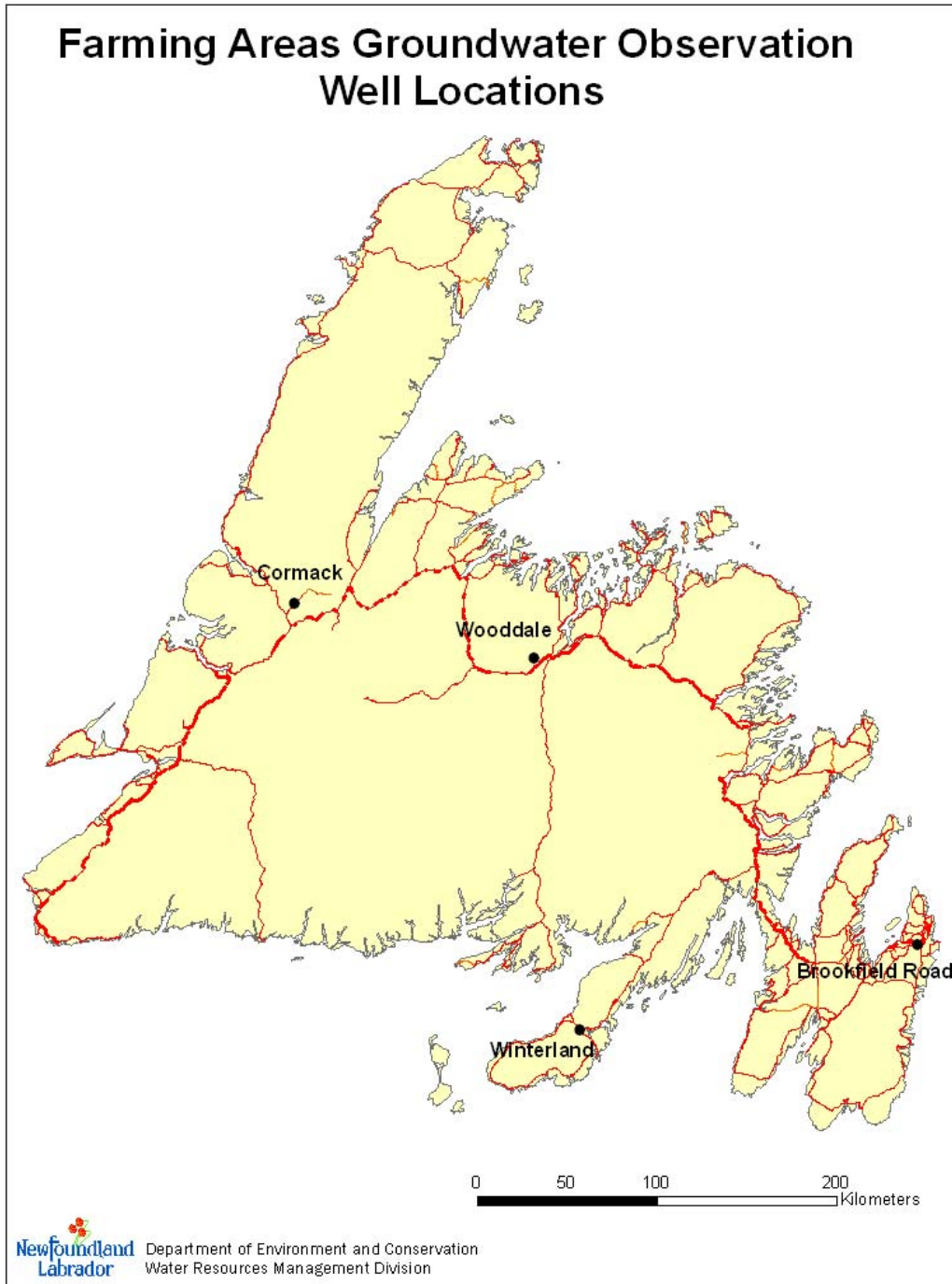
There is little information presently available on water table fluctuations in the province. Budget restraints have made it increasingly difficult to maintain the present observation well network in its existing form. A system is needed that is automated thereby reducing the manpower necessary to operate the system. Observations wells are already established in most farming areas, but the technology and manpower necessary to transmit information to the general public is not practical in the present form. A real time system using satellite technology coupled with web site application is the way to achieve our goal of easy access information to the farming community and general public.

