MacAskill Brook Dam Reservoir

Source Water Protection Plan

CBRM Water Utility

2014

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1.0 INTRODUCTION

The Nova Scotia Drinking Water Strategy (Nova Scotia Environment and Labour 2002) outlines a multi-barrier approach to achieve the delivery of safe, clean drinking water to all Nova Scotians. The barriers are:

- keeping clean water clean: select the highest quality sources of water and protect these sources to prevent contamination,
- making the water safe to drink: treat water to remove natural and manmade impurities, and
- proving the water is safe to drink: consistently monitor water quality and take swift, corrective action when deficiencies are identified.

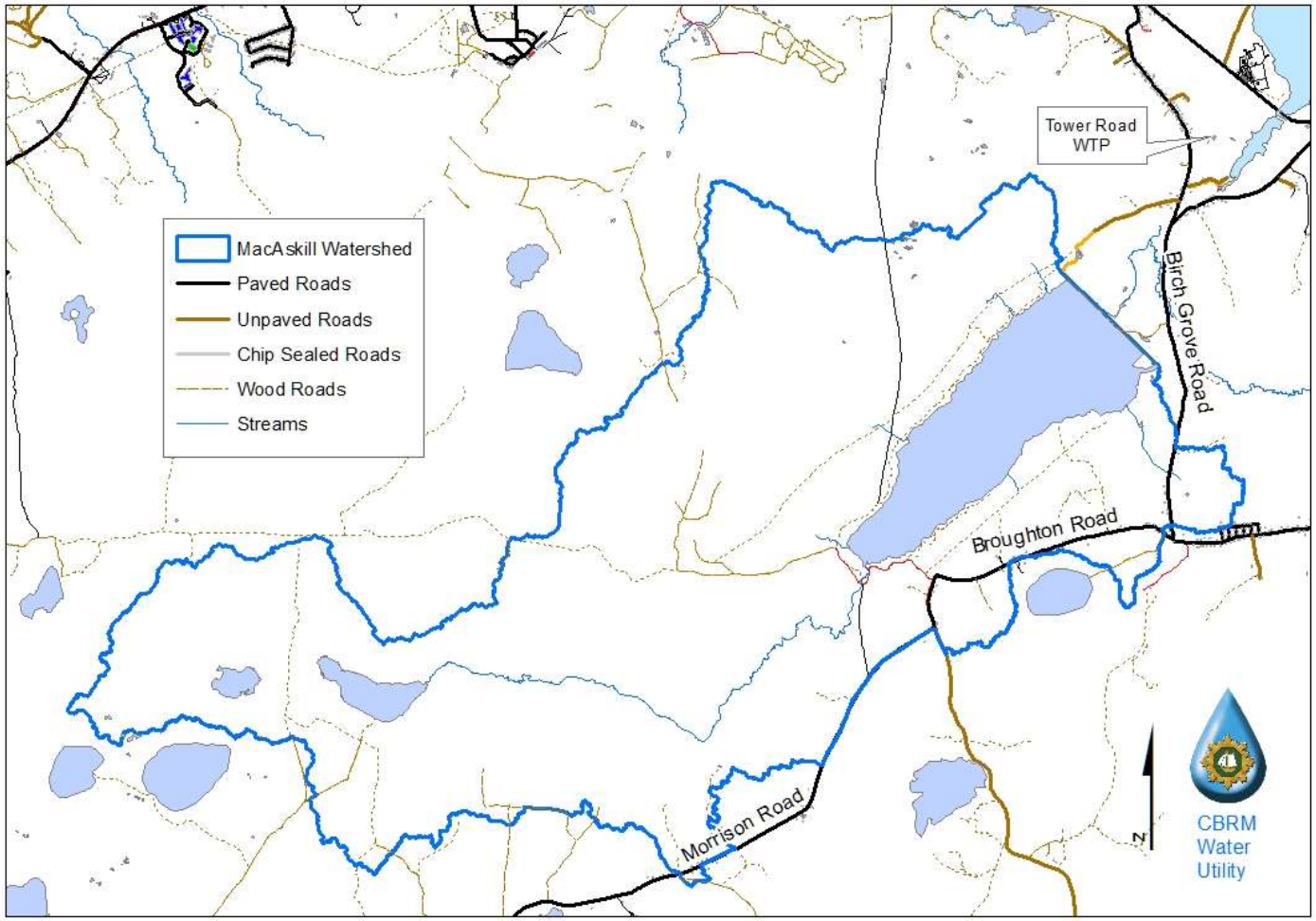
To address the first barrier, keep clean water clean, all municipal units must develop a source water protection plan (SWPP). A SWPP is a document outlining the drinking water supply area. The plan identifies potential risks to the drinking water quality and quantity, and lastly, identifies strategies to reduce those risks.

This SWPP was prepared by the CBRM watershed coordinator following the direction of the Source Water Protection Committee (described in more detail in Section 2.2).

1.1 Overview of the Drinking Water Supply Area

Glace Bay residents consumed water from Sand Lake or its brook for over 100 years until 2003, when a water treatment plant (WTP) started operating at Tower Road. Water flows to the WTP via pipeline from MacAskill's Brook Dam which served the former Atomic Energy of Canada Limited (AECL) heavy water plant. The WTP serves Glace Bay, Dominion, Reserve Mines, Tower Road, Port Caledonia, Birch Grove, Donkin, and Port Morien. Birch Grove and Port Morien were added in 2011 and 2012 respectively, resulting in closure of treatment plants on John Allen Lake (Figure 1) and Sand Lake.

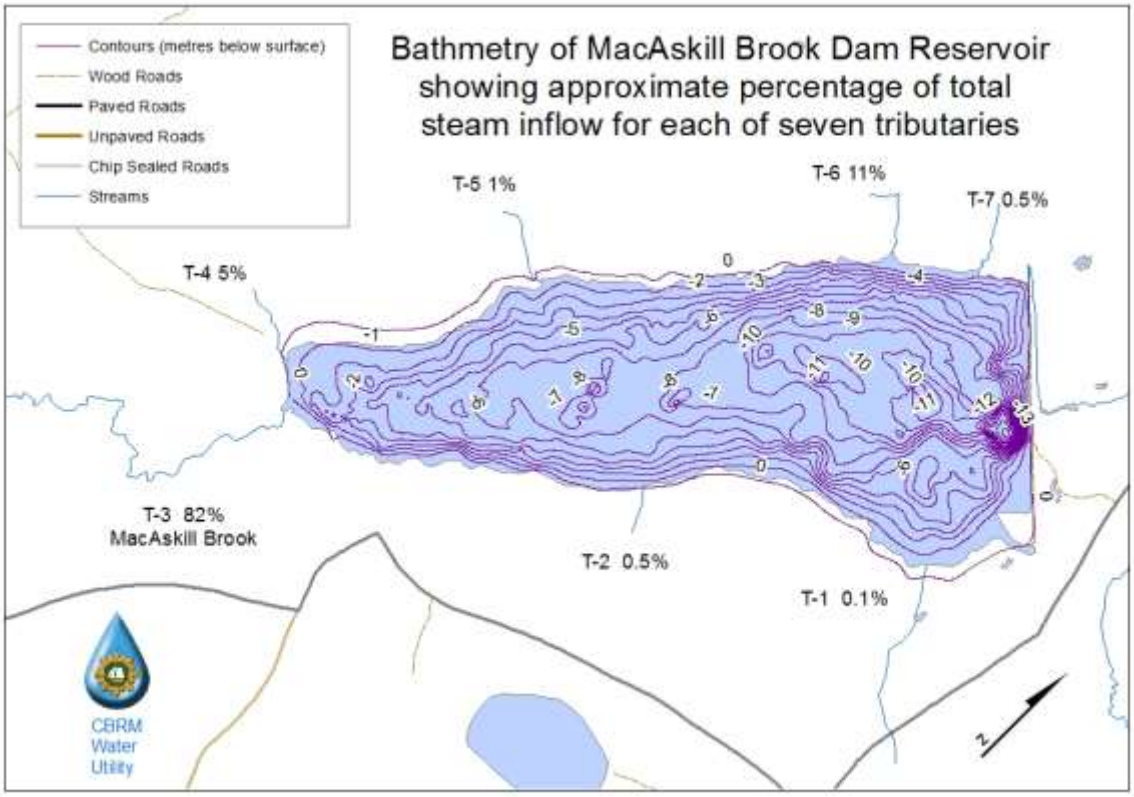
Figure 1. John Allen Lake and MacAskill Brook reservoir; G. Langille photo 2008



Map 1. MacAskill Brook watershed area showing Tower Road WTP

MacAskill Brook watershed is in the Lowland Hydrological Region Homoclinal Flank District as defined by Baechler et al (in progress). There are four Hydrostratigraphic Units (HUs). Surface runoff initially flows within the soil and organic (wetland) HUs perched over the thin glacial till HU. Some runoff infiltrates the lower permeable till HU and recharges the Upper Morien (bedrock) HU. With a high water surplus, relatively low bedrock and till permeability, and low topographic relief, topographic highs form groundwater recharge areas and discharge into the adjacent topographic lows.

The reservoir covers 329 hectares and drains an area of 3763 hectares (37.6 square kilometres). According to Hill (1974) there are seven brooks feeding the reservoir, although two of them provide 93 per cent of the inflow. MacAskill Brook supplies 82 per cent of the inflow and 11 per cent flows from a brook about 650 metres from the dam on the northwest side of the reservoir (see Map 2). MacAskill Brook water levels can be seen online at: http://www.wateroffice.ec.gc.ca/graph/graph_e.html?stn=01FJ002



Map 2. Bathymetry from Spooner (2008) and tributaries from F. C. Hill (1974)

Most of the MacAskill Brook Dam Reservoir is six to ten metres deep; with a depression 17 metres deep near the intake. AECL determined the storage capacity of the reservoir to be 4.5 billion imperial gallons (over 20 million cubic metres). Spooner (2010) calculated that MacAskill Brook Reservoir has a volume of 16 million cubic metres and a maximum depth of 17.45m at a surface water elevation of 23.2m above sea level (asl). With an average daily withdrawal of 10,000 cubic metres, the reservoir provides over four years of storage.

1.2 Drinking Water System

The water treatment plant (WTP) at Tower Road, operating under Approval No. 2008-061194, is less than 100 metres southeast of two 750 mm (30 inch) wire wound wood stave pipelines. The water originally flowed by gravity from the dam, built in 1973, to the former AECL heavy water plant. In 2012, as part of decommissioning the heavy water plant, the pipeline was terminated just past Glace Bay WTP.

The heavy water plant closed in 1985 and the reservoir and surrounding lands were deeded to the Town of Glace Bay in 1994. Municipal amalgamation in 1995 transferred the reservoir to the Cape Breton Regional Municipality. In 2003 a 16 inch raw water line was laid from the closest 30 inch wood stave line to the water treatment plant. A valved cross connection was established between the two wood stave lines.

The surface water supply intake is part of the dam structure completed in 1973. Coarse screens and a new concrete gate house were added in 2003 during construction of the water treatment plant. The original intake included trash rack, intake tunnel, intake tower, bulkhead chambers, slide gates and coarse screens (Dillon, 2004).

The Tower Road water treatment facility provides oxidation, coagulation, flocculation, clarification, filtration, fluoridation, and chlorine disinfection. Sludge from the clarifier and backwash water from the filters is directed to a pair of Freeze-Thaw Bed Lagoons for settlement and concentration of solids, with periodic discharge of clean effluent back to MacAskill Brook down gradient of the dam. Treatment objectives are to reduce organic colour, organic carbon, iron, manganese, corrosiveness, and turbidity.

The treated water is pumped through mains and laterals from the Tower Road Pumping Station. Construction of a third clear well and installation of three pumps is planned for 2014. There are 8,425 water accounts serving 23,760 people. Large users are the hospital and a couple of fish plants. A 1.3 million imperial gallon (5910 m^3) storage tank on Main Street adjacent the Taigh Na Mara residential care facility provides a 12 hour water supply. There is also a 100,000 gallon (455 m^3) standpipe on Mitchel Avenue in Reserve, a booster station on Phalen Road and a chlorine booster station near Sterling Road in Glace Bay, and a pump house in Reserve. The 465 m^3 water tower adjacent John Alan Lake has been maintained as part of the Birch Grove distribution system and water for Port Morien water is distributed from another 465 m^3 water tower off Prendergast Lane.

CBRM's utility manager, a water operations manager, and a water supervisor are responsible for safety of the various water supplies throughout the municipality. A treatment supervisor works with a team of certified treatment and distribution system specialists and plant maintenance staff in day-to-day operations of the various physical plants and distribution systems. They are supported by two operations supervisors, a water quality analyst, a water quality tester, a water systems engineer, meter reading and repair staff, and a watershed coordinator. The Glace Bay plant has operators on duty seven days a week and the System Control and Data Acquisition (SCADA) system includes an auto dialer/alarm system to alert plant operators of problems.

1.3 Water Quality

Dillon (2004) characterized MacAskill Brook raw water as very soft; corrosive and acidic, high in colour, turbidity, iron and manganese; and with elevated levels of aluminum. The aluminum is probably from naturally occurring aluminum silicates commonly found in clay particles. Seven parameters in raw water from the MacAskill Brook reservoir exceeded the limits set out in the Guidelines for Canadian Drinking Water Quality (GCDWQ) or American Water Works Association (AWWA) criteria: turbidity, colour, iron, manganese, aluminum, total organic carbon, and alkalinity.

Turbidity is a measurement of the ability of light to pass through water and is caused by suspended particles, such as clay, silt, organic and inorganic matter, plankton, and other microscopic organisms. Turbidity can be caused by viruses and bacteria or could be caused by clay or silt which might reduce the ability of disinfectants to kill disease organisms. The GCDWQ set a maximum of 1.0 Nephelometric Turbidity Units (NTU) for water entering a distribution system, but will allow turbidity up to 5.0 NTU if disinfection is not compromised. ADI (2007) reviewed available chemical analytical results from 1998 to 2004 and reported moderately high turbidity (1.0 to 8.0 NTU) in MacAskill Brook source water. Monthly maximum turbidity values in 2012 for raw water ranged from 1.12 to 2.32 NTU. There were no exceedances of NTU from any of the three filters in 2012.

