Groundwater Protection Strategy
Final Report

August 2006

AS PM I HAVE ENSURED THAT:

- Appropriate wise counsel was sought and obtained
- Appropriate key staff were used
- Best efforts were applied towards achieving agreed schedule commitments and budgets
- Appropriate checks were carried out and staff
- All required independent reviews were completed
- I was satisfied with this final deliverable before its release.

PM _____ DATE 23/08/06

AS TRP I HAVE ENSURED THAT:

- An appropriate PM is managing the project
- Appropriate key staff have been used
- Required independent reviews have been completed by qualified reviewers
- There was no reason for me to prevent the release of this final deliverable.

TRP _____ DATE 10/12/06

Cape Breton Regional Municipality

05-4532-0300

Submitted by:

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August 23, 2006

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ATTENTION:

Sydney Wellfield, Final Groundwater Protection Strategy

We are pleased to submit the following Groundwater Protection Strategy Final Report for the Sydney Wellfield. This strategy has been developed to ensure that the Sydney Wellfield is preserved and managed in an efficient manner. The Emergency Response Plan and Groundwater Resource Monitoring Plan are submitted as appendices to the Groundwater Protection Strategy; they are also available as stand alone documents.

We look forward to your comments. If you have any questions, please contact the undersigned at your convenience.

Yours truly,

DILLON CONSULTING LIMITED

Robert McCharles, CET, CCEP
Project Manager

RJM/CCG:eeg

Our File: 05-4532-0300

Executive Summary

The Middle Lake Road Wellfield was commissioned in April 1996. It has provided sufficient source water with an acceptable quality. In order to secure the integrity of this water supply long into the future, in 1996 a groundwater protection strategy as part of the groundwater supply development was initiated and developed by Dillon Consulting Limited (Dillon). In the draft report of 1996 Dillon summarized the protection zones related to the wellfield and identified the potential sources of contamination located in each zone. Activities and sites of concern within the groundwater recharge area included farming, transportation, petroleum storage, former dump site and septage storage. The Dillon report also presented recommendations for protection of the water supply, including groundwater monitoring, maintaining an up to date contaminant inventory, public education, land acquisition, selecting a Wellfield Protection Committee, and developing an Emergency Response Plan. The draft strategy report was never finalized, nor implemented, and has been outdated with time.

In order to be in compliance with the current guidelines, Dillon was requested to revise and update the draft Groundwater Protection Strategy. Based on the incorporation of the updated information, the revised strategy involves site mapping, wellhead protection area delineation, sources of contamination identification and risk assessment, land use activity controls and groundwater supply protection and management. The numerical modeling and digital mapping based on Geographic Information System (GIS) were employed in this study. The main advantage of numerical modeling is that it can combine variations in hydrogeology and pumping condition.

Groundwater delay time zones to define specific protection zones were delineated by using a numerical model. Recordings from pumping wells, and measurements from the monitoring well network were incorporated into the numerical model, with the exception of the data sets prior to the pumping tests conducted during groundwater development.

The delineated one-year and ten-year delay time protection zones are within the zone of contribution which has officially been designated as a protected public water supply watershed area under the Nova Scotia Environment Act. The Municipality provides ownership and controls much of the property within these protection zones.

The intent of this strategy is to minimize risks to the water supply through appropriate land use controls that recognize the need to assess and balance the many aspects of groundwater protection. With the application of digital mapping, a technical assessment included determination of historical and current land use and identification of associated potential sources of contamination within the protection zones.

Within the one- and ten-year zones, the primary land use is that it belongs to a protected watershed area. The primary source of potential contamination of the protection zones is the transportation of fuel and dangerous goods along Route 22; the secondary source is associated with the above ground fuel storage tanks located on Ormond Cresent. Road salt may be another potential source of contamination, therefore, cautious use in these zones should be prescribed. Activities associated with the burrow pit are a potential source of industrial contamination.

The zone of contribution is a protected public water supply watershed zone and is primarily owned by CBRM. Although a land acquisition program has been designed, it is unattainable to acquire all privately owned parcels. Therefore, the monitoring of on-site sewage disposal systems for all land owners should be implemented. All storage tank systems should meet or exceed applicable regulations.

Public awareness to protect a groundwater resource is a persistent and significant program. Cooperation and understanding from the public, residents, businesses, government agencies and environmental groups is critical for this strategy implementation.

The groundwater protection strategy is a significant document for identifying and minimizing potential risks associated with contamination of the groundwater resources. However, some risks will always exist. The Emergency Response Plan is drafted and updated to address these potential risks. This plan is prepared to respond to an event such as a hazardous material spill along Route 22 or a fuel oil spill that presents a risk to the water supply. In this plan key contacts, communication and actions in an emergency situation have been presented. Parties with designated responsibilities include CBRM, the local volunteer fire department, local emergency measures organizations, local equipment and service providers and various regulatory agencies etc. The Groundwater Resource Monitoring Plan is intended to ensure the monitoring of groundwater quality and quantity. The sampling frequency and processes have been prescribed in this plan. The Emergency Response Plan and Groundwater Resource Monitoring Plan should be reviewed and updated to the responsible party, to accommodate charges in regulatory guideline and personnel, their rolls and responsibilities.