## 3.0 Start of Project

The project was initiated in mid August, 2007 with the formal signing by the Federal Minister of Agriculture and Agri-Food at the time, Hon. Chuck Strahl, and the provincial ministers of Environment and Conservation, and Intergovernmental Affairs. The final locations of the four observation wells were determined after discussion with Agrifood representatives. The locations agreed on were Brookfield Road, St. John's, Winterland, Wooddale, and Cormack. A map showing these locations is shown on the following page. There were existing groundwater observation wells situated at all the locations except Cormack. It was necessary to drill a new observation well in that community. A visit was made to Cormack and discussion held with the town clerk to determine a

suitable location for the new well. It was agreed that the well would be located on town council property about 200m from the town office.

Equipment ordering was started immediately due to a required tendering process and expected long equipment delivery time for the Vedas II loggers. Plans for the observation huts were conveyed to the Department of Transportation and Works carpentry shop so that this work could be started immediately.



#### 4.0 Provincial Commitment

The provincial share of this agreement consisted of:

- all purchasing and paper work associated with the agreement
- calibration, testing, and installation of all equipment
- materials, construction, and installation of two observation huts
- supervision of well drilling
- creation of web site and data presentation
- water quality index calculator inception
- maintenance of completed network
- final report

#### 5.0 Observation Hut Construction and Installation

Two observation huts were constructed rather than one as outlined in the agreement. A small dog house type shelter was situated over the well at Brookfield Road. This was replaced with a hut. The other hut was for the new well in Cormack. Plans for the observation huts and base were obtained from Environment Canada. The huts and wooden base were built at the Dept. of Works Services carpentry shop, Pleasantville. Materials were purchased and conveyed to the carpentry shop. Steel doors were used to prevent vandalism. The huts rest on a 6”x 6” pressure treated wooden lumber which are interlocked and held together by spikes. A backhoe was hired for each installation to lift the hut over the well and prepare the ground for the base. A metal sign was attached to the door identifying the use and ownership of the observation well hut. The Brookfield Road hut was installed in August. The Cormack hut was installed after well drilling in September.



Observation well hut installation

## **6.0 Water Quality Index**

The Agri-Food Water Quality Index (AFWQI) 1.0 was adapted from the National Water Quality Index and developed by the Water Resources Management Division, in agreement with Agriculture and Agri-Food Canada as part of the Canada-Newfoundland and Labrador National Water Supply Expansion Program.

The calculator is used to summarize water quality information into easy to understand rankings that will rank the quality and suitability of water for use in agricultural (irrigation and livestock watering) applications. The AFWQI and data reports will be accessible to farmers and the general public via a website.

The Agricultural Water Quality Index is a tool which can be used to screen groundwater from various sites, prioritize sites based on their suitability for agricultural operations, and evaluate the impact of various Agricultural Best Practices on groundwater quality. More information on this valuable tool can be found in the Appendix A and B.

## **7.0 Web Site Development**

The provincial Federation of Agriculture was contacted concerning web site location and content. It was agreed that the main web site information would reside with Water Resources Management Division. The Federation of Agriculture would have a brief explanation of the program followed by a link to the Water Resources web site. A print out of the web site content can be seen in the Appendix C.

## **8.0 Cormack Observation Well**

As mentioned previously, a new observation well was constructed in Cormack. The location was picked after consultation with the town office manager. Tenders were called for the well drilling and Northeast Well Drilling of Springdale was awarded the contract. The well drilling was carried out in September.

During well drilling it was determined that a two aquifer regime separated by an impermeable clay layer exists in Cormack. Farmers are accessing the upper aquifer via dug wells, while the deeper aquifer is being tapped by drilled wells. It was then decided, while the rig was on site, to drill a shallow well. This would allow monitoring of both aquifers. A review of funding available and a negotiated price realized that both wells could be constructed for the \$10,000 allotted for well drilling. A well screen was ordered and flown in that night to be used in the shallow well the next day. Both wells were completed in two days.

An observation well hut was then installed over the deep well using the services of a local backhoe. The base frame was put together and then the hut attached to it. An aluminum mast and solar panel completed the hut installation.



Photo of the Cormack wells being drilled.