Colour in water may result from natural metallic ions such as iron or manganese, acids from humus and peat, plankton, dissolved plant material, or industrial wastes. The GCDWQ requires treated water be limited to 15 True Colour Units (TCUs). Dillon (2004) reported the source water from MacAskill Brook to be highly coloured (37 to 160 TCU). In 2012 the reservoir recorded TCUs of 64 and 59, respectively, in the March and September raw water samples.

The March and September iron concentrations of 0.42 and 0.67 mg/L in raw water exceeds the GCDWQ aesthetic objective (AO) of 0.3 mg/L for treated water. The manganese concentrations of 0.17 and 0.13 mg/L, and values for aluminum of 0.17 and 0.15 mg/L in the raw water also exceeds the recommended AO of 0.05 and 0.1 mg/L respectively for levels of manganese and aluminum in treated water. Treatment, of course, ensures all metal concentrations meet the required guidelines.

Although Total Organic Carbon (TOC) is not regulated by GCDWQ, the level can affect the formation of trihalomethanes (THMs), produced by the interaction of chlorine and organic material, and considered carcinogenic. The March and September 2012 reservoir water values for total organic carbon were 5.8 and 5.2 mg/L, which exceed the AWWA target of $\leq$ 3.0 mg/L for control of disinfection products. In 2012, Tower Road WTP treated water was tested each quarter for trihalomethanes. Results varied from 0.042 to 0.084 mg/L, averaging 0.057, all values below the GCDWQ requirement of 0.10 mg/L.

Alkalinity is a measure of water's ability to neutralize acids or bases and is needed to allow most water treatment processes to proceed. Alkalinity readings for MacAskill

Reservoir raw water in March and September 2012 were 5.3 mg/L and <5 mg/L, well below the AWWA criteria of >40 mg/L for corrosion protection. MacAskill Reservoir raw water, with a maximum hardness reading in 2012 of 8.2 mg/L is also below the 80 to 100 mg/L range (as $CaCO_3$) considered soft (Vaughan and Associates 1995).

Drinking water should have a pH range between 6.5 and 8.5; pH is a measure of the hydroxyl (OH^-) ion and the neutral state between base and acid is 7.0. MacAskill Brook Reservoir water is acidic; in 2012 the raw water monthly pH minimums averaged 5.25 and the monthly pH maximums averaged 6.42.

Analytical laboratories calculate a Langelier Saturation Index for water samples to determine if the water will tend to deposit calcium carbonate on pipelines (a positive index) or tend to corrode pipe (a negative number). In 2012, Maxxam Analytics derived a negative maximum Langelier Index at 20 degrees Celsius of -4.07 for raw water.

In 2009, MacAskill Brook Reservoir raw water was tested for polychlorinated biphenyls (PCBs) and a number of organic chemicals that would indicate petroleum or industrial contamination. No contaminants were detected. As a condition of water withdrawal approval, NS Environment has requested a water sample be collected of reservoir water once a year during a low flow period. This has been added to CBRM's water testing program.

1.4 Water Quantity

As stated earlier, when water is overflowing the spillway at 76 feet (23.16 m) above sea level there are 16 million cubic metres of water behind the dam. The average daily withdrawal at the Glace Bay WTP in 2012 was 2,039,995 imperial gallons (9274 cubic metres), less than 14 per cent of the 2012 permitted withdrawal of 68,000 m^3 per day (Approval 2007-055931 - Authorization # 2953). In 1988, AECL was given permission to withdraw 13 million gallons per day (59,100 m^3) for industrial use.

Vaughan Engineering and Associates (1995) defined safe yield as the amount of water that can be extracted from a source each day, indefinitely, without depleting the water supply or otherwise damaging the aquatic system. Vaughan indicated that, for a surface water supply, safe yield is a function of the size, topography, and geology of the watershed. Safe yield also depends on the capacity to store water from periods of high flow for use in drier months. ADI Limited and Hydro-Com Technologies (2007) calculated a safe yield for the MacAskill Reservoir of 21.8 million litres (21,800 m^3) per day. Once CBRM had complete control of all flow in the pipeline in April 2013, they requested a reduction in water withdrawal quantity from NS Environment. The new withdrawal amount is tied to the rated capacity of the treatment plant; 17,500 m^3 per day, although CBRM has requested to have that increased to 20,000 m^3 per day.

In reviewing the CBRM application for water withdrawal, NS Environment staff estimated daily mean flows into the reservoir ranged from 31,968 to 274,752 m^3 per day. However, during 7Q10 (the lowest 7-day average flow that occurs (on average) once every 10 years) and 60Q50 (the lowest 60-day average flow that occurs (on average) once

every 50 years, flow events inflow would be 4,665 or 5,443 m^3 per day. During periods of low flow, there is, of course, abundant storage in the reservoir, and a maintenance flow to MacAskill Brook is provided by the pipeline under the dam. Canada Fisheries and Oceans (DFO) have determined that a maintenance flow of five ft^3 (0.14 m^3) per second is required at the NS Power fish ladder downstream of the Birch Grove Road. DFO calculate that one ft^3 per second is provided by the Sand Lake watershed, meaning that only four ft^3 per second of flow is required from the MacAskill Brook Dam. As CBRM Water Utility calculates that the 30 centimetre line to the mechanical spillway provides 4.13 ft^3 per second of flow to MacAskill Brook, CBRM is meeting the DFO maintenance flow requirements. NS Environment has made the provision of maintenance flow a condition of the water withdrawal approval for MacAskill Brook Dam.

As the NS Environment approval for water approval also provides approval for operation of the MacAskill Brook Dam, another condition of approval is the monitoring of storage levels in the reservoir and monitoring water flows to the downstream channel via the emergency spillway. NS Environment suggests a staff gauge extending from the top of the spillway extending a metre beyond the spillway invert, which is also the full supply level of the reservoir. NS Environment provided Excel templates for recording flow per day and daily water levels.

1.5 Source Water Protection Process

Nova Scotia Environment and Labour Water and Wastewater Branch (2004) prepared a handbook for municipalities, *Developing a Municipal Source Water Protection Plan: A Guide for Water Utilities and Municipalities.* ADI Limited has used this document as a template for their background reports on several CBRM water supply watersheds. CBRM Water Utility has also used the five-step process to guide the structure of this report.

1.5.1 A Five-Step Process

STEP ONE **Advisory Committee**	• The committee should reflect the jurisdictional make-up of the water supply area. It is important to include municipal councillors, water utility engineers, planners, landowners, and residents from the area. • In addition, the committee may also include stakeholders from sectors such as agriculture, forestry, and other commercial operations, as well as special interest groups with a stake in the water supply area.
STEP TWO **Delineate Boundary**	• Use maps and land-use information to delineate the boundary of the watershed area or groundwater capture zone. • Mark the water supply boundary on a 1:50,000 scale (or less) map. • Solicit public input during this step if necessary to provide information about the watershed.
STEP THREE **Assess Risks**	• Conduct a comprehensive assessment of all land-use activities within the water supply area. • Determine what activities impact or impair water quality. • Identify potential future sources of contamination. • Assess the risk that each activity or source of contamination will have on the source water. • Solicit public input at this step if needed.
STEP FOUR **Management Plan**	• Compile all information and set goals and objectives. • Evaluate options. • Develop management strategies to reduce negative impacts to water quality. • Management options may include the following: (A)cquisition of land (B)ylaws - municipal planning for land-use (B)est Management Practices (C)ontingency planning for emergency situations (D)esignation (E)ducation • Consult the public
STEP FIVE **Monitor & Evaluate**	• Develop a monitoring program and schedule. • Continue to evaluate the effectiveness of the management plan. • Develop a mechanism for the committee to respond to impairment or changes in water quality. • Modify the plan if necessary.

Table 1. Developing a Source Water Protection Plan summary chart

From Nova Scotia Environment and Labour Water and Wastewater Branch (2004, pages 8 and 9), *Developing a Municipal Source Water Protection Plan: A Guide for Water Utilities and Municipalities.*

2.0 ADVISORY COMMITTEE

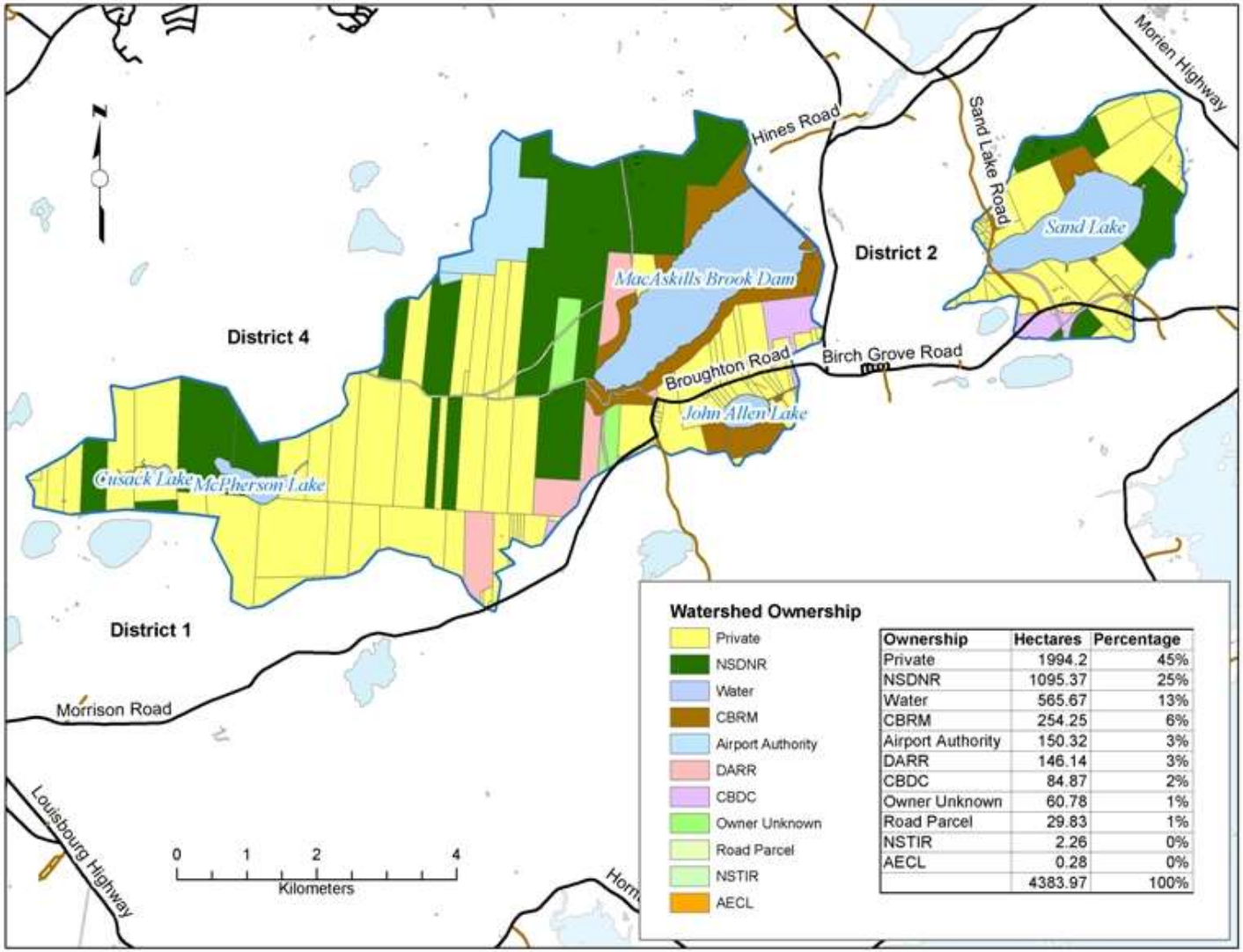
The CBRM Water Utility considers the residents and landowners within the watershed the most important members of an advisory committee. In 2008, using a geographic information system (GIS), the watershed coordinator generated a map of landowners within three existing areas zoned by CBRM Planning Department in 2004 as water supply zones in the Birch Grove vicinity. These Public Water Supply (PWS) Zones were intended to correspond with the natural watershed boundary and were based on the best mapping available at the time. In late September 2008, letters were sent out to 115 private landowners within the PWS Zones for Sand Lake, John Allen Lake, and the MacAskill Brook Reservoir (see Map 3). The letter explained the requirement by NS Environment to develop source water protection plans for the three public water supplies. Addressees were invited to attend a meeting in October 2008, or to contact the watershed coordinator.

Most landowners present at the meeting in the Birch Grove Fire Hall were reluctant to become involved in an ongoing process, but five people representing the three watershed areas agreed to sit on the source water protection committee. An initial source water protection committee meeting was held in December 2008. The meeting was attended by the five landowners; the municipal councillor; the watershed coordinator; a watershed planner and an inspector specialist from NS Environment; a forester and a geologist from Nova Scotia Natural Resources; along with one representative from each of the Cape Breton Development Corporation (CBDC), Enterprise Cape Breton Corporation (ECBC), Marconi Trail Blazers ATV club, the Port Morien Wildlife Association, and Citizens against Strip Mining (CASM).

By the third meeting in March 2009, the committee had developed and accepted a Terms of Reference document, which is included in Appendix B. Membership was divided between voting and non-voting members as shown below. By 2013, MacAskill Dam Reservoir was the only source of supply and remaining CBDC staff was part of ECBC.