Recommendations of the revised groundwater protection strategy are presented as follows:

- Re-evaluate amendments of the existing Municipal Planning Strategy and Land Use By-Law based on the protected zones presented in the groundwater protection strategy.
- Make every effort, where possible, to reduce road salting within the protected zones.
- Implement the Emergency Response Plan such that all designated parties are adequately prepared to respond to an emergency situation.
- Continue to implement continuously the Groundwater Resource Monitoring Plan to monitor the integrity of wells, water levels and groundwater quality.
- Ensure that all petroleum storage tank systems within the protection zones meet or exceed applicable regulations.
- Communicate with the owner/operator of the gravel/borrow pit the importance of storage and handling of petroleum products on site; Control access to the gravel/borrow pit such that it is not at risk of being used as a refuse disposal area.
- Designate those responsible to oversee monitor compliance within the protection areas. This could be in the form of an Advisory or Management Committee, separated from the existing community liaison committee.
- Provide information on the groundwater protection strategy to private landholders within the protection zones.
- Provide information to the general public concerning the vulnerability of the groundwater supply and the measures undertaken for its protection.
- Revise and update Emergency Response Plan and Groundwater Resource Monitoring Plan every 24 months.

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1.0 Introduction

The following report details a groundwater protection strategy for the Cape Breton Regional Municipality (CBRM) and its groundwater supply for the city of Sydney and surrounding area. Dillon Consulting Limited (Dillon) was requested to bring the former report entitled, *Groundwater Protection Strategy Draft October 1996* up to date and in compliance with current guidelines.

Revising the 1996 Draft report included the study of various aspects, including, site mapping, wellhead protection area delineation, potential contamination identification, land use activity controls, protection and management, emergency response and resource monitoring. This strategy details the objectives, methods, results and recommendations to ensure a safe and protected groundwater supply.

2.0 Background

The Cape Breton Regional Municipality began supplying customers of the water utility with groundwater from the eleven (11) production wells located on Middle Lake Road in April 1996. Prior to its commencement, Dillon was awarded a contract to carry out an evaluation of a new water supply to augment or replace the City of Sydney's surface water supply. The project involved an assessment of existing surface water quality for treatment options and a groundwater exploration program. Due to the many benefits associated with the development of a groundwater supply, Dillon carried out a groundwater exploration program (Dillon 1993, 1994 and 1995).

Based on the exploration and program of a pilot plant study, the groundwater supply for Sydney was commissioned on April 22, 1996. As a part of the groundwater supply development project Dillon assembled a draft groundwater protection plan in October 1996. The strategy was never finalized, nor implemented, and has since been outdated with time.

The following report is an update and an in-depth review of the *Groundwater Protection Strategy Draft Report 1996*.

3.0 Objectives

To keep clean water clean and ensure a safe and secure groundwater supply for the future requires that a groundwater protection plan and management strategy are developed and implemented. Dillon has updated the groundwater protection plan titled *Groundwater Protection Strategy Draft October 1996*. Components of the plan include:

- an update of the wellhead protection area by use of groundwater modelling software Visual ModFlow Version 3.0.0.180. The computer modelling groundwater protection zones are based on groundwater travel (delay) time;
- a compilation of past and present land use activities within and surrounding the protection zones, and identification of potential sources of contamination;
- an update of the management plan and a renew of the response plan to act promptly in emergency situations that might threaten the quality of the resource; and
- the draft of municipal planning strategy amendments and land use restrictions or zoning changes.

4.0 Wellhead Protection Area Delineation

4.1 Groundwater Modeling

Groundwater modeling is an efficient tool used to estimate aquifer response and time dependant capture zones associated with a pumping well or wellfield. The technique consists of developing and calibrating a numerical simulation of the groundwater flow system under non-pumping conditions, then adding the pumping wells to predict the response of the aquifer over time. This procedure provides an approximation of the influence that pumping wells may have on the aquifer.

4.1.1 The Process

The intent of this exercise is to use the existing model to determine time based capture zones in order to confirm previous work and ensure adequate protection of the resource. The process attempts to make predictions of changes (in pumping rates, recharge and other variables) in a complex natural system. Due to the complexity of the natural system, many simplifying

assumptions are used to enable the use of the model as a best approximation of what will happen when changes are made (i.e. changes in pumping rates, in production well field pumping configuration, and in precipitation which change the rate of recharge). The more data available for the model the better the estimation can be. It is therefore important to refine and update the model as more information is acquired following the commissioning of the wellfield.

The process of updating the existing model consisted of the following tasks:

- Verification of existing model
- Collection of pumping data from select wells in the area surrounding the wellfield
- Refinement of the model grid
- Incorporation of the many years of
  - monitoring data from the monitoring well network
  - pumping rate data for the wellfield
  - precipitation data from the Sydney airport

The Groundwater modeling data is not presented here but can be found in the Dillon 2003 report titled Sydney Water Groundwater Modeling Program.

4.1.2 The MODFLOW Model

Visual MODFLOW Pro version 3.0.0.180 was used to simulate the Middle Lake Road Wellfield. This is an updated version of the original model used to delineate the capture zone. Visual MODFLOW is a powerful and fully integrated pre- and post-processor for MODFLOW. As with previous capture zone delineations, groundwater particle traces were used to derive time dependant capture zones.

4.1.2.1 Grid

The grid for this rendition of the model was expanded and refined to incorporate more of the surrounding area and greater depth below surface. The current model consists of a grid 24 km by 21 km wide to a depth of 500 m below sea level. The grid is spaced with 246 cells in the x direction, by 230 cells in the y direction, and 12 cells in the z direction. The cells vary from 20 to

120 m in thickness for the x, y and z grid. Further discussion can be found in the Dillon 2003 report for the updated model.

4.1.2.2 Initial Head Distribution

Consistent with the previous modeling exercises, the initial head distribution for this model was based on the pre-pumping water levels for the observation well network. However, additional water levels from the various surface water bodies were incorporated into the new model for a more realistic representation.