### **9.0 Hydrolab Groundwater Monitoring Equipment**

Six Hydrolab Quanta G groundwater monitoring sondes were purchased from Campbell Scientific Ltd. The same equipment is being used by Water Resources Management Division for environmental monitoring. One extra sonde was purchased for calibration purposes so that calibration could be done in a non outdoor environment and then put in a well replacing the existing sonde. Cables of suitable length to match well depth were ordered at the same time. The sonde is lowered down the well and is suspended by its cable which is connected to the VEDAS II Logger.

Each sonde was ordered with the following probes:

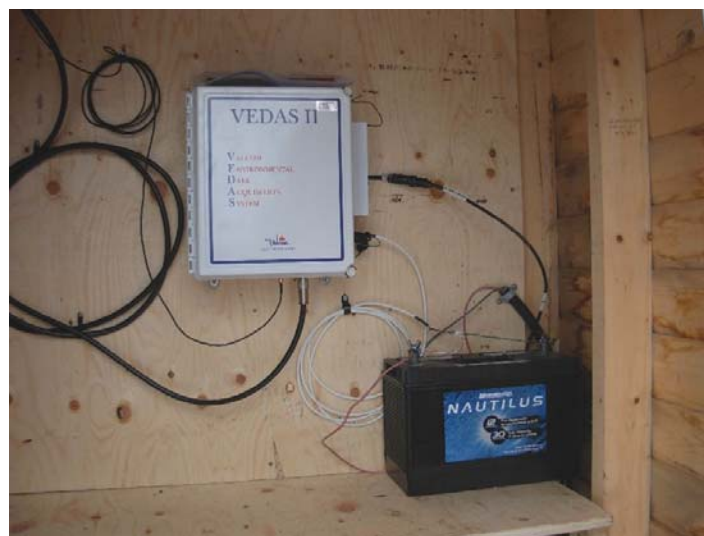
- water depth (m); a measure of the water table fluctuation
- water temperature (deg. C); the groundwater temperature at the instrument depth
- pH (pH units);
- Salinity (mg/L);
- ORP – Oxidation Reduction Potential (mV)
- Conductance (us/cm)
- Battery voltage (V); measures the battery voltage



A Hydrolab sonde being lowered down a well.

### 10.0 VEDAS II Satellite Equipment

The VEDAS II is a self-contained real-time data acquisition platform made by Valcom Industries in Ontario. Its modular design makes it completely user programmable and configurable. Its high accuracy, reliability, rugged packaging and real-time software is ideal for military, aviation, industrial, hydrological and meteorological applications. This acquisition platform coupled with a satellite transmitter and Yagi directional antenna provided the instrumentation necessary to gather and send measurement from the groundwater sonde to be broadcast near real time on a web site.



VEDAS II acquisition platform and battery

### 11.0 Solar Panels

Two solar panels, mounting brackets, aluminum masts, and batteries were purchased for the Brookfield Road and Cormack observation wells to power the equipment. Solar panels already existed at Wooddale and Winterland. The batteries at Winterland and Wooddale were replaced due to their age and small size. Solar panels were installed in September and October, 2007.



Solar panel and Yagi antenna.

### 12.0 Equipment Installation

Due to the late arrival of the VEDAS II satellite equipment, actual installation did not start till January 2008. Table 1 shows the start up dates of each station. The installation requires that each unit be given a unique identifying code and time signal for satellite broadcast. The logger was attached to the wall of the hut. An antenna was assembled and attached to the solar panel mast. The antenna must be aimed at a predetermined bearing of 252 degrees from true north and an elevation angle from horizontal of 22 degrees was used. As an example, the Winterland antenna had to be aimed at 252 deg. azimuth and 22 deg. above the horizontal. The azimuth was obtained using a Global Positioning System (GPS) receiver. The horizontal angle is pre-adjusted during antenna assembly. There is also a built in GPS receiver in the VEDAS unit for precise timing of the transmission signal. After installation and before leaving the site, a call was made to our office to see if the equipment was working and information was arriving at our web site.

**Table 1 of Observation Well Information**

<b>Station</b>	<b>NL Gov. #</b>	<b>Date Deployed</b>	<b>Latitude</b>	<b>Longitude</b>
Brookfield Rd. Deep	NLENVGW005	Jan. 17, 2008	47° 31'0.5" N	52° 46' 46.7"W
Winterland	NLENVGW006	Jan. 29, 2008	47° 09'4.8"N	55°17' 46.7"W
Wooddale	NLENVGW003	Feb. 25, 2008	49° 01'6.5" N	55°34' 33.3"W
Cormack Deep	NLENVGW017D	Feb. 26, 2008	49° 18'1.1" N	57°23' 43.1"W

**13.0 Deficiencies**

The shallow Cormack well cannot be made operational until the snow is gone and the frost is out of the ground. A trench needs to be dug for the Hydrolab cable from the shallow well to the deep well observation hut. The cable should be inside conduit pipe. This will be done during the spring/summer of 2008.