Voting Members
Private Landowner Representatives – 5 members (representing the three supplies)
Citizens Against Strip Mining (CASM) - 1 member
Port Morien Wildlife Association – 1 member
Marconi Trail Blazers ATV Club – 1 member
Port Morien Development Association – 1 member
Birch Grove Rural Development Association – 1 member
CBRM Council – 1 member
CBRM Water Utility – 1 member
Cape Breton Development Corporation (CBDC) – 1 member
Enterprise Cape Breton Corporation (ECBC) (DARR) – 1 member
NS Department of Natural Resources – 1 member

Resource Members (non-voting)
NS Department of Environment
Cape Breton Regional Police Services

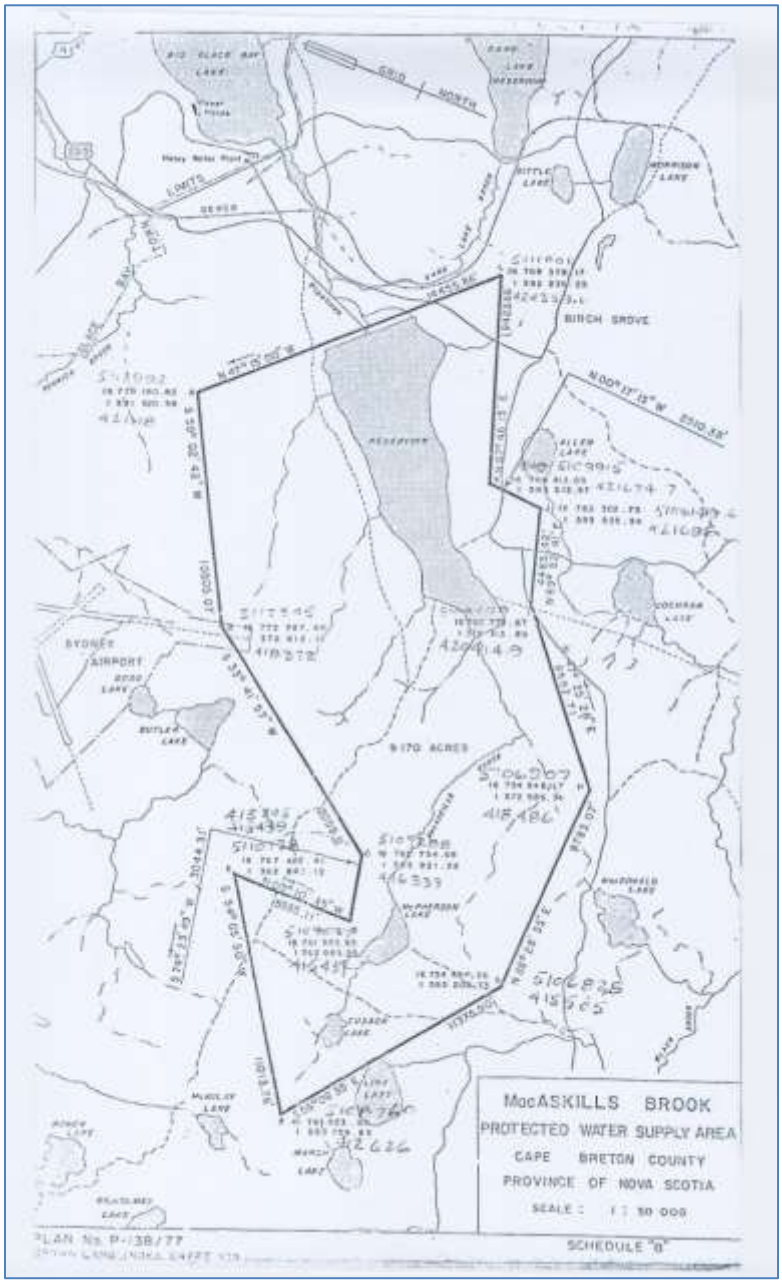


Ownership	Hectares	Percentage
Private	1994.2	45%
NSDNR	1095.37	25%
Water	565.67	13%
CBRM	254.25	6%
Airport Authority	150.32	3%
DARR	146.14	3%
CBDC	84.87	2%
Owner Unknown	60.78	1%
Road Parcel	29.83	1%
NSTIR	2.26	0%
AECL	0.28	0%
	4383.97	100%

Map 3. Land Ownership in three PWS Zones in the Birch Grove area in 2008

3.0 DELINEATE BOUNDARY

A source water area is the watershed or wellhead zone that contributes all the water used to supply drinking water from the source. The source water area for the Glace Bay water treatment plant is the watershed draining into MacAskill Brook upstream of the former AECL dam. Delineations of the MacAskill Brook Dam Reservoir drainage basin or watershed go back to 1977 when the Nova Scotia Department of Natural Resources prepared a map showing a suggested boundary for a Protected Water Supply Area (see Map 4 below).

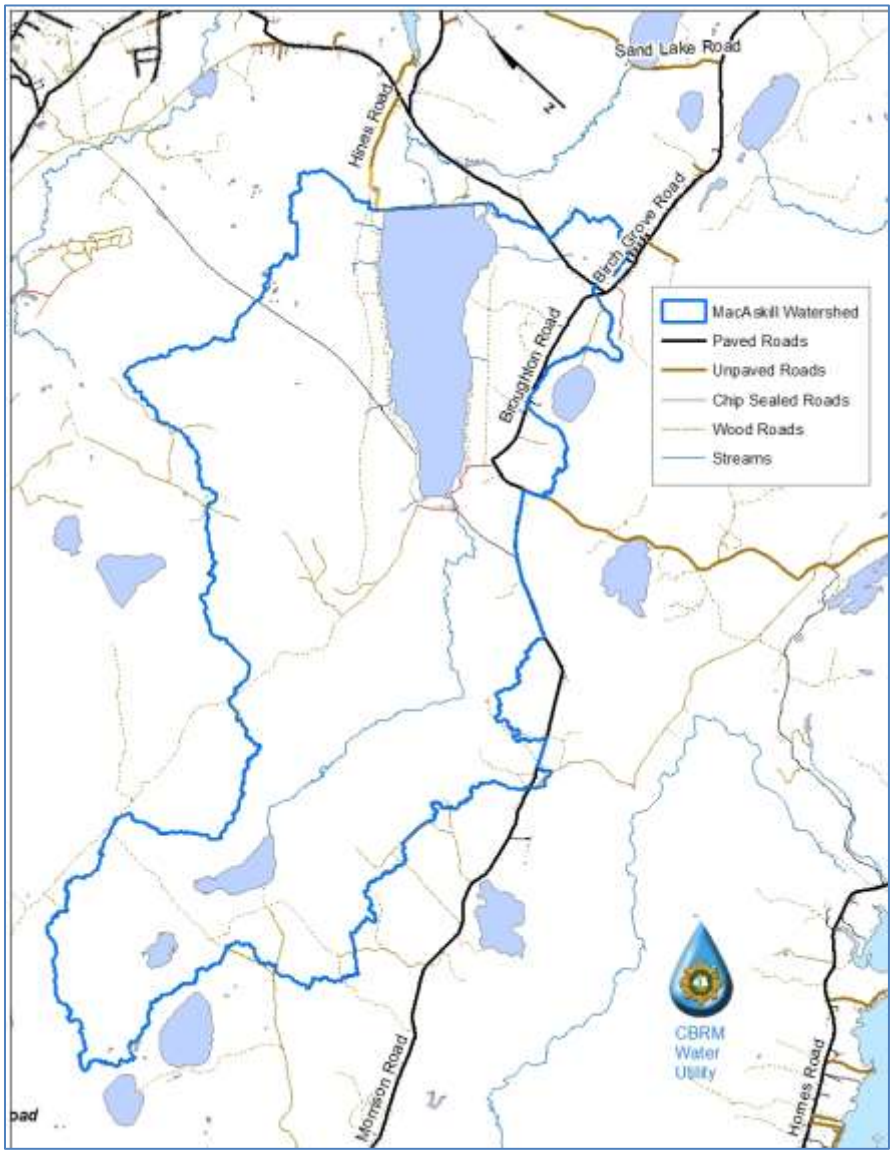


Map 4. Draft Protected Water Supply Area 1977

3.1 Natural Watershed Boundaries

A watershed is *the area drained by, or contributing to a stream, lake or other body of water. It is the area that topographically appears to contribute all the water that passes through a given cross-section of a stream* (Nova Scotia Environment and Labour, Environmental and Natural Areas Management, no date a, page 7).

Map 4 indicates the MacAskill Brook Dam Reservoir drainage basin above the dam, based on the best available data at the time. The Protected Water Supply Zone boundary was probably based on 1:50,000 mapping from the 1960s adapted to straight lines that could be surveyed and defined in a legal document. Map 5 shows the draft watershed boundary prepared from one metre contours derived from LiDAR data obtained in 2008. This draft boundary was improved in 2013 through the use of Global Mapper software.



Map 5. MacAskill Brook Dam Reservoir drainage basin based on 2008 LiDAR data

4.0 ASSESS RISK

Step Three of the source water protection planning process should produce:

- *a complete listing of all identified existing and potential issues that pose a risk to drinking water quality, and*
- *a list of existing and potential issues prioritized in the order in which they are to be addressed in the management plan.*

NSEL, (no date b, page 3) provides a flowchart to guide risk assessment.

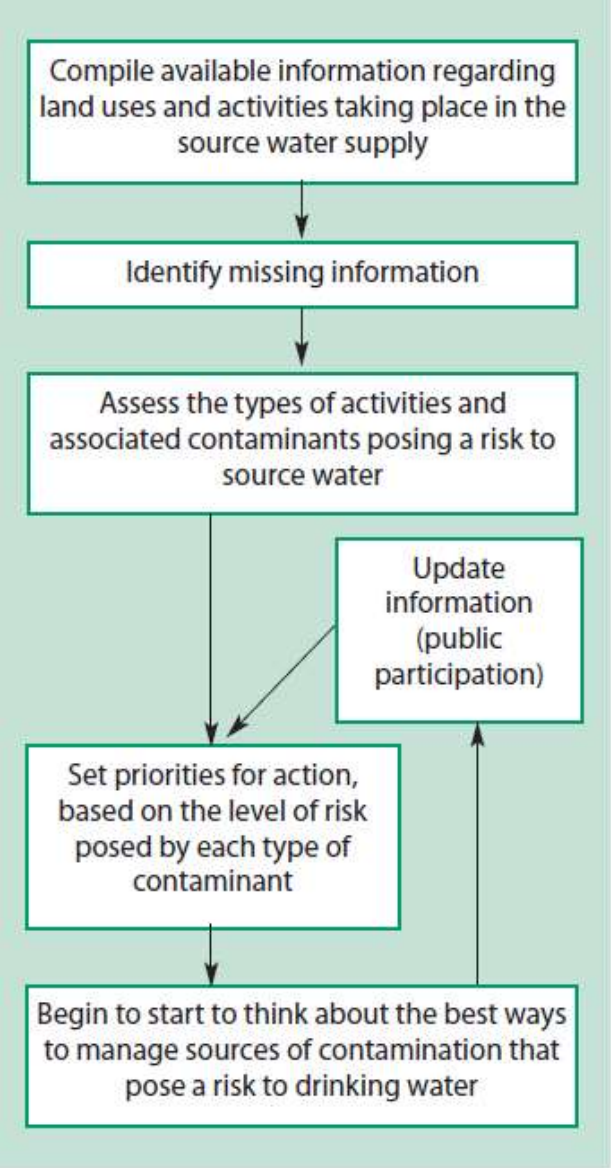
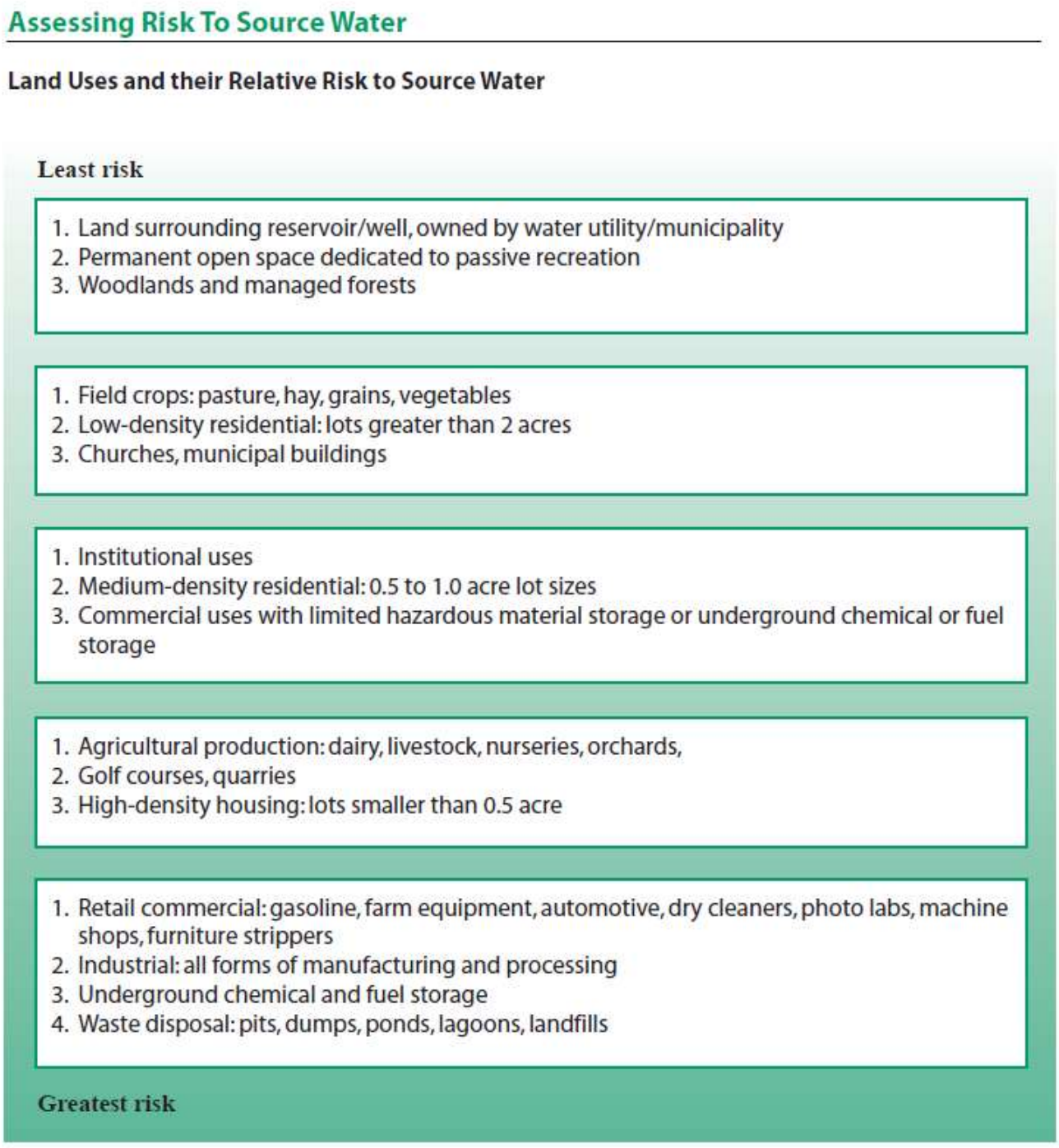


Figure 2. Risk assessment flowchart for source water protection from NS Environment

NSEL, (no date b, page 5) offers a list of land uses and their relative risk to source water.