4.1.2.3 Aquifer Parameters

Previous pumping test analysis from the initial testing of the wellfield combined with more recent testing of wells in the surrounding areas resulted in a well-defined range of hydraulic parameters for the wellfield. No changes were made to the model for the various aquifer parameters. Further discussion on the aquifer parameters can be found in the Dillon 2003 report.

4.1.2.4 Recharge

Recharge in modeling terms is the water that an aquifer receives due to infiltration from precipitation or interaction with surface water bodies. The Sydney airport has precipitation records that go back to the early 1900's though some of the early data is discontinuous. Based on the last twenty years of data the yearly average precipitation for the Sydney area is approximately 1.5 m per year. Previous models had used values of 10 to 20% of the precipitation (i.e. 0.15 to 0.30 m per year) as recharge to the water table as supported by scientific literature estimates. The model for this exercise used a value of 0.10 m per year as a conservative low estimate of recharge to ensure that the model would draw groundwater from as far away from the wellfield as would be reasonable.

4.1.2.5 Pumping Wells

Time averaged pumping rates were used from the highest values that are currently permitted to ensure the greatest (i.e. largest aerial extent) amount of capture possible from the wellfield area. A total pumping rate of 4.2 million imperial gallons per day (MIGD) was used for the wellfield. The wells were modeled to extract water only from the open portion of the wellbore (i.e. not from the cased off upper portions of the aquifer).

4.1.2.6 Lake and Aquifer Hydraulic Interaction

Previous models incorporated recharge from some of the lakes in the area. This version of the model used 32 lakes and their respective interconnecting brooks/streams. Stage elevations were also taken from average mapping values, where available, or 1 m below ground surface, where data was not available.

4.1.3 Model Calibration

Considering that the prediction of capture zones was conservatively based on estimated low recharge and high pumping rates that are not actually being observed, it was not considered necessary to recalibrate the model as part of this exercise. Details pertaining to model calibration can be found in the Dillon 2003 report.

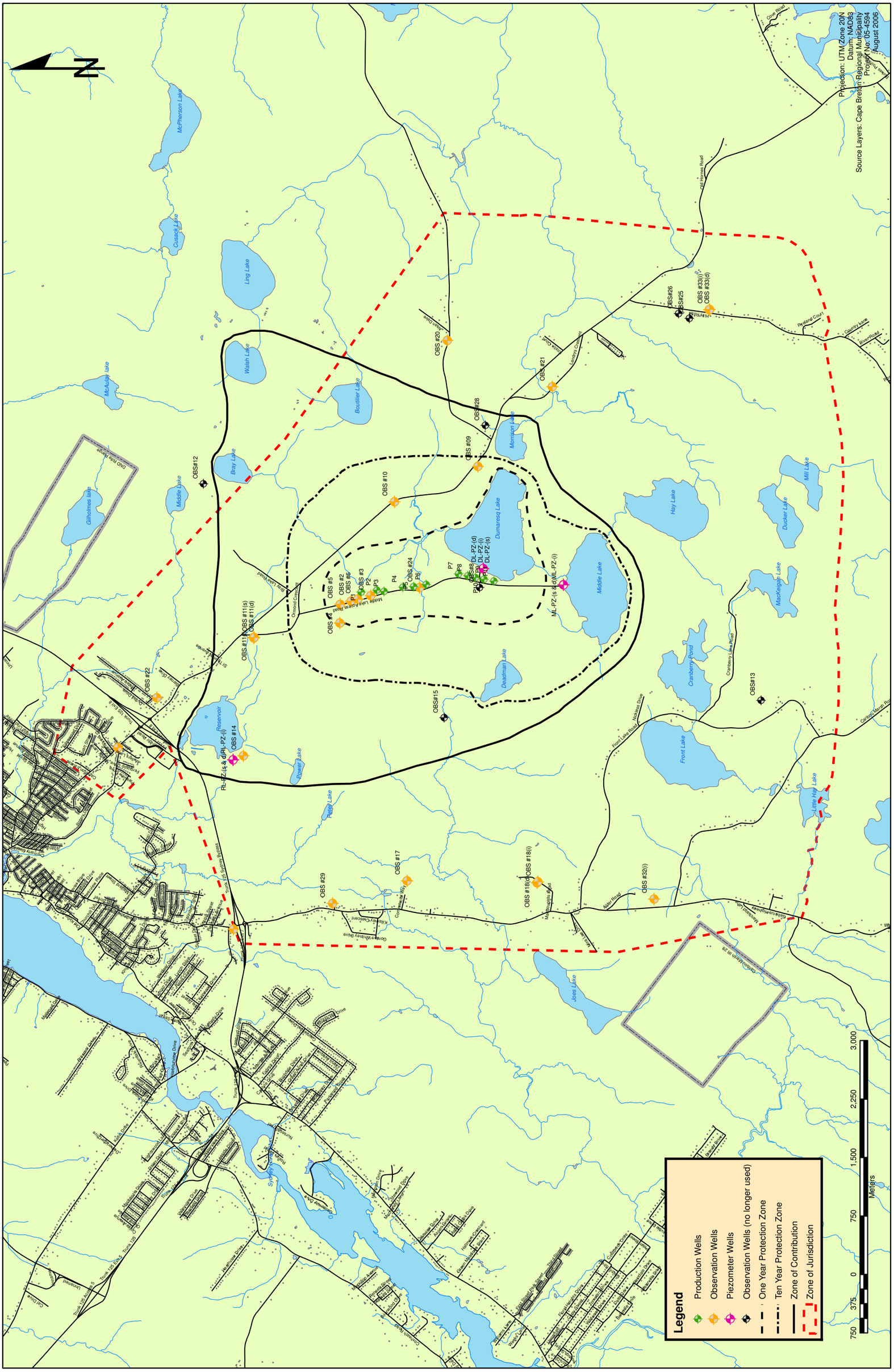
4.2 Groundwater Delay Time Protection Zones