**14.0 Conclusion**

The four observation wells are operational and a web site has been created for viewing by the farming community and the general public. The water quality index is functional and a report has been submitted outlining the work done.

## **Water Quality Index**

### *Personal Communications:*

#### **Newfoundland**

Contact: Tara Morgan. Environmental Farm Planner. Forestry and Agrifoods Agency.

Info: In most cases, Canadian Water Quality Guidelines are the standard. No mention of water quality limits in Environmental Guidelines Series.

Contact: Rick Carey, Manager of Soils and Mapping Services, Dept of N.R.

Info: Natural Resources-Forestry and Agrifoods Agency does not have specific water quality guidelines, only the federal guidelines for such activities.

#### **Nova Scotia**

Contact: Dr. Robert Gordon. Dean of Research. NSAC.

Info: NS follows CCME guidelines for irrigation and livestock watering. It has been suggested to consider evaluating irrigation guidelines that better reflect risk. Should vegetables consumed raw have same guidelines as those prepared cooked?

#### **Prince Edward Island**

Contact: Tyler Wright. Livestock division of PEI provincial government.

Info: For livestock, PEI does not have specific guidelines. "It is interesting timing as PEI Soil and Crop Improvement Association is just completing a project where they studied and established a baseline of water quality for livestock on pasture. The study used basically the CCME guidelines you had mentioned as the threshold levels in identifying problems. All of the parameters were well below acceptable levels. The only parameter measured that was not useful was the microbial activity. Due to the laboratory's inability to dilute, the numbers were mostly off the scale of the lab.

#### **New Brunswick**

Contact: Kelvin Lynch. IPM Specialist. NB Dept of Agriculture and Aquaculture.

Info: Endorse and recommend CCME guidelines for producers

#### **Quebec**

Contact: Richard Laroche, P. Eng. MAPAQ, Quebec City.

Info: Quebec has no specific requirements concerning cattle watering and irrigation. The Ministry of Environment recommends one refer to the CCME guidelines for these particular uses.

#### **Ontario**

Contact: Kevin McKague. Engineer, Water Quality. Ontario Ministry of Agriculture, Food and Rural Affairs.

Info: Recommends CCME agricultural guidelines

#### **Manitoba**

Contact: Nicole Armstrong. Water Quality Management Section.

Info: 2002 Document listing guidelines, which ARE from CCME, with the exception of the two newest guidelines (2005). Hoping to release updated version later in 2008.

### **Saskatchewan**

Contact: Richard Zitta. Senior Water Policy Analyst. Saskatchewan Ministry of Environment.

Info: Recommend following ALL CCME guidelines, not just those listed in Saskatchewan's 'Surface Water Quality Objectives, Interim Edition, EPB 356 July 2006'.

### **Alberta**

Contact: Kim Westcott. Water Policy Advisor. Alberta Environment.

Info: Alberta will not officially adopt the new CCME guidelines until a revision of the Surface Water Quality Guidelines for Use in Alberta (1999). Unofficially, they do follow the new guidelines as well.

### **British Columbia**

Contact: Kevin Rieberger. Water Quality Science Specialist. Science and Information Branch, Water Stewardship Division. BC Ministry of Environment.

Info: Approved Water Quality Guidelines 2006 is most recent guidelines.

[http://www.env.gov.bc.ca/wat/wq/wq\\_guidelines.html](http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html)

In B.C., the approved water quality guidelines take precedence over other guidelines, including CCME.

Working guidelines are those for parameters for which no approved B.C. specific guidelines exist (including CCME).

### *Reference list of Guidelines used in Calculator:*

#### *Canadian Guidelines:*

Canadian Council of Ministers of the Environment (CCME). 2005. Canadian water quality guidelines for the protection of agricultural water uses: Summary table. Updated October 2005. *In*: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

#### *British Columbia:*

B.C. Environment and Lands. 2006. British Columbia Approved Water Quality Guidelines 2006 Edition. Science and Information Branch, British Columbia Department of Environment and Lands. Retrieved on February 4, 2008 from

[http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv\\_wq\\_guide/approved.html](http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv_wq_guide/approved.html)

Nagpal, N.K., Pommen, L.W., Swain, L.G. 2006. Water Quality: A Compendium of Working Water Quality Guidelines for British Columbia. British Columbia Ministry of Environment, Environmental Protection Division, Science and Information Branch.