Assessing Risk To Source Water

Land Uses and their Relative Risk to Source Water

Least risk

1. Land surrounding reservoir/well, owned by water utility/municipality
2. Permanent open space dedicated to passive recreation
3. Woodlands and managed forests

1. Field crops: pasture, hay, grains, vegetables
2. Low-density residential: lots greater than 2 acres
3. Churches, municipal buildings

1. Institutional uses
2. Medium-density residential: 0.5 to 1.0 acre lot sizes
3. Commercial uses with limited hazardous material storage or underground chemical or fuel storage

1. Agricultural production: dairy, livestock, nurseries, orchards,
2. Golf courses, quarries
3. High-density housing: lots smaller than 0.5 acre

1. Retail commercial: gasoline, farm equipment, automotive, dry cleaners, photo labs, machine shops, furniture strippers
2. Industrial: all forms of manufacturing and processing
3. Underground chemical and fuel storage
4. Waste disposal: pits, dumps, ponds, lagoons, landfills

Greatest risk

Table 2. List of land uses with relative risk to source water from NS Environment

Considering the continuum of risks presented in Table 2, and using the example provided by Nova Scotia Environment (see Appendix D), but considering the large dam, the committee prepared a risk assessment matrix (see Table 3).

Current Contamination Issue	Activity\Cause	Scale of Problem*	Priority Rank**
loss of water supply, infrastructure, and human life	dam failure	1	1
road salts, siltation, hydrocarbons, other contaminants	Cow Bay Road, Broughton Road, and Birch Grove Road	3	2
hydrocarbons, other contaminants	illegal dumping	3	3
hydrocarbons, siltation, and water storage	forestry	4	3
contaminants, hydrocarbons	scrap yard	5	3
hydrocarbons and\or siltation	ATV, snowmobile and 4x4 use	4	4
acid rock drainage	bootleg mines	4	4
pathogens from wildlife	beaver activity	5	5
biological contamination	residential wells and septic	5	5
contaminants, hydrocarbons, biological	recreation\boating	5	5
hydrocarbons, siltation, other contaminants, siltation	agriculture	5	5
metals	stream and lake sediments	5	5
acid, colour, and metals	wetlands	5	5
hydrocarbons, siltation, pathogens, and water storage	**PROPERTY DEVELOPMENT**	5	5

*** Scale** 1 = Severe 3 = Moderate 5 = Minimal **** Rank** 1 = High 3 = Moderate 5 = Low

Future concerns in bold, all caps: example **PROPERTY DEVELOPMENT**

Table 3. List of activities and relative risk developed by SWPP committee

4.1 Relative Risks

The following sections discuss each of the risks identified by the SWPP committee in the order of risk priority.

4.1.1 Dam Failure

The Birch Grove and Area Source Water Protection Committee determined that catastrophic failure of the former AECL MacAskill Brook Dam was the single most obvious risk to the Glace Bay and area water supply. In 2008, Nova Scotia Power Inc. carried out a site inspection of its MacAskill Brook weir, which was formerly part of NSPI's Seaboard Generating Station. As part of that inspection, NSPI's Senior Specialist Engineer also performed a cursory inspection of the Cape Breton Regional Municipality Water Utility's MacAskill Brook dam (NSPI 2008).

The cursory inspection by the NSPI engineer identified several issues requiring immediate attention: spillway channel vegetation to be removed; driftwood to be removed from the spillway; vegetation on the crest, face, and toes of the dam to be removed; missing rip rap to be replaced; and the steel checker plate in the gate house to be replaced with open grating.

In the summer of 2010 a local contractor removed all the vegetation from the spillway channel and the top, face, and toe of the dam. Figure 3 shows before and after photographs of the spillway channel, which now has significantly more discharge capacity during significant flood events.

Figure 3. Spillway channel September 2008 on left and September 2012 on right

During flood conditions, stumps behind the spillway can accumulate additional debris and significantly reduce the discharge capacity of the spillway. Figure 4 shows the contractor completing the removal of the stumps from the spillway in September 2010.

Figure 4. Stumps blocking spillway January 2010 and being removed September 2010

Vegetation on dams should be removed because roots can penetrate and loosen soils, as well as create voids when the plants die and the roots decay. The presence of vegetation also makes a proper inspection of the dam difficult or impossible. As such, any early warning signs of problems with the dam (such as sinkholes or significant leakage) could be missed during routine inspections. Figure 5 shows the dam face before and after vegetation removal and Figure 6 displays the difference in the view of the top of the dam from the spillway following brush removal.

Figure 5. Dam face September 2008 on left and November 2010 on the right

The NSPI review determined that the condition of the rip rap on the upstream slope of the dam varied from "poor" in those areas exposed to significant wave action, to "good" in those areas which are more sheltered from wave action. The variability of the type, shape and size of rip rap along the length of the dam indicated it had been repaired locally on previous occasions. In the area of greatest fetch (longest wind distance over open water), the rip rap was almost completely missing, as shown on the left in Figure 7. Since the riprap protects the upstream slope of the dam from wave action, this dangerous condition increases the likelihood of wave-induced erosion and a resulting overtopping failure.

Figure 6. Top of dam from spillway June 2009 on left and July 2013 on right

Figure 7. Missing rip rap June 2009 and same section following repair August 2011

Along the length of the dam, there were localized areas of rip rap displacement. Near the abutments, the original rip rap was almost completely disintegrated. In the vicinity of the intake structure, the rip rap was displaced and appeared undersized for the application. In addition, the rip rap did not appear to extend high enough, as evidenced by driftwood located well above the rip rap. As a result of the NSPI review, CBRM contracted an engineering firm to assess the design of the rip rap and its bedding material along the entire length of the dam and prepare a plan for emergency remediation. A local contractor was then hired to replace or repair bedding and\or rip rap as required. Figure 8 shows an area near the gate house before and after the repairs.

NSPI also had concerns that the original grating in the gate house over the air vents for the low-level sluice gate had been replaced with steel checker plate. To provide the necessary air flow to the low-level sluice gates at partial gate openings, this checker plate was replaced in 2011 with steel grating as shown on the original design drawings.

Figure 8. Before and after rip rap repairs July 2009 and July 2011

As noted in the NSPI review, the November 2008 site inspection was a cursory review only and did not take the place of a comprehensive site inspection by a qualified team of Dam Safety specialists. Following the vegetation removal and rip rap repairs in 2011, CBRM worked with the NSPI Senior Specialist Engineer to develop a Request for Proposals for a Dam Safety Review of both NSPI and CBRM infrastructure on MacAskill Brook. That review was contracted to a local engineering firm, exp Services Inc., in 2012 and the final report was received in October 2013.

Using the Canadian Dam Association (CDA) 2007 Dam Safety Guidelines, exp Services Inc. (2013b) concluded that failure of the MacAskill Dam would produce "Very High" consequences. Failure would likely result in loss of human life and considerable damage to public infrastructure and private property. Losses would include the Glace Bay water supply, the NSPI weir, the Birch Grove Bridge, and the Route 255 Bridge. At least 25 residences and the CBRM water treatment plant in Tower Road would be flooded. There would also be damage to the piping plover colonies on the Big Glace Bay Lake sand bar.

Exp concluded that the spillway does not meet CDA guidelines for structural analysis. Under extreme flood load, large hydrostatic pressures might result in a sliding failure of the spillway middle structure. Exp recommends an evaluation by a licensed Structural Engineer with experience in dam rehabilitation to determine what remediation would be required for the spillway to meet CDA guidelines for dam safety.

The spillway does have sufficient hydraulic capacity to safely pass the design flow and existing freeboard for the impervious core. However, existing freeboard for rip rap erosion protection on the main dam is too low. The gravel cover over the impervious core is only 0.3 metres, which does not meet the CDA recommendation of 1.2 metres. Exp notes this does not provide sufficient cover material to prevent freezing and thawing of the core and would permit the core to dry out and crack during warmer months.

Exp concluded, given the geometry of the MacAskill Dam, the foundation and embankment materials used, and the length of time the dam has been in service, the potential for hydraulic fracturing or deformation is low. MacAskill Dam is more likely to

fail from piping and internal erosion. Internal erosion could start at the bedrock contact and adjacent the intake conduit and concrete encased supply lines running through the dam. It is not known if these structures were constructed with a properly graded filter material or how the exposed bedrock was prepared. Exp recommends a geotechnical investigation to assess the "as built" condition of the dam. Piezometers could be installed to determine pore pressure distribution in and below the embankment. Test pits at the downstream toe could determine the preparation of the bedrock surface, the materials around the intake, and the condition of the concrete encasing the supply pipes.

Since 2008 consultants have expressed concern about the surface standing water at several locations on the downstream toe of the MacAskill Dam. Exp recommended draining the surface water and grading to existing drainage features. The toe of the dam needs to be dry to facilitate visual assessment of potential seepage flows. In late fall 2013, CBRM staff, an NSE Inspector specialist, and a local contractor visited the site of several ponds and developed a plan to remediate the ponds (see figure 9). Work is slated for spring 2014.

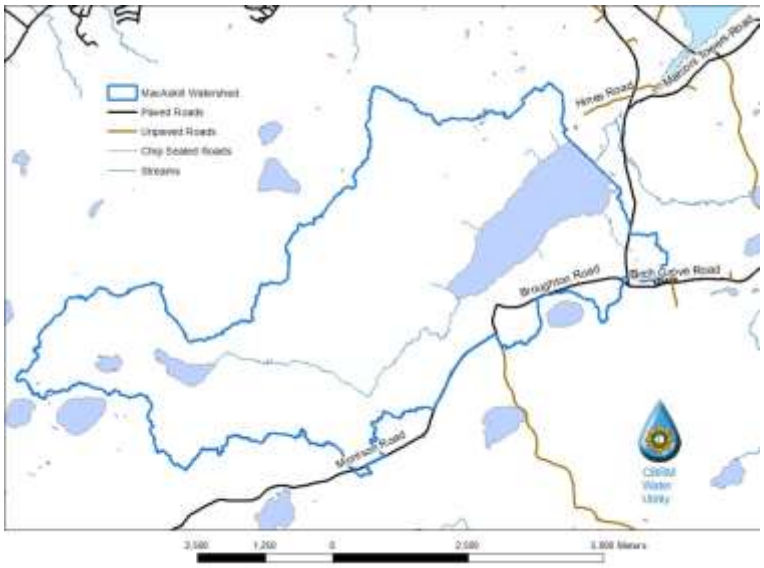
Figure 9. Ponded areas to be remediated

Minor seepage in the area of the blanket drain as shown in Figure 9 has been observed over the years and the blanket drain was repaired in 1993. Although exp says this seepage is not unexpected, they recommend collecting and measuring the volume of seepage flow at regular intervals. Tracking flow seasonally and with pond level will help establish anticipated flow levels. Unexpected changes in flow could be a warning sign of potential problems with the dam requiring further investigation (exp Services Inc. 2013b).

Another Dam Safety Review will be required in 2018. In the near future, in preparation for that review and to meet CDA guidelines, CBRM will need a detailed Emergency Response Plan, Emergency Preparedness Plan, and a Communications and Warning Plan. The main requirement for Dam Safety Management; an Operation, Maintenance, and Surveillance Manual, must be completed soon.

4.1.2 Transportation

The Birch Grove Road, Broughton Road, and Morrison Road have sections within the MacAskill Brook Reservoir watershed (see Map 6). The section of Birch Grove Road is 800 metres long, the Broughton Road portion is 3000 metres long, and a 2500 metre stretch of the Morrison Road is in the watershed or bordering it. These roads are maintained by the Department of Transportation and Infrastructure Renewal. Roads are salted in the winter, but roadside weeding is done mechanically, not with herbicides.



Map 6. Public Roads within MacAskill Brook Reservoir watershed

The Sydney airport owns land in the northern part of the watershed and, as seen in Figure 10, aircraft, such as this one in January 2010, are often flying low over the reservoir.

Figure 10. Hercules Transport plane crisscrossing reservoir airspace January 2010

4.1.3 Disposal Sites and Illegal Dumping

ADI Limited (2007) reported no NSEL permitted active or abandoned waste disposal sites within the MacAskill Brook watershed. However, Dillon (2004) listed illegal dumping as a potential source of watershed contamination and the old Cow Bay Road, seen in the foreground in the left hand image in Figure 11 is a popular dumping place.

Figure 11. Cow Bay Road and CBU cleanup crew with reservoir in the background

4.1.4 Forestry Activities

Forestry activity occurs on private land within the watershed, with clear cuts of various ages along the Old Cow Bay Road. As outlined in the May 2004 edition of Opflow (Ernst and others, 2004), increased forest cover in a watershed reduces the cost of treating drinking water. Forests, riparian areas, and wetlands act as natural filters, reducing the flow of pollutants to water bodies. Figure 12 shows a cut over on the upper reaches of MacAskill Brook and the skidder trail to take the wood closer to the Old Cow Bay Road.

Figure 12. Cut over near MacAskill Brook and skidder trail

The Source Water Protection Committee first expressed concern in 2009 about the metal plate bridge on old Cow Bay Road crossing MacAskill Brook above the reservoir. CBRM sent an email to NSTIR expressing the fear that without guard rails or even curb stops, there was considerable risk of a vehicle sliding into the brook and contaminating the

water supply. There was no response from NSTIR and the committee asked again in 2013 that CBRM reiterate their concern to the Province, who owns old Cow Bay Road. Following an accident on Thanksgiving weekend 2013, in which an ATV landed in the brook, CBRM Manager of Utilities Administration sent a letter to the District Director-Eastern of Nova Scotia Department of Transportation and Infrastructure Renewal asking for road upgrades. Figure 13 shows the somewhat icy bridge used by logging trucks and the lack of a curb stop to prevent vehicles sliding into MacAskill Brook.

Figure 13. Bridge over MacAskill Brook on old Cow Bay Road

4.1.5 Scrap Yard

At a Source Water Protection Committee meeting in June 2009, members expressed concern about the salvage yard in Birch Grove as it is adjadcent to a brook flowing to the reservoir. Figure 14 shows the large number of vehicles on site in 2008.