The overall concept of groundwater delay time protection zones is relatively simple. Knowing the pumping rate from a wellfield and the aquifer transmissivity (how much resistance the aquifer provides to groundwater flow determined from the response of water levels in the aquifer during a pumping test) one can calculate the time it takes for groundwater to travel from a given distance to the wellfield (delay time) and establish a protection zone within the area based on delay time.

Theoretically, if a contaminant was to be spilled in a delay time protection zone it would take approximately the delay time to reach the wellfield (contaminants tend to move slower than the groundwater depending upon their chemical characteristics and whether or not they degrade). Generally, two to three zones of protection are determined based upon the level of protection to be established. The shortest delay time protection zone is the most sensitive to contamination and therefore, requires the highest degree of protection. The zones of protection that have been established for the Middle Lake Road Wellfield are the 1-year delay time protection zone and the 10-year delay time protection zone. Additionally, the zone of recharge (i.e. the zone in which most if not all the groundwater the wellfield receives comes from) is included.

The groundwater flow model developed using Visual MODFLOW was used to delineate those zones illustrated in Figure 4-1. The wellfield pumping rate was maintained at the current

Figure 4-1: Wellfield and Protection Zones



maximum of 4.2 MIGD while recharge from precipitation was reduced to 0.10 m per year based on the minimum precipitation data obtained by the Sydney Airport from the last 20 years.

Moreover, as indicated in Figure 4-1 there is also a zone of jurisdiction. The zone of jurisdiction was created for the Contingency Plan (NSEL 1996), which is based upon the zone of influence (area in which changes in water level due to pumping of the wellfield can be expected to occur). The zone of jurisdiction is not necessarily the same as the zone of capture. The most recent model does not indicate a need to adjust the zone of jurisdiction, as conditions have not changed since the previous model.

5.0 Land Use

Historical and present land use activities were researched for areas within the aforementioned protection zones, contribution zone and the zone of jurisdiction. Both historical and present land use information was gathered from aerial photography, property mapping, and from numerous site visits throughout the protection zones and zone of jurisdiction.

5.1 One Year Protection Zone

The one year protection zone contains eleven (11) pumping wells at the center of the zone of jurisdiction, as well as, Dumaresq Lake and one access road. The zone is 245 hectares of primarily forested land, the majority (91%) of which is owned by the Cape Breton Regional Municipality. In addition, 8% of the zone is owned by the Government of Nova Scotia and is ungranted, while the remaining 1% of land is privately owned.

5.1.1 Historical Land Use Summary

Review of aerial photography and mapping for areas within the one-year zone indicated that historical land use was minimal. The primary historical land use within the one year zone included the watershed protection area for the City of Sydney and an access road to Middle Lake Reservoir and former pumping station. The watershed became a protection area in the mid-1950s. There has been minor forestry activity in the northern areas.

5.1.2 Present Land Use Summary

The primary land use within the one-year protection zone is a protected watershed area for the CBRM. The zone is limited to the access road for the Middle Lake Reservoir and former pumping station. There has also been a substantial amount of tree cutting within the northwestern area of the one-year protection zone adjacent to the access road leading to observation well #4. During wellfield monitoring activities within the Middle Lake Road Wellfield, Dillon personnel have seen evidence that hunting activity has and is still occurring in the area. A steel locked gate located at the entrance of Middle Lake Road is presently being used to limit public usage. There is additional security to the wellfield as a fence and gate is located prior to observation well #5 along Middle Lake Road. It should be noted that due to snow removal requirements, this fence gate is left open during the winter months.

5.2 Ten Year Protection Zone

The ten year protection zone completely encloses the one year protection zone and extends to include an additional 663 hectares of land, for a total of 908 hectares. Included in this zone are Dumaresq Lake, Deadman Lake and Middle Lake, the land is primarily forested however some farm clearings do exist. The majority (81%) of the land is owned by the Cape Breton Regional Municipality, 14% is privately owned, Nova Scotia ungranted land totals 4% and 1% is designated as road ways.

5.2.1 Historical Land Use Summary

Review of aerial photographs and maps show the majority of land within this zone to be mainly forested. In 1958, the City of Sydney began purchasing much of the land within its designated watershed. Through the 1960s many of the residents along Route 22 sold their lands to the City of Sydney. This resulted in reduced tree cutting and agricultural activities within this protection zone. The CBRM currently owns most of the protection area. In the late 1960s the population in the Mira Road area increased with the addition of more than 90 homes in the Charlestown Subdivision. The NSPI transmission line was constructed in the late 1960s and expanded in the 1970s with the addition of the Lingan Generating station.

5.2.2 Present Land Use Summary

Presently, the entire ten year protection zone is classified as a protected surface watershed. As well, the ten year protection zone is completely enclosed in the groundwater zone of contribution. Transportation routes include Route 22 and Ormond Crescent. The access road leading to the Middle Lake Reservoir, production wells and observation wells extends 3.46 km and is entirely included in the ten year protection zone. Although numerous properties are privately owned within the ten year protection zone, only four properties contain buildings, two are private dwellings, and two are utility buildings privately owned but located on CBRM property.