Retrieved on February 5, 2008 from:

<http://www.env.gov.bc.ca/wat/wq/BCguidelines/working.html#table1>

*Provincial publications of Guidelines for Agricultural Water Quality*

*Alberta:*

Alberta Environment. 1999. Surface Water Quality Guidelines for Use in Alberta. Environmental Assurance Division, Science and Standards Branch. T/483.

*Ontario:*

Ontario Ministry of the Environment. 1999. Water Management, policies, guidelines: Provincial Water Quality Objectives of the Ministry of Environment and Energy (1994, reprinted Feb 1999) Retrieved on February 5, 2008 from <http://www.ene.gov.on.ca/envision/gp/3303e.htm#9>

*Quebec:*

BPR Consulting Group. 2003. Analysis of Water Supply Issues for the Agricultural Sector. National Water Supply Expansion Program. Province of Quebec. Final Report. BPR Consulting Group, Quebec City, Canada. Retrieved on January 31, 2008 from [http://www.agr.gc.ca/pfra/water/nwsi\\_que\\_e.pdf](http://www.agr.gc.ca/pfra/water/nwsi_que_e.pdf)

*Saskatchewan:*

Saskatchewan Environment. 2006. Surface Water Quality Objectives: Interim Edition. Environment Protection Branch, Regina. EPB 356

*Manitoba:*

Williamson, D. 2002. Manitoba Water Quality Standards, Objectives and Guidelines: Final Draft November 22, 2002. Water Quality Management Section, Water Branch. Manitoba Conservation. Retrieved on February 1, 2008 from [http://www.gov.mb.ca/waterstewardship/water\\_quality/quality/mwqsog\\_2002.pdf](http://www.gov.mb.ca/waterstewardship/water_quality/quality/mwqsog_2002.pdf)

*Nova Scotia:*

\*Guidelines based on the selected limits used during testing of the WQI in Atlantic Canada. Only Nova Scotia and Prince Edward Island were tested using livestock and irrigation water supply criteria.

Environment Canada, New Brunswick Department of Environment and Local Government, Newfoundland and Labrador Department of Environment and Conservation, Nova Scotia Department of Environment and Labour, and Prince Edward Island Department of Fisheries, Aquaculture, and Environment. 2004. Application and Testing of the CCME Water Quality Index in Selected Water Bodies in Atlantic Canada. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.

*Prince Edward Island:*

\*Guidelines based on the selected limits used during testing of the WQI in Atlantic Canada. Only Nova Scotia and Prince Edward Island were tested using livestock and irrigation water supply criteria.

Environment Canada, New Brunswick Department of Environment and Local Government, Newfoundland and Labrador Department of Environment and Conservation, Nova Scotia Department of Environment and Labour, and Prince Edward Island Department of Fisheries, Aquaculture, and Environment. 2004. Application and Testing of the CCME Water Quality Index in Selected Water Bodies in Atlantic Canada. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.

*New Brunswick:*

Snowdon, M. 2000. Guidelines for Livestock Drinking Water Quality. New Brunswick Department of Agriculture, Fisheries and Aquaculture. Retrieved on January 30, 2008 from <http://www.gnb.ca/0170/01700014-e.pdf>

The provincial department of agriculture and aquaculture endorses and recommends producers follow Canadian Water Quality Guidelines by the CCME (Personal communication with Kelvin Lynch).

*Yukon:*

Government of Yukon. 2002. Environment Act. O.I.C. 2002/171: Contaminated Sites Regulation. Retrieved on February 6, 2008 from [http://www.gov.yk.ca/legislation/regs/oic2002\\_171.pdf](http://www.gov.yk.ca/legislation/regs/oic2002_171.pdf)

*Northwest Territories:*

Government of the Northwest Territories. Drinking Water Quality Database. Retrieved on February 7, 2008 from <http://www.maca.gov.nt.ca/operations/water/homepage.asp>

Statistics Canada. 2006. Census of Agriculture, *Farm Data and Farm Operator Data*, catalogue no. 95-629-XWE.