Figure 14. Birch Grove salvage yard as seen in 2008 photography

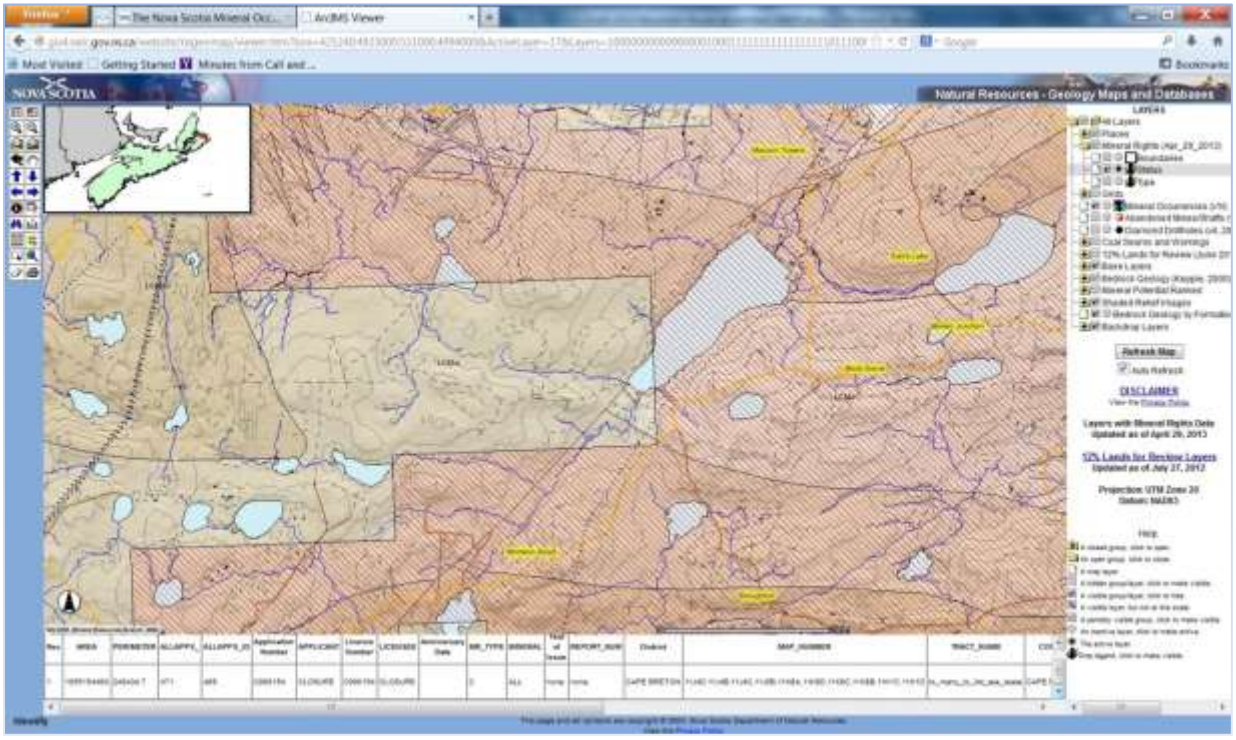
The District Manager for NS Environment in Sydney provided an information session on regulations for auto salvage yards in general and informed the committee of the results of a two day inspection by NSE staff of the salvage yard on Birch Grove Road. Although the facility in Birch Grove has a crusher, vehicles accumulate in times of poor market conditions for salvaged automobile parts. On the whole, NS Environment inspectors found the Birch Grove facility to be well run with virtually no staining of the ground caused by leakage of fluids.

4.1.6 ATV, snowmobile , and four wheel drive use

Fishing and hunting or other recreational activities are not prohibited by any regulations, but boating is not condoned. Many folks use the old Cow Bay Road and there are several campfire locations around the mouth of MacAskill Brook. These are a problem when plastics and tires are burned. The old Cow Bay Road is heavily used by four wheel drives and ATVs. Although their presence is discouraged, ATVs and snowmobiles travel at high speed along the dam. An accident putting them in the water would release hydrocarbons near the intake. The Marconi Trail Blazers are represented on the watershed committee and working with their members, instilling respect for the reservoir and its environs.

4.1.7 Mining Activities

The NS Mineral Rights database http://www.gov.ns.ca/NATR/MEB/links/modblinks.asp in late 2013, listed mineral claims within the MacAskill Brook Dam watershed as closed.



Map 7. Mapping version of the Nova Scotia Mineral Rights Database

4.1.8 Wildlife

ADI Limited (2007), reviewing historical NS Environment information, noted a nuisance license to AECL in 1993 to destroy beaver dams at or near MacAskill Brook. During an inspection of flooded borrow pits in 2013, an NS Environment Inspector recommended removing the beaver dam just below the maintenance flow from the former AECL dam. Beaver dams can result in redirection or restriction of runoff waters in the watershed and are a source of the protozoa Giardia. A trapper, who visits all CBRM water supply watersheds twice a year, trapped eleven beaver from MacAskill Dam Reservoir in 2013.

4.1.9 Residential Land Use

Dillon (2004) listed septic tank effluent and domestic fuel storage as potential sources of watershed contamination. Dwellings can also be a source of contamination from lawn chemicals and fertilizers, poor waste disposal, and improperly constructed or maintained water wells. There are forty two residential buildings within the MacAskill Brook Dam Reservoir . About half of these are served by the Birch Grove sewer and water systems and are over one kilometer from the reservoir. Of the other dwellings served by on-site septic systems and wells, the closest are about half a kilometer from the public water supply and are not considered a threat to water quality. Exp Services Inc. (2013a) reported that microbial risks are related to only natural total and faecal coliform bacteria, as well as Cryptosporidium or Giardia, which can be present in surface waters draining a natural environment. In spite of the low risk, these homes should eventually be visited by CBRM water utility staff or a consultant to ensure that best management practices with respect to well and septic system maintenance and fuel oil storage are being practised.

4.1.10 Recreation and Boating

Figure 15. Former access used by prohibited boaters at MacAskill Reservoir

During the July 2013 meeting of the Birch Grove and Area Source Water Protection Committee several members said that people were still boating on the MacAskill Brook Dam reservoir. They felt CBRM needed to gate the access to the area where boats are launched. Our Public Works staff from Glace Bay thought a solid barricade might be more effective and contracted a local company to erect the barrier pictured above.

4.1.11 Agricultural Land Use

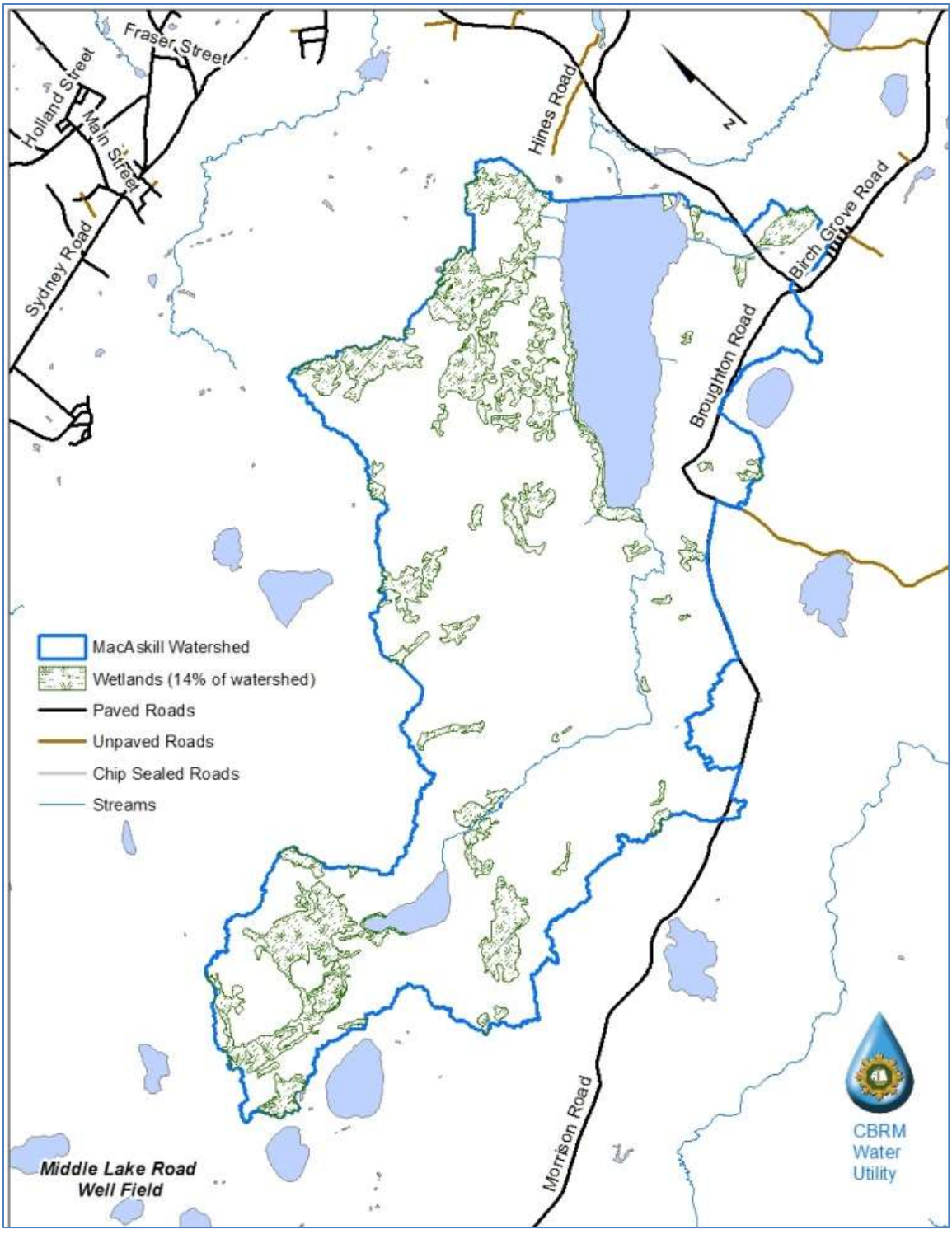
Agriculture activities are basically confined to two properties along the Broughton Road. The first property has approximately 6 sheep and 100 laying hens (numbers may vary). The second property has between 6 to 12 beef cattle (depending on the time of year) and field crops consisting of pasture land and hay. Dillon (2004) listed manure from small farms as a risk for the watershed but exp Services Inc. (2013a) felt only natural sources would be a concern for the watershed. The source water protection committee members agree that the low level of agricultural activity ensures the risk of contamination from manure is extremely low.

4.1.12 Stream and Lake Sediments

Surficial geological deposits in the area are sandy basal till but there is no geochemical information available on glacial till. Various metals can be adsorbed onto the surface of fine grained sediments in the bed of streams and lakes, and then be refluxed up into the water column in dissolved form. ADI Limited (2007) reviewed the Geochemical Atlas of Nova Scotia (Lombard, 1990), finding elevated metal concentrations in stream sediments in the general MacAskill Brook area for cobalt, copper, lead, zinc, iron, arsenic, tin, antimony, nickel, chromium, tungsten, rubidium, thorium, uranium, barium, and lanthanum. Lake sediments were also elevated in cobalt, copper, lead, zinc, iron, arsenic, antimony, nickel, and uranium, plus manganese, mercury, and molybdenum. The consultant stressed that although there may be elevated metals on stream and lake sediments, concentrations are not necessarily above environmental quality standards. They also may not be available in dissolved form for intake by organisms.

4.1.13 Wetlands

Map 8 displays wetlands in the MacAskill Brook Dam reservoir watershed area. Water from wetlands contain organic acids that can lower stream pH and buffering capacity, create coloured water systems, and elevate iron and manganese levels. Although wetlands constitute only 14 per cent of the watershed, MacAskill Brook Dam raw water is acidic and coloured, exceeds the Canadian Drinking Water Quality Guidelines aesthetic objective (AO) for iron and manganese in treated water, and alkalinity readings are much less than the AWWA criteria of greater than 40 mg/L required for corrosion protection.



Map 8. Wetlands within MacAskill Brook Dam watershed

5.0 MANAGEMENT PLAN

Guided by the list of land uses with relative risk to source water (Table 2), the MacAskill Brook Dam source water protection committee prioritized concerns for the watershed (Table 3) and developed an implementation schedule presented below in Table 4.

	2013				2014	
Management Strategy	**Jan - Mar**	**Apr - Jun**	**Jul - Sep**	**Oct - Dec**	**Jan -Mar**	**Apr - Jun**
Outreach and Education						
Work with ACAP CB to create community awareness						
Put source water protection materials on the CBRM web site						
Establish watershed protection signage at access roads						
Encourage household well, septic system and oil tank maintenance						
Have open meeting in Birch Grove to finalize SWPP (done 2011)						
Develop and distribute SWP Plan Newsletter (done fall 2012)						
CBRM Policy, Procedure, and Practice						
Implement Dan Safety Review (final report received 2013)						
Remediate ponds at base of dam						
Update contingency/ EMO plans for spills\accidents						
Review water sampling program (updated 2013)						
Work with CBRM Planning Department on zoning requirements						
Develop CBRM policy on mineral exploration in watershed						
Research, Mapping and Monitoring						
Survey location and condition of all stream inlets						
Research lake bottom sediment and aquatic life						
Conduct regular dam surveillance and monitoring						
Take water samples for bacteria, chemicals, (PAHs, phenols)						
Install water level gauge near dam						
Obtain bathymetry and develop stage-storage curves (done 2010)						
Support of Provincial and Federal Initiatives						
Sustainable forestry methods education (NSWOOA letter 2013)						
Work with NSE to develop designation regulations?						
Review and update SWP Plan						
Support better management of the Cow Bay Road (dumping)						
NSEN Water Caucus						
Evaluate impact of provincial wetland strategy on watershed						

Table 4. Source water protection plan implementation schedule

As shown, the implementation schedule for the MacAskill Brook Dam Reservoir is grouped in four categories:

- Outreach and Education
- CBRM Policy, Procedure, and Practice
- Research, Mapping, and Monitoring
- Support for Provincial and Federal Initiatives

5.1 Outreach and Education

The CBRM Water Utility encourages inclusive rather than restrictive use of water supply watersheds. The Utility stresses education of the community to encourage cooperative use of the watersheds while supporting enforcement of regulations against the disrespectful minority. These themes are the foundation of public education and outreach work encouraged by the Birch Grove and Area source water protection committee.