5.3 Zone of Contribution

As previously discussed the zone of contribution is the area of land in which water captured will eventually travel to the point of production at the approximate center of the wellfield. The zone of contribution is again primarily owned by CBRM, however a larger portion of land (16%), is privately owned.

5.3.1 Historical Land Use Summary

Historical land uses throughout the zone of contribution was minimal due being mostly wooded and undeveloped. As stated previously the City of Sydney began purchasing much of the land within its designated watershed, which is presently encompassed by the zone of contribution. Through the 1960s many of the residents along Route 22 sold their lands to the City of Sydney, thus minimizing the potential for adverse affects to the area.

5.3.2 Present Land Use Summary

Land uses within the zone of contribution include 77% land ownership by the CBRM. Other land uses include 16% private land ownership with Nova Scotia ungranted lands acquiring 6%. Private dwellings are most concentrated in the southeastern area of the zone in the Morrison Road area. The Cape Breton Regional Hospital is also contained within the zone of contribution at the northwest.

5.4 Zone of Jurisdiction

The surrounding areas of the ten year protection zone are classified as the zone of jurisdiction of the Cape Breton Regional Municipality's groundwater supply. The communities of Mira Road, Front Lake Road, Caribou Marsh, Dutch Brook and Hills Road have been defined as the zone of jurisdiction for the Middle Lake Road Wellfield. Users/owners of wells situated within the zone of jurisdiction have been protected against loss of quality or quantity of well water potentially impacted by production of the wellfield by the "*Contingency plan for Potential Impact of Domestic/Commercial Groundwater Supplies within the Zone of Jurisdiction, Middle Lake Wellfield*". This contingency plan was established in 1996 and amended in June 1998. The contingency plan was to also provide a procedure to resolve differences, which may arise due to water supplies potentially impacted by the production of the wellfield.

5.4.1 Historical Land Use Summary

During the 1950s, land outside the designated protection zones was mostly wooded and undeveloped with residential population occurring near the roads in Prime Brook, Dutch Brook, Front Lake, and Mira Road areas. Light forestry activities occurred in some of the wooded areas for the past 50 years and presently continue throughout the zone of jurisdiction and the protected zones. During the 1960s, the Front Lake area consisted of an automobile wrecking/salvage yard having 50 cars and increasing to approximately 200 vehicles in the 1970s.

Approximately 12 homes were located in the Prime Brook area, 3-4 homes in the Dutch Brook/Front Lake area, and 40 homes in the Mira Road area. The 1960s and 1970s showed an increase in population due to the addition of approximately 90 homes in the Charlestown Subdivision. Population growth also increased in the Prime Brook and Dutch Brook areas throughout the 1970s. The 1980s showed the development of industrial businesses in the Prime Brook area.

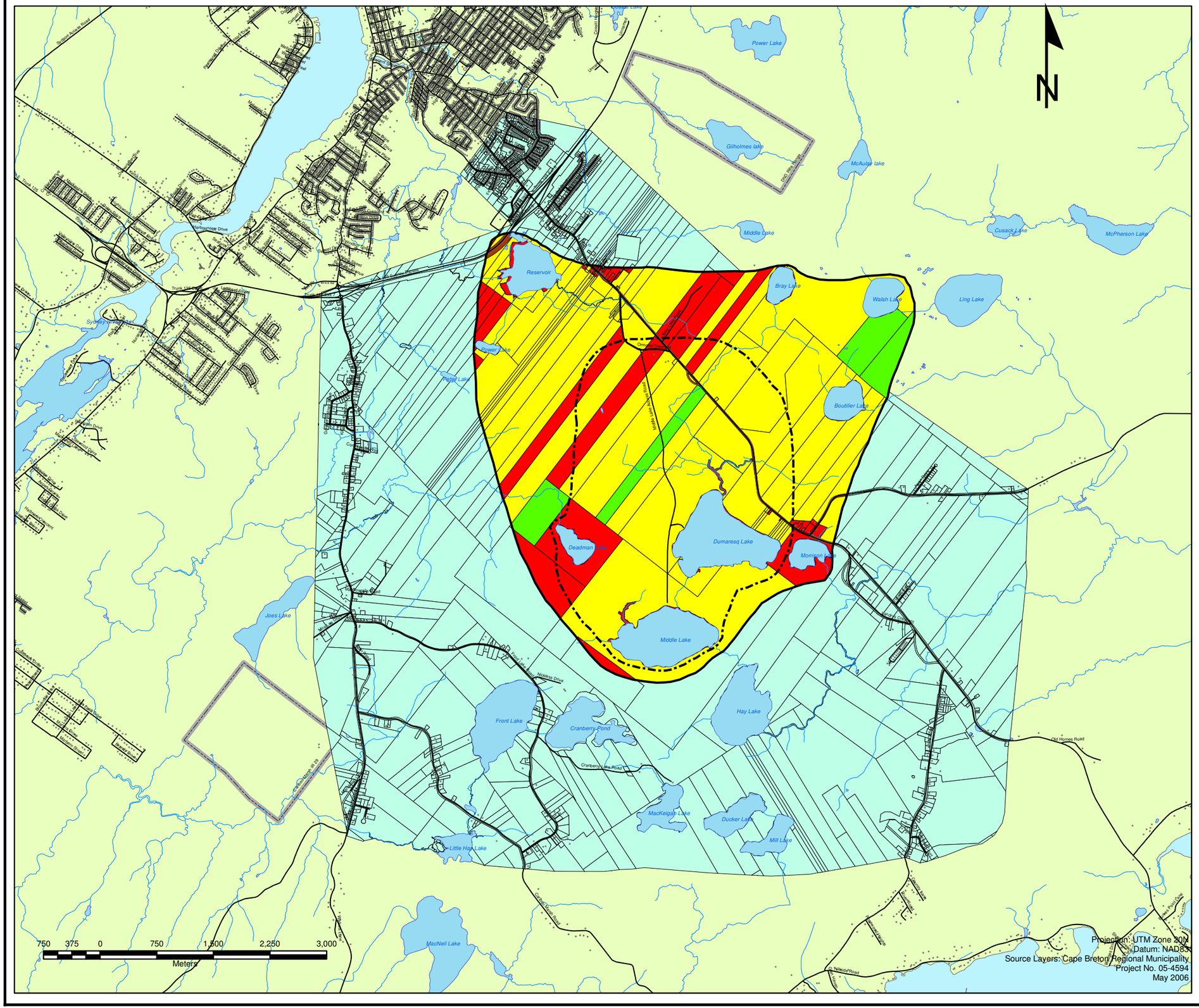
5.4.2 Present Land Use Summary

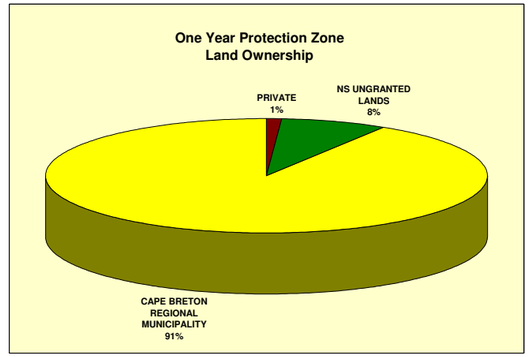
Present land use within the zone of jurisdiction is mainly forested with having numerous domestic dwellings and includes a wide range of industrial and commercial businesses throughout Route 327. Businesses range from a convenience store to an auto body repair shop. Residential areas of the Charlestown Subdivision and the southern area of Hills Road have been

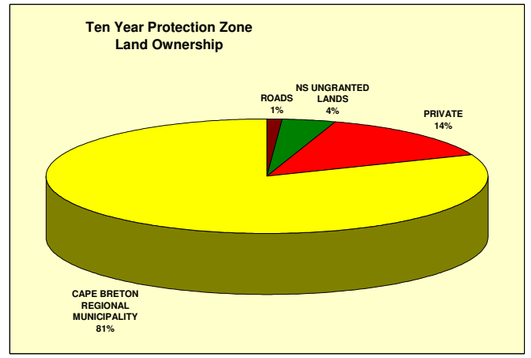
expanding as new homes are presently being built. The Front Lake Road area consists of an auto salvage yard, a dump site and Landry's Septage Disposal, which is continuously monitored and permitted through the NSEL.

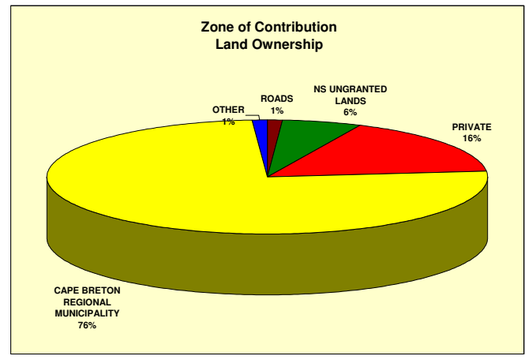
The following Figure 5-1, shows a detailed summary of the present land use and land ownership throughout the protection zones, zone of contribution and the zone of jurisdiction.

Figure 5-1: Protection Zones and Land Distribution









Legend

- Contribution Zone
- One Year Protection Zone
- Ten Year Protection Zone
- National Defence Jurisdiction

Land Distribution

- PRIVATE LAND
- CAPE BRETON REGIONAL MUNICIPALITY
- NS UNGRANTED LANDS
- ROAD PARCEL OWNER UNDETERMINED
- ZONE OF JURISDICTION LAND PARCELS

6.0 Potential Sources of Contamination

As shown in Figure 4-1 and 5-1, the 1-year delay time protection zone is entirely undeveloped and mostly owned by the CBRM. The only items of interest within this area are the streams in the vicinity of pumping wells P4, P5 and P6 and Dumaresq Lake near wells P9, P10 and P11. The GUDI (groundwater under the direct influence of surface water) assessment (Dillon 2006) indicated that the surface water bodies are not directly linked to the wells such that they would influence the chemical quality of the groundwater. This suggests that while the water bodies may recharge the groundwater for the wells, the aquifer is providing sufficient filtration and time delay travel to remove any microbial contaminants of concern. Care should be taken to ensure that these nearby surface water bodies remain unimpacted by human activities.

The 10-year delay time protection zone shown in Figure 4-1 and 5-1 is also primarily undeveloped and mostly owned by the CBRM with some residential properties and roads running along the periphery in the northeastern portion of the zone. Additional items of interest within this area include additional streams, Middle Lake and Deadman Lake.

Micro-organisms generally decease, go dormant, or are filtered out of the groundwater relatively quickly. Volatile and reactive chemicals generally evaporate or break down. Therefore, neither of these contaminant groups is considered to represent a threat for the delay time protection zones greater than 1 year. However, chemicals such as fuels, pesticides, road salt and other contaminants that may persist for longer periods of time, or produce daughter products that may in term be contaminants of concern should be identified. Their use should also be restricted or eliminated in both the 1 year and 10 year delay time zones.