The *Municipal Planning Strategy of the Cape Breton Regional Municipality* (CBRM 2007a, page 9.7) discusses public education:

The majority of people will respect the need to protect the watershed of a source of public drinking water. However, people need to know if and when they are within a watershed. The responsibility of the Regional Municipality is to notify and educate. Notification in the form of signage will be placed directly within the watersheds. Property owners could regularly receive literature (e.g. along with their tax bill) that they own land within a public water supply watershed and what conservation methods are recommended.

Signs have been distributed throughout the watershed areas to inform the public where the water supplies are located. So-called "Violation" signs (see Figure 16 below and Figure 17, Appendix G) have been placed near most water supplies on CBRM land. Other "Keep it Clean" signs (see Figure 18, Appendix G) are placed in the watershed on private lands where the landowner has requested it or on Crown land with the permission of NS DNR staff. These signs have been placed around the MacAskill Brook Reservoir and along ATV trails throughout the watershed.

Figure 16. Violation sign near MacAskill Brook

CBRM and the Atlantic Coastal Action Plan Cape Breton (ACAP CB) continue to develop media messages related to source water protection core goals and objectives.

Goals:

- Increase awareness about the importance of source water protection
- Increase awareness of the locations of water sources for each community
- Increase awareness of the behaviour that is prohibited close to water sources (i.e. illegal dumping, swimming, littering, burning, cutting, ATVs, boating, personal watercraft and snowmobiles)

Objectives:

- Deliver consistent messaging, incorporated into all initiatives
- Engage students and residents in activities that support and encourage positive behaviour and increase awareness about our water sources

New activities in 2013/2014 include Watershed Explorers and the Water Cycle Video Series. The Watershed Explorers program plans to guide elementary students on tours of watersheds near their schools. The Water Cycle Video Series is being prepared by a local media company based on a script developed by CBRM and ACAP CB. It is directed at high school students and will be distributed by DVD and on line. The video includes three segments, the first being Source Water, then Water Treatment, and Water Distribution.

Water Walks or snow shoe tours of CBRM water sources continue to be popular and introduce more folks to our water supply watershed areas. A MacAskill Brook Dam snow shoe event is planned for early March 2014. ACAP CB continues to promote the Water Tool Kit as part of the Cape Breton Victoria Regional School Board (CBVRSB) curriculum. ACAP CB also organizes many high profile fundraisers, programs, and events each year, which present an opportunity to benefit from media coverage and an increased awareness of source water protection.

CBRM's watershed coordinator maintains a portion of the CBRM web site:

http://www.cbrm.ns.ca/source-water-protection.html

The Glace Bay page links to mapping and minutes of the Birch Grove and Area SWPP committee meetings and the source water protection plan. ACAP CB also promotes source water protection activities on their web site and social media links. As well, ACAP CB has revamped their water display at the Centre for Sustainable Communities to include a YouTube educational video playlist which is continually refreshed.

In 2012, the CBRM Water Utility and ACAP CB collaborated on a newsletter that was included in the water bills to all customers of the Glace Bay and Area water distribution system. The *Word on the Watershed* newsletter showed the spillway and the hydrometric station on MacAskill Brook and portrayed the repairs made to maintain the stability and integrity of the large dam. The newsletter, which is included in Appendix H, was also made available at the Glace Bay Citizen Service Centre (CSC).

5.2 CBRM Policy, Procedure, and Practice

5.2.1 Implement Dam Safety Review Recommendations

The MacAskill Brook Dam Safety Review confirmed that the dam was high enough to avoid overtopping in flood conditions, although another 30 centimeters of rip rap along the top would be beneficial for erosion control. Ponds at the toe of the dam make it impossible to determine if water is leaking under the dam. CBRM has obtained permission from NS Environment to remediate these former borrow pits and a contractor has been hired to do the work.

NS Environment and Fisheries and Oceans Canada require CBRM to provide 5 cubic feet per second (cfs) of maintenance flow to the NSPI fish weir on MacAskill Brook at all times. As Sand Lake Brook provides at least one cubic foot of flow, CBRM needs to provide four cfs through the maintenance flow pipe under the dam. Conservative estimates indicate there is a minimum of 4.13 cfs of flow from the dam at all times, which meets the DFO/NSE requirements.

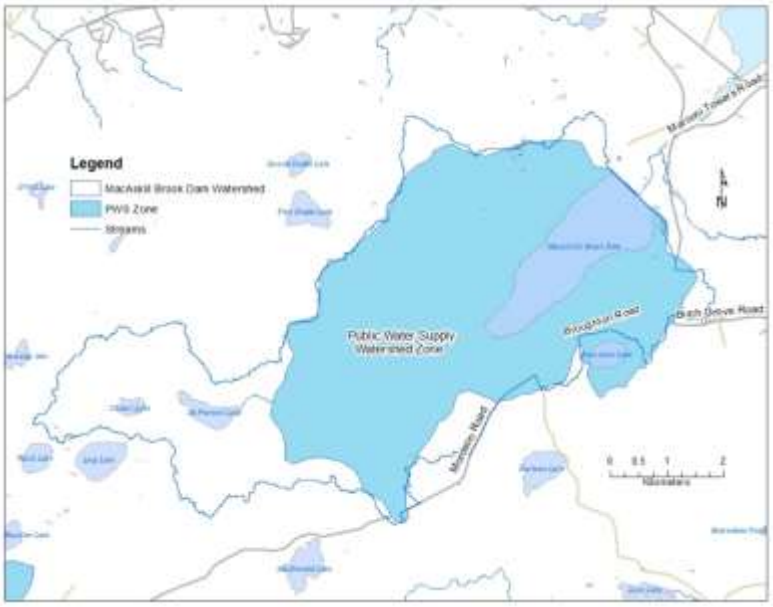
NS Environment and exp consultants both noted the lack of monitoring of storage levels in the reservoir. Although the gate house would originally have housed equipment to record water level, this was vandalized over the years. CBRM, as part of its approval to withdraw water, will install water level recorders for the reservoir.

5.2.2 Emergency Response Plan

In their 2013 water system assessment, exp Services Inc. (2013a) recommended that CBRM undertake scenario planning with EMO and operations to enhance response time and approach to various critical issues, which could impact yield and quality (e.g. forest fires, downed aircraft approaching Sydney airport, dam breach/break, etc.). A generic contingency plan is included in Appendix C of this report. This will be replaced with a current MacAskill Brook Dam Emergency Response Plan when it is completed. As there is no back-up water supply for Glace Bay, contingency planning is crucial.

5.2.3 Land Use and Planning

The Cape Breton Regional Municipality, through their planning department, developed a regional municipal planning strategy and land-use by-law in August, 2004. This regional plan created a Public Water Supply (PWS) Zone which was applied to the various water supply watersheds throughout the municipality, including MacAskill Brook Damreservoir. PWS permitted uses do not include commercial or industrial development, requirements for residential development are very specific, and no intensive agriculture is allowed. The boundary for the MacAskill Brook Dam PWS Zone was prepared years ago before detailed LiDAR data was available. Map 9 shows the discrepancy between the zoning and the recently mapped watershed boundary. The PWS permitted uses are listed below the map.



Map 9. MacAskill Brook Reservoir watershed and PWS Zone

Section 1 PWS Uses Permitted

Development Permits shall only be issued in the PWS Zone for one or more of the following uses in compliance with any relevant section of the General Provisions Part, and any specific section of this Part devoted to the use.

- ***agricultural – only the following***
- *crop farming*
- *animal grazing*
- *existing agricultural buildings housing or impounding animals highlighted on the Land Use By-law Map*

- ***conservation and water utility related uses – (all)***

- ***forestry uses – only the following***
- *harvesting*
- *silviculture*

- ***residential – only the following***
- *existing residential dwellings*
- *mobile/mini/rectangular dwellings in compliance with Section 2*
- *single detached dwellings in compliance with Section 2*

Section 2 Lot Development Requirements for dwellings

- *Minimum lot size = 5 acres*
- *Minimum public street/road frontage = 300 feet*
- *The lot on which the dwelling is to be constructed shall only front along a public street/road that existed on the date this Land Use By-law came into effect.*

CBRM (2007b, page 98)

5.3 Research, Mapping, and Monitoring

Exp Services Inc. (2013a), in a system assessment of the Glace Bay water supply, made the following recommendations regarding SWPP monitoring:

- Enhance the frequency of monitoring for select parameters to aid in identifying impacts due to a changing climate.
- Undertake a limnological investigation to determine changes in water and biological quality with depth, space, and time. This would also form a baseline for assessing the impact of changing climate.
- Add all historical raw water chemistries to the database to provide a longer time series for trending.

With regard to provincial Guidelines for Monitoring Public Drinking Water Supplies parameters monitoring (NS Environment 2005), exp recommended:

- Monitor additional parameters under special circumstances e.g. use of fire suppressant chemicals to deal with forest fires, presence of blue-green algae, or other biological elements as climate changes.

5.4 Support of Provincial and Federal Initiatives

5.4.1 Inspection and Enforcement

The CBRM Water Utility desires inclusive rather than restrictive use of water supply watersheds. The utility encourages recreational use of the watershed by hikers, cross country skiers, and other self-propelled users. It is hoped that these users would provide a certain level of inspection and security. CBRM has no watershed enforcement staff and needs help investigating illegal activities such as dumping, conducted by the disrespectful minority. Exp Services Inc. (2013a) recommended maintaining a special constable for solid waste to deal with illegal dumping in the watershed. Funding for this person is provincial.

With respect to provincially permitted activities, the SWPP committee learned that NSE inspections are completed using a risk-based approach—salvage yards, for example, may be inspected every three to five years depending on the situation. If committee members feel there are problems with the yard in the watershed they can contact the Sydney office of NS Environment and request an inspection. NS Environment staff indicated that a salvage yard in a drinking water watershed would be checked more regularly anyway.

5.4.2 Road Maintenance

As discussed in section 4, Nova Scotia Department of Transportation and Infrastructure Renewal (TIR) maintain the paved roads in the area of MacAskill Brook Dam. CBRM has relayed SWPP concerns to NSTIR over the lack of guardrails near the Cow Bay Road. The Cow Bay Road, itself, is owned but not maintained by NSTIR. The bridge

over MacAskill brook requires a curb or guard rail and TIR staff have been told of this deficiency.
TIR and CBRM must ensure road works employ the necessary containment devices for temporary fuel storage and erosion controls to reduce the potential for migration of sediments from disturbed sites. This may need to be achieved through the inclusion of wording in all contracts and purchase orders.

5.4.3 Forest Management Best Management Practices (BMPs)

Other source water protection plans for CBRM have looked at best management practices for forestry, agriculture, mining, and residential development. Provincial or municipal reports were reviewed by the watershed coordinator and by committee members with knowledge in the particular sector. Pertinent practices are then recommended in the source water protection plans. Agriculture, residential, and mining activities are not a concern for the MacAskill Dam Reservoir watershed, but forestry is.

The Nova Scotia Department of Natural Resources and Nova Scotia Environment and Labour (2005a) collaborated on a manual of best practice, *Best Management Practices/Forest Planning in Municipal Drinking Water Supply Areas Nova Scotia*. Appendix A of the provincial document, "Summary of Existing Regulations and Practices that Contribute to Maintaining Water Quality," encourages due diligence and includes reasonable practices to mitigate or protect against foreseeable potentially damaging actions or activities. Appendix B is entitled "Potential Analysis, Planning, Implementation, Inspection, Monitoring and Continual Improvement Process."

Appendix C of *Best Management Practices/Forest Planning in Municipal Drinking Water Supply Areas Nova Scotia* outlines examples of enhanced practices that might be adopted following an analysis and planning exercise (see appendix F of this report). The CBRM Water Utility could provide assistance with trail planning and locating vegetable-based oil and spill kits. Contractors on municipal land and landowners working on their own properties will be provided with information on forest management best management practices. Forest harvesters will also be directed to staff from NS Environment and NS DNR for advice on stream crossings and wetlands delineation.

5.4.4. Residential Septic Systems and Wells Best Management Practices

In 2004, CBRM adopted a regional planning strategy. Part 8 of this document, "Public Works Infrastructure Services," looked at alternatives to conventional wastewater disposal systems where on-site disposal systems were experiencing problems. As a result of problems with existing on-site systems, an expensive urban sewer system was built in Birch Grove and a community well serviced by CBRM was constructed in Floral Heights in Sydney River. Inspection of existing systems near MacAskill Brook Dam should be done before problems arise. Most locations near MacAskill Dam Reservoir are too far removed from municipal sewer and water to be considered for those services and homeowners must ensure domestic wells and the lake are not contaminated by failed septic systems. ACAP CB has the expertise to explain to homeowners how to properly

maintain rural wells and septic systems. They could also inspect domestic oil storage tanks which can be a source of water contamination.

Part 9 of the 2004 CBRM Municipal Planning Strategy, entitled "Environmental Issues," began with a section on public water supply watersheds. Policy 1.e of part 9 encouraged Council to adopt a by-law that would create wastewater management districts (WMDs) to service residential septic systems in water supply watersheds. Monitoring and maintenance programs for septic systems would become mandatory within these areas. This might include inspections of all on-site sewage disposal systems, cost sharing replacement programs for malfunctioning or antiquated systems, and regular septic tank clean outs. The program would be carried out by the municipality and paid for by the owner as an additional taxed service. To date, no waste water management districts have been implemented in CBRM. The regional waste water strategy and the Integrated Community Sustainability Plan (Stantec 2010) reviewed the waste water management model, but none were identified within CBRM.

6.0 MONITOR AND EVALUATE

Source water protection monitoring is a formalized review process that reviews the performance of the source water protection plan. This typically involves monitoring the quality of source waters to evaluate changes in the state or health of the water supply area. The plan may not be meeting its objectives if water quality is deteriorating in the water supply or the identified management options (such as BMPs) are not being followed. A municipality or utility should be able to link deterioration in water quality to one or more of the risks identified in the source water protection plan.