As shown in Figure 4-1 and Figure 5-1 the recharge capture zone encompasses six additional lakes with their respective brooks and streams and includes additional residential areas in the northern, eastern and southern portions of the zone. The remaining areas are essentially undeveloped and mostly owned by CBRM. Contaminants in this area may impact the wellfield if the contaminants are persistent or applied over large areas. As such significant land use restrictions are not required. The area should, however, continue to be monitored.

On the other hand, six potential sources of contamination were identified in the *1996 Draft Groundwater Protection Strategy*. Each of the six sources has a potential impact on at least one

of the zones identified by this report, the one and ten year protection zones, as well as the contribution zone and jurisdiction zone. Sources range in severity due to quantity and quality of contaminates and are subdivided as residential, industrial, commercial, transportation, utilities and recreational sources of contamination.

6.1 Residential – Potential Sources of Contamination

Residential impacts within the one year protection zone do not exist at the present time. Given the land ownership distribution it is unlikely that such a potential source of contaminant would exist within this zone. Residential sources are therefore not a concern in this zone.

Potential residential source of contaminants are limited to the ten year zone, contribution and jurisdiction zones. The northern most region of the ten year protection zone includes the Ormond residence and farm. The Ormond farm covers approximately 4800 m^2 adjacent to the entrance of Middle Lake Road.

Within the zone of contribution approximately 21 domestic buildings exist, two of which are located within the ten year protection zone. Due to the quantity of contaminates present and the projected time of travel for contaminates to reach the point of production wells, homes outside the protection zones pose a minimal threat to potentially contaminating the source water supply.

As shown in figure 6.1, domestic dwellings are most abundant within the zone of jurisdiction. Domestic dwellings cause a potential for contamination due to fuel storage tanks, on-site septic services, automobiles, recreational vehicles and possibly pesticide/insectide storage and usage. Domestic dwellings pose an additional threat in that monitoring and regulating activities potentially causing adverse effects is limited.

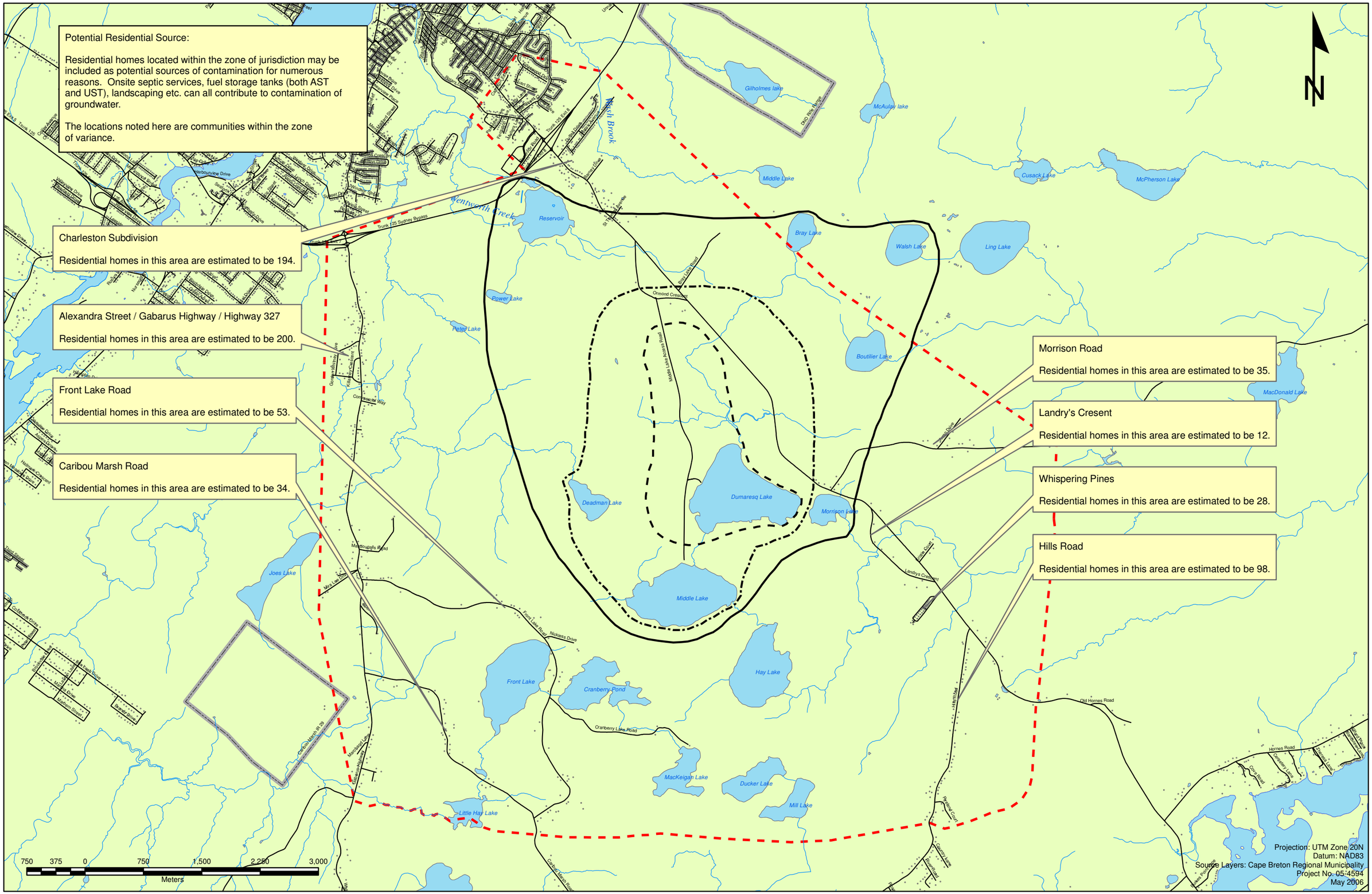


Figure 6-1: Potential Residential Sources of Contamination

Potential Residential Source:

Residential homes located within the zone of jurisdiction may be included as potential sources of contamination for numerous reasons. Onsite septic services, fuel storage tanks (both AST and UST), landscaping etc. can all contribute to contamination of groundwater.