Source water protection monitoring complements, but is different from, regulatory compliance monitoring completed by a utility or municipality on its raw water to meet regulatory requirements. Raw water quality monitoring may be on a much more frequent basis depending on the source of supply, risk of contamination, type of treatment, and similar factors.

As well, SWP plans need to be regularly reviewed to ensure new land uses or activities, or, conversely, the cessation of land uses/activities are included. Also, any changes to the water supply infrastructure, such as construction of a new well or the introduction of new legislation, should be noted. The monitoring and evaluation program for the SWPP will help assure the Birch Grove and Area Source Water Protection Planning Committee that the plan remains current with changing conditions and priorities in the water supply area.

6.1 Regulatory Compliance Monitoring

Under the requirements of the *Environment Act*, the Activities Designation Regulations, and the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations, CBRM samples raw water before it enters the treatment process. The raw water is tested daily for turbidity and pH and twice yearly (spring and fall) for chemical quality. Although the health based Guidelines for Canadian Drinking Water Quality (GCDWQ) do not apply to raw water, seven parameters in raw water from the MacAskill

Brook reservoir exceeded the limits set out in the GCDWQ or American Water Works Association (AWWA) criteria: turbidity, colour, iron, manganese, aluminum, total organic carbon, and alkalinity.

Water samples taken from various locations throughout the distribution system once a week are tested for total and fecal coliform and free chlorine residual. Treated water, like raw water, is also tested twice a year for the levels of chemicals and metals. In 2012 there were no exceedances of any parameters in treated water. Quarterly tests are done for levels of trihalomethanes (THMs), bromodichloromethane, and haloacetic acids (HAAs). Again, there were no exceedances. The water utility prepares annual reports for each treatment plant summarizing sampling results. See Appendix E for the 2012 baseline chemical quality reports for MacAskill Brook Dam Reservoir.

In 2009, MacAskill Brook Reservoir raw water was tested for polychlorinated biphenyls (PCBs) and a number of organic chemicals that would indicate petroleum or industrial contamination. No contaminants were detected. The full parameter testing will be conducted in all water supplies again in 2014. As a condition of water withdrawal approval, NS Environment has requested a water sample be collected of reservoir water once a year during a low flow period. This testing will begin in 2014. Since 2012, CBRM Water Utility has also been taking monthly water samples at the spillway as a control for phenol and PAH (polycyclic aromatic hydrocarbons) testing of raw water at the plant. This test will indicate if any creosote is leaching from the wood stave lines feeding the plant. To remove any chance of such contamination, CBRM intends to run plastic pipe through the existing wooden lines.

Exp Services Inc. (2013a), as part of the water system assessment selected a total of thirteen inorganic chemical indicators for trend analysis to determine if any changes were occurring in raw water chemistry that would indicate further action was required for protecting the supply. Two samples per year from 2009 to 2012 were available. The major ion indicators (total dissolved solids (TDS), chloride, sulfate, alkalinity and silica) indicated no notable trends. The physical indicators (pH, turbidity, colour) indicated a gradual decline in colour. The nutrient indicators (nitrate+nitrite as N and total organic carbon) indicated no notable trends. The metal indicators (iron, manganese and aluminum) indicated a gradual decline in manganese. The trends maybe associated with seasonal and/or storm related events.

The consultants recommended:

- All raw water chemistries, including those collected by Atomic Energy of Canada Limited and/or Nova Scotia Power Incorporated (NSPI) should be added to the CBRM's Excel spreadsheet for raw water quality monitoring data to aid in providing a longer time baseline of conditions.
- Any additional monitoring recommended in the Dam Safety Assessment Report should be implemented.

6.2 Water Supply Area Monitoring

In addition to monitoring the water supply area through water quality and quantity sampling, municipalities should also undertake visual monitoring of their water supply area. For example, regularly driving by or walking through the watershed area can identify potential water quality problems, such as all-terrain vehicles in watercourses. Surveys and discussions with local landowners can reveal if they are following best management practices. This may help determine if additional education efforts are required, identify problems that are not being adequately addressed, or may identify activities that are in violation of the bylaws or regulations that have been put in place to protect water quality.

The watershed coordinator regularly visits the MacAskill Dam Reservoir area to monitor activities. Beginning in 2014, operations staff will be on site more regularly as part of the dam safety surveillance and monitoring program. ACAP CB will try to organize at least one "Water Walk" in the area, and CBRM and ACAP CB will discuss home visits to educate homeowners on proper maintenance of wells and septic systems.

6.2.1 Data Management

CBRM water supply system data is managed using programmable logic controls (PLC) and automatic communication to servers linked to a supervisory control and data acquisition (SCADA) system. The plant processes are manually controlled by the operator. There is a SCADA (supervisory control and data acquisition) system which monitors the tank levels and relays them to the Sydney Water Treatment Plant. There is some on-line instrumentation including turbidimeters and a flow monitor. The readings from these instruments are used for local display only; they are not stored for further analysis and development of trends.

CBRM had hoped for a regional communications upgrade with all information reporting to a central server, but this may not be possible. Security has been improved by requiring a VPN (virtual private network) sign in before reaching the SCADA computer, meaning users must authenticate twice to access SCADA remotely. Although the digital database is continually upgraded as change occurs, the current efforts of the CBRM are focussed on systems to document and track drinking water quality. Expansion of the system will be required to accommodate suggested monitoring programs.

The CBRM planning department has significant GIS capability. Geographic information systems (GIS) provide a valuable planning tool for watershed protection. The current watershed coordinator was a former GIS technologist with the CBRM planning department and has been able to build GIS files for all the watershed areas. Future monitoring data must be supplied in digital formats that can be related to the georeferenced GIS files. It is also important that the water utility retain an employee with GIS skills, as the CBRM engineering and public works department relies totally on CAD software which does not provide the analytical tools required for watershed management.

6.3 Source Water Protection Plan Review and Update

A hydrogeologist, making a presentation to the Pottle Lake SWPP committee, stressed that further data is needed to manage watersheds. The following suggestions for monitoring or research could be applied to MacAskill Brook Dam Reservoir:

- collect and analyze water samples identifying bacterial and chemical/mineral levels, and lake bottom sediment throughout the year to protect human and aquatic health,
- identify amounts of water going into the lake via surface and ground water runoff and amounts of water extracted for human use and being lost through evaporation,
- install monitoring equipment to collect baseline data for future reference and assess climate change impacts to the lake, and
- develop a contingency plan for the lake.

The Birch Grove and Area SWPP Committee will regularly review and update the source water protection plan. NS Environment watershed planners recommend annual reviews of the plans and full revisions every five years or after significant changes to the water supply system or its source. Suggested questions for review include:

- How many source water committee meetings have been held in the past year?
- Have there been any changes to committee membership?
- Have there been any changes made to the committee terms of reference?
- Have changes to the system infrastructure been made (e.g. wells constructed or decommissioned)?
- Have there been changes to property ownership within the watershed or aquifer area?
- Have new land uses begun (or existing uses changed or ceased) within the watershed or aquifer area?
- Have activities continued, declined or increased with the past year within the watershed or aquifer area?
- Have any new risks to the watershed or aquifer area been identified? What risk reduction strategies will be employed?
- Have any accidents/emergencies occurred within the watershed or aquifer area within the past year?
- Has source water monitoring (differs from regulatory compliance monitoring) been undertaken? Please describe the results.
- Has your contingency plan been reviewed and contact information updated?

NS Environment also recommends providing an updated implementation plan, including items completed, ongoing, or yet to be completed. Based on consideration of all the above questions, committees need to identify items to be added to the implementation plan.

6.4 Further Research

There is a lack of detailed hydrological and hydrogeological studies for the MacAskill Brook watershed area. ADI Limited (2007), referring to the MacAskill Brook Reservoir, recommended long-term monitoring programs. They suggested undertaking affordable, practical programs each year to obtain information pertinent to answering specific operation or protection issues as they arise.

Priority questions might include:

• *How much water resides in storage within the lake? How does it fluctuate seasonally/annually? How much is accessible at the extraction point?*
• *What are the seasonal, storm, and snowmelt fluctuations in the water chemistry? What chemicals are present on the lake bottom sediments?*
• *Does MacAskill Brook provide fish habitat? If so, how should flows be managed to maintain and improve it?*

CBRM Water Utility staff may eventually develop programs such as stream flow monitoring for both inflow and outflow, collection of air and water temperatures at stream flow gauges, stage monitoring, and the monitoring of fresh water aquatic life. Fortunately, lake bathymetry surveys were completed and were essential in the dam safety assessment.

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APPENDIX A SWPP COMMITTEE

2014 Birch Grove and Area
Source Water Protection Planning Committee

2014 Birch Grove and Area Source Water Protection Planning Committee

Kevin Saccary, CBRM Councillor - chair
Doug Lawrence, Landowner (CBRPS) - vice chair
Audrey Turnbull, Landowners
David Turnbull, Landowner, MacAskill Brook Dam Reservoir and
Birch Grove Rural Development Association
Ross MacDonald, Landowner
Ed Barrington, Landowner, MacAskill Brook Dam Reservoir
David Mayich, Enterprise Cape Breton Corporation (ECBC)
Britt Roscoe, CBRM Watershed Coordinator
Brian MacSween, DNR Forester
Allister MacLean, Marconi Trail Blazers ATV Club
Rob Boutilier, Port Morien Wildlife Association
Ron Peach, Port Morien Development Association and
Citizens Against Strip Mining (CASM)
Position not currently filled, NSEL Watershed Planner
Charlie Morrison, NSE Inspector Specialist

APPENDIX B COMMITTEE TERMS OF REFERENCE

Terms of Reference
Birch Grove and Area Source Water Protection Planning Committee

TERMS OF REFERENCE

Birch Grove and Area Source Water Protection Planning Committee

1.0 PURPOSE:

The purpose of the Birch Grove and Area Source Water Protection Planning Committee is to protect three watersheds by:

(a) Advising the CBRM Water Utility on the management of MacAskill Brook Dam Reservoir, John Allen Lake, and Sand Lake watersheds in order to ensure an adequate supply of safe drinking water from the watersheds;

(b) Collecting and reviewing information from stakeholders and other resources, and using that information to work with stakeholders to protect the water supplies to Glace Bay, Dominion, Reserve Mines, Tower Road, Donkin, Birch Grove, and Port Morien;

(c) Providing a forum for landowners, residents, and users of the watershed to contribute and receive information and discuss all matters related to the management of the watersheds;

(d) Preparing, and helping to implement through activities such as education, a water supply watershed management strategy for the MacAskill Brook Dam Reservoir, John Allen Lake, and Sand Lake watersheds.

2.0 SCOPE

The water supply watershed includes MacAskill Brook Dam Reservoir, John Allen Lake, Sand Lake, and all those lands, watercourses, water bodies, and wetlands which drain into the three lakes.

3.0 MEMBERSHIP

Voting Members
Private Landowner Representatives – 5 members (representing the three supplies)
Citizens Against Strip Mining (CASM) - 1 member
Port Morien Wildlife Association – 1 member
Marconi Trail Blazers ATV Club – 1 member
Port Morien Development Association - 1 member
Birch Grove Rural Development Association – 1 member
Councillor, CBRM – 1 member
CBRM Water Utility – 1 member
Cape Breton Development Corporation (DEVCO) – 1 member
Enterprise Cape Breton Corporation (ECBC) (DARR) – 1 member
NS Department of Natural Resources - 1 member

Resource Members (non-voting)
NS Department of Environment
Cape Breton Regional Police Services

Note:
The current membership constitutes the committee, but representatives of other groups of interest may be accepted.

4.0 OPERATION OF COMMITTEE

(a) The committee chair and vice-chair will be elected every two years by the committee.

(b) CBRM will provide secretarial services.

(c) The committee will endeavour to conduct business by consensus which requires:
- much discussion involving all sides or points of view
- agreement by all concerned on a specific issue
- encouragement of participation and involvement by everyone

Should the committee be unable to attain consensual agreement on an issue, voting may be necessary. All motions require support from at least a two-thirds majority of the members present. Members representing more than one group shall have only one vote.

(d) Eight voting committee members will constitute a meeting quorum.

(e) A Public Meeting may be called at the discretion of the committee.

(f) The Terms of Reference may be modified or updated by the committee by motion.

APPENDIX C CONTINGENCY PLAN

CONTINGENCY PLAN

A contingency plan is a set of predetermined actions and communications to be initiated in the event that a water utility cannot provide adequate water supply due to contamination or a loss in available quantity. The area around MacAskill Brook Dam Reservoir is reasonably remote; however, in an effort to be vigilant, the contingency plan identifies key personnel, other resource people including agencies such as EMO and the Department of Environment. The Contingency Plan for MacAskill Brook watershed is currently being completed by the CBRM Water Utility.

Source Water Contamination and Operational Issues:

Potential contamination of the watershed could occur from various situations and land uses. Loss of water quantity is a result of the lack of normal precipitation, mainly during the summer months. Specific land use activities/hazards that have been identified for potential contamination and immediate response may include:

- Bacterial contamination
- Petroleum spill from any mechanized vehicle or machinery
- Increased siltation from significant climatic events
- Illegal dumping
- Forest fires

Additionally, other problems can occur that would require immediate response. They include:

- Power outage
- Break in chlorine line
- Vandalism

Being prepared with a list of options is important to ensure a fast and efficient response to emergencies. Making an inventory of existing and required equipment allows the utility to document what options exist in an emergency. The following are important considerations to be prepared for an emergency:

Bacterial Contamination:

- What was the source?
- Kept abreast of Boil Order Procedures and communications plan.

Chemical/oil spill:

- EMO, fan out list (existing)
- Develop an inventory of all materials and/or chemicals that travel through the watershed on a regular basis
- Confirm contacts for emergency excavators and booms (existing)

Siltation:

- Monitor changes in siltation after significant events.

Garbage:

- Prepare an inventory of sites where illegal dumping has occurred.
- Monitor sites for dumping.
- Prepare to remove garbage immediately.

Forest Fires:

- Continue to work with DNR to develop contingency actions regarding forest fires.
- What are alternative sources of water?

Power Outage:

- Standby power generation (existing).

Break in chlorine line:

- Duplex Chlorine System (existing).

Vandalism:

- Inventory possible impacts from vandalism.

Action Plan

1. Shut water system down

CBRM Water Utility is to immediately block all water lines to the public.

Francis Romard, Senior Treatment Plant Operator: (902) 565-6193

2. EMO Notification and Environmental Emergencies

John Dilney, EMO Co-ordinator: (902) 563-2352

Environmental Emergencies: 1-866-424-5620

The EMO Co-ordinator has a list of all people, agencies, and groups that must be called and their telephone or pager numbers, for any type of emergency.

Anyone responsible for a spill or release of dangerous goods or hazardous wastes, or anyone witnessing such an incident is responsible for reporting such to the proper agencies. All calls should be directed first towards the Public Works Operator at (902) 563-5255 or 911.

The EMO Co-ordinator and Committee will be responsible for ensuring the proper agencies, groups and people are notified in an emergency. They will authorize the commitment of any resources that may be required, act as focal points for information exchange, and be responsible for communication with government personnel.

Callers should be prepared to report:

- The substance, if known, and the amount
- Location of the spill
- Time of the spill
- Source of the spill

Other agencies and people that must be contacted through the EMO Director:

- Department of Environment 1-800-705-2388
- Cape Breton HazMat Team, George Muise (902) 563-6396
- Coast Guard Environmental Emergencies 1-800-565-1633
- Department of Fisheries and Oceans (902) 564-2400
- Canadian Transport Emergency Centre (CANUTEC) Emergency Information Line (613) 996-6666

3. Communicate information to the public

- Alert on TV/Radio
- Public Works (902) 563-5255

4. Provide options for alternative water supply to residents

- Employ boil order
- Employ alternate water sources (determine what would that be)

List of Emergency Contact Numbers:

EMO 24 Hr. Contact Number: (902) 424-5620
John Dilney Co-ordinator (902) 563-2352

Environmental Emergencies: 1-866-424-5620

Glace Bay Water Treatment Plant:	1-902-842-4203
Pager/Cell for Superintendent:	1-902-565-6193
Emergency Back-up:	1-902-563-5255
Cape Breton HazMat Team	1-902-563-6396
Coast Guard Environmental Emergencies:	1-800-565-1633
CANUTEC Emergency Information Line:	(613) 996-6666

APPENDIX D RISK ASSESSMENT MATRIX

Contamination Issue	Activity/Cause	Scale of Problem*	Priority Rank**
Nutrients	• Agriculture	3	2
Fuel Leaks	• Domestic oil tanks	4	1
Sedimentation	• Construction • Agriculture • Forestry	1 2 4	1 2 3
Pesticides	• Agriculture	4	2
Bacteria	• Domestic septic systems • Manure • Municipal effluent	2 3 3	1 2 3
Salt	• Road de-icing	3	4

** 1 = Severe, 3 = Moderate, 5 = Minimal ** 1 = High, 3 = Moderate, 5 = Low*

NS Environment list of activities with relative risk to source water

APPENDIX E MACASKILL BROOK DAM WATER CHEMISTRY

2012 Annual Report Glace Bay Water Treatment Plant

April 1st, 2013

Table 8: BASELINE CHEMICAL QUALITY

Parameter	Health-based Guideline (mg/L)	AO [or OG] (mg/L)	RAW WATER - Glace Bay Water Treatment Plant 2281 Birch Grove Rd		TREATED WATER- Glace Bay Water Treatment Plant 2281 Birch Grove Rd	
			March 14th (mg/L)	September 19th (mg/L)	March 14th (mg/L)	September 19th (mg/L)
Alkalinity (Total as $CaCO_3$)	--	--	5.3	<5	27	22
Total Aluminum	--	0.1	0.17	0.15	0.019	0.019
Nitrogen (Ammonia Nitrogen)	--	--	<0.05	<0.05	<0.05	<0.05
Total Antimony	0.006	--	0.0021	<0.001	0.0011	<0.001
Total Arsenic	0.010	--	<0.0006	<0.0006	<0.0006	<0.0006
Total Barium	1	--	0.0088	0.0067	0.0074	0.0064
Total Boron	5	--	<0.1	<0.1	<0.1	<0.1
Total Cadmium	0.005	--	0.000028	<0.000017	<0.000017	<0.000017
Total Calcium	--	--	1.6	1.1	20	16
Dissolved Chloride	--	≤250	9.3	8.2	12	11
Total Chromium	0.05	--	<0.001	<0.001	<0.001	<0.001
Colour (TCU)	--	≤15 TCU	64	59	<5	<5
Conductivity (µS/cm)	--	--	50	41	160	140
Total Copper	--	≤1.0	0.078	0.048	0.021	0.027
Dissolved Fluoride	1.5	--	<0.1	<0.1	0.51	0.5
Hardness as $CaCO_3$	--	--	8.2	6.2	54	44
Total Iron	--	≤0.3	0.42	0.67	<0.1	<0.1
Total Lead	0.01	--	<0.001	<0.001	<0.001	<0.001
Total Magnesium	--	--	1	0.82	1	0.91
Total Manganese	--	≤0.05	0.17	0.13	0.031	0.033
Nitrate	10	--	0.054	0.054	<0.05	0.053
pH	--	6.5 - 8.5	6.3	5.8	7.1	7.3
Total Potassium	--	--	<0.6	<0.6	<0.6	<0.6
Total Selenium	0.01	--	<0.001	<0.001	<0.001	<0.001
Total Sodium	--	≤200	5.7	5.2	8.5	10
Dissolved Sulphate	--	≤500	4.3	2.7	32	29
Calculated Total Dissolved Solids	--	≤500	28	21	93	84
Total Organic Carbon	--	--	5.8	5.2	2.5	2.4
Turbidity (NTU)	1.0	--	1.1	0.96	<0.1	<0.1
Total Uranium	0.02	--	<0.00015	<0.00015	<0.00015	<0.00015
Total Zinc	--	≤5	0.055	0.018	0.066	0.064
Other Parameters Sampled						
Total Beryllium	--	--	<0.0005	<0.0005	<0.0005	<0.0005
Total Bismuth	--	--	<0.002	<0.002	<0.002	<0.002
Total Cobalt	--	--	<0.001	<0.001	<0.001	<0.001
Total Lithium	--	--	<0.001	<0.001	<0.001	<0.001
Total Molybdenum	--	--	<0.004	<0.004	<0.004	<0.004
Total Nickel	--	--	<0.003	<0.003	<0.003	<0.003
Nitrite (N)	--	--	<0.01	<0.01	<0.01	<0.01
Nitrite + Nitrate	--	--	0.054	0.054	<0.05	0.053
Orthophosphate	--	--	<0.01	<0.01	0.08	0.077
Total Phosphorus	--	--	<0.1	<0.1	0.16	0.13

Table 8: BASELINE CHEMICAL QUALITY (CONTINUED)

Parameter	Health-based Guideline (mg/L)	AO [or OG] (mg/L)	RAW WATER - Glace Bay Water Treatment Plant 2281 Birch Grove Rd		TREATED WATER- Glace Bay Water Treatment Plant 2281 Birch Grove Rd	
			March 14th (mg/L)	September 19th (mg/L)	March 14th (mg/L)	September 19th (mg/L)
Total Silver	--	--	<0.0001	<0.0001	<0.0001	<0.0001
Total Strontium	--	--	0.016	0.012	0.03	0.023
Total Thallium	--	--	<0.0008	<0.0008	<0.0008	<0.0008
Total Tin	--	--	<0.02	<0.02	<0.02	<0.02
Total Titanium	--	--	<0.003	<0.003	<0.003	<0.003
Silica	--	--	2.1	1.5	2.3	1.9
Total Vanadium	--	--	<0.002	<0.002	<0.002	<0.002
Calculated Parameters						
Anion Sum (me/L)	--	--	0.46	0.29	1.59	1.4
Bicarbonate Alkalinity as $CaCO_3$	--	--	5.3	<1	27	22
Carbonate Alkalinity as $CaCO_3$	--	--	<1	<1	<1	<1
Cation Sum (me/L)	--	--	0.43	0.38	1.45	1.33
Ion Balance (% Difference)	--	--	3.37	13.4	4.61	2.56
Langelier Index (@ 20C)	--	--	-4.07	NC	-1.5	-1.49
Langelier Index (@ 4C)	--	--	-4.32	NC	-1.75	-1.74
Saturation pH (@ 20C)	--	--	10.4	NC	8.6	8.79
Saturation pH (@ 4C)	--	--	10.6	NC	8.85	9.04
Dissolved Organic Carbon	--	--	5.4	5.4	2.1	2.4

Has any of the parameter exceeded Guidelines: No

If Yes provide date of occurrence and date when Department was notified:

Action taken:

Certified Lab:

Maxxam Analytics
90 Esplanade
Sydney, Nova Scotia
B1P 1A1
Tel: (902) 567-1255
Fax: (902) 539-6504

APPENDIX F ENHANCED FORESTRY PRACTICES

Appendix "C" Enhanced Practices that May Be Adopted from *Best Management Practices/Forest Planning in Municipal Drinking Water Supply Areas Nova Scotia* Nova Scotia Department of Natural Resources and Nova Scotia Environment and Labour, 2005.

The following are examples of further enhanced practices frequently recommended within municipal water supply areas.

Roads

• Follow the long term and short term road plans approved by the Watershed or Wellfield Advisory Committee. Note: Reduce the overall road network, minimize stream crossings and the length and number of skid trails.

• Roads should be located wherever possible on grades less than 10%.

• There should be minimal road width and curve radius to reduce road erosion.

• Establish grass cover on slopes and ditches adjacent to roadways.

Stream Crossings/Bridges/Culverts

• Water turnouts should be used on all roads where they approach streams to divert storm runoff from roads onto the forest floor.

• Roads should be gravelled where they approach streams with clean gravel.

• Road crossings should be placed at the narrowest section of the stream where stable approaches are available. The approaches and structure should be at right angles to the stream. This reduces sedimentation occurrence.

• Streams should be assessed for bridge or culvert installation and properly sized for peak flows. Failure to do so may result in frequent washouts and sedimentation.

• Open bottom culverts should be used when possible and properly set for fish passage. There is less washout with open bottom culverts. Open bottom culverts can usually be installed with less disturbance to the stream bottom.

• Bridge and culvert placement should create as little disturbance as possible.

Harvest Operations

• Pre-treatment conditions should be recorded.

• Follow operating plan prescriptions.

• Ribbon off stream buffers, special management zones, environmentally sensitive areas and any culturally significant areas.

• Meet or exceed regulations.

• Consider options to save or secure natural regeneration in harvesting applications.

• Operate machines in a manner to minimize impacts to soil, regeneration and understory.

• Time operations in sensitive areas to summer when ground is dry or in winter when ground is frozen or protected by snow cover.

• Keep machinery out of watercourses. Temporary bridges must be removed when the operation is completed.

• Keep debris out of waterways, recreational trails, roads, neighbouring immature stands, boundary lines and ribboned non cut areas.

• All garbage must be removed from the site and all hazardous substances properly disposed of outside the watershed.

• Forest debris should be left on the forest floor after harvesting.

• Portable toilet facilities should be used.

Equipment Maintenance/Oil Spills

- Power saws should be used according to the following practices:
    - Use vegetable-based oil to lubricate chains.
    - Store fuel in approved containers and labelled clearly.
    - Remove fuel containers from the site when work shift is over.
    - Fuel power saws over a spill pad and keep all fuels on the spill pad.
    - Use fire retardant pouches with each saw.
- Use of machinery should follow these precautions:
    - Vegetable-based oil should be used to lubricate chains.
    - Machines should be kept clean and leak-free.
    - Machines should be equipped with industry approved fire extinguishers.
    - Machines should carry a spill kit.
- Fuel tanks for machinery should be clean, leak-free, have a locking device, a no-drip nozzle, used with a spill kit, and should be stored on mineral soil as far away as possible from watercourses (at least 100 metres or 330 feet).
- No fuel or oil should be stored within the boundaries of the watershed or stored in approved areas.
- Refuelling should take place on spill pads outside of all buffer zones.
- All fuel leaks over five litres should be reported to the Water Utility and Nova Scotia Environment and Labour within one hour.
- Fire extinguishers should be available during all harvesting operations and should also meet required specifications.
- All trucks with loaders should have remote engine shut down.
- All trucks with loaders should have a hydraulic tank float switch.

Special Management Zones

- Zones may be enhanced beyond the regulations at specified locations, in cooperation with landowners, particularly the main water supply bodies and those close to the point of intake. Examples include enhanced machine exclusion zones, greater amounts of living trees to be retained in harvesting operations, no cut zones and limits on size of openings within a special management zone that can be created.

Harvesting

- Limits on clearcut size, distribution of cuts and amount of harvest area within specified time frames are sometimes negotiated with landowners.

Fire Fighting Equipment

- Persons in charge of an operation or activity conducted in the woods or within 305 metres (1,000 feet) of the woods during the fire season are required by regulation under the Forest Act to provide and maintain fire fighting equipment. Further details may be obtained from the Department of Natural Resources.

APPENDIX G WATERSHED SIGNS

Figure 17. Violations Sign

Figure 18. Keep it Clean Sign

APPENDIX H WATERSHED NEWSLETTER

This hydrometric station measures MacAskill's Brook water flow into the reservoir.

CBRM Water Utility

Committed To Quality

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Canada B1P 7B9

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2012/2013

Photograph by Audrey Turnbull

Glace Bay and Area MacAskill's Brook Dam

CBRM WATER UTILITY

MacAskill's Brook Dam Reservoir

This watershed provides the water to the Glace Bay and Area Water Treatment Plant and to your home's tap.

Major repairs have been made to the dam over the past two years and a dam safety review has been completed. This investment was required to maintain the stability and integrity of the dam.

A local Source Water Protection Committee developed a protection plan for your reservoir.

For more information on the committee or about MacAskill's Brook Dam Reservoir,
please contact Britt Roscoe, Watershed Coordinator, at **563-5551** or **blroscoe@cbrm.ns.ca** .

Photo 1
Vegetation was removed from the dam to improve access and allow easier dam inspection.

Photo 2
Rip rap rock was added to protect the dam on the water side and gravel was added to the top to reduce the possibility of waves eroding the dam.

Photo 3
The dam's spillway allows overflow water to leave the reservoir. Tree stumps that collected in the spillway were removed to prevent any potential damage from occurring during the winter freeze.