The locations noted here are communities within the zone of variance.

Charleston Subdivision

Residential homes in this area are estimated to be 194.

Alexandra Street / Gabarus Highway / Highway 327

Residential homes in this area are estimated to be 200.

Front Lake Road

Residential homes in this area are estimated to be 53.

Caribou Marsh Road

Residential homes in this area are estimated to be 34.

Morrison Road

Residential homes in this area are estimated to be 35.

Landry's Cresent

Residential homes in this area are estimated to be 12.

Whispering Pines

Residential homes in this area are estimated to be 28.

Hills Road

Residential homes in this area are estimated to be 98.

Projection: UTM Zone 20N
Datum: NAD83
Source Layers: Cape Breton Regional Municipality
Project No. 05-4594
May 2006

6.2 Industrial – Potential Sources of Contamination

There is no industrial activity occurring within the one year protection zone. Given that CBRM owns the majority of the land within this zone, industrial sources should remain absent from the one year zone.

The ten year protection zone is subject to a burrow pit with the potential for contamination in the form of moving heavy machinery and vehicles throughout the northeast area located behind the Duffy property on Ormond Crescent. There are no services onsite for fuelling or septage collection. As previously discussed, the pit is a potential source of contamination from an accidental fuel oil release from heavy machinery and trucks travelling to Route 22.

Within the contribution zone, industrial activity is limited to the burrow pit operation as discussed as a potential industrial source of contamination within the ten year protection zone.

Potential industrial sources of contamination within the zone of jurisdiction include several operations such as a cement plant, construction, trucking, delivery and transport operations. Contaminants may include, but are not limited to, fuel oil, both diesel and gas, large quantities of cleaners, and other hazardous shipments, construction debris and garbage, cement mixers and chemicals, etc.

Refer to Figure 6-2 for a detailed summary of potential industrial sources of contamination.

Figure 6-2: Potential Industrial Sources of Contamination

Potential Industrial Source:
1467 Gabarus Highway

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage (Shared)

Fuel Storage:
10,000L AST Diesel Tank
10,000L AST Oil Tank

Operation Details:
Cement Plant. Chemicals stored onsite such as, retarders, air training agents, accelerators, and super plasticizers for mixing cement.

Potential Industrial Source:
1475 Gabarus Highway

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage (Shared)

Fuel Storage:
38,000L AST Diesel
900L AST Oil

Operation Details:
Trucking and transport operation.

Potential Industrial Source:
1501 Gabarus Highway

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
None - Electric Heat

Operation Details:
Trucking and delivery operations. Note: Historically, underground tanks were located onsite, with noted leakage. Cleaning supplies, oil and other potentially hazardous chemicals may be stored on site while in transit.

Potential Industrial Source:
1559 Gabarus Highway

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
10,000L AST
Gas/Diesel Tank

Operation Details:
Contracting and construction operations. Seven (7) dump trucks, (two) 2 excavators.

Potential Industrial Source:
1710 George Street

Drinking Water Supply:
Well - Private

Sewage Disposal:
On-Site Septage

Fuel Storage:
2,000L AST Diesel
900L AST Furnace Oil

Operation Details:
Construction business, operating several pieces of heavy equipment.

Potential Industrial Source:
Ormond Cresent

Drinking Water Supply:
None

Sewage Disposal:
None

Fuel Storage:
None

Operation Details:
Used as a gravel supply pit by a local construction company. Several trucks and heavy equipment are operating on site daily.

Gilholmes lake
McAulay lake
Middle Lake
McPherson Lake
Reservoir
Bray Lake
Walsh Lake
Ling Lake
Power Lake
Peter Lake
Boutilier Lake
Deadman Lake
Dumaresq Lake
Morrison Lake
Joes Lake
Middle Lake
Front Lake
Cranberry Pond
Hay Lake
MacKeigan Lake
Ducker Lake
Mill Lake
Little Hay Lake
Trunk 125 Sydney Bypass
Trunk 125 East
Ormond Crescent
Bray Lake Road
Middle Lake Acres Road
Cranberry Lake Road
Front Lake Road
Nickerson Drive
Mira Lee Drive
Mira Road
Macdougalls Road
Old Hornes Road
Landrys Crescent
Hillcrest Court
Pyeland Court
Country Lane
Dawn Drive
Allison Drive
Mercier Way
Commercial Way
Northern Street
Bennet Street
Carrie Mount IR 29

0 375 750 1,500 2,250 3,000
Meters

Projection: UTM Zone 20N
Datum: NAD83
Source Layers: Cape Breton Regional Municipality
Project No. 05-4594
May 2006

6.3 Commercial – Potential Sources of Contamination

There is no commercial activity occurring within the one or ten year protection zones as well as, the zone of contribution. There are ten (10) businesses operating within the zone of jurisdiction whereby posing a threat to the groundwater supply. Potential contaminants range from paint, degreasers, and cleaning supplies to fuel storage tanks and sewage disposal. Refer to Figure 6-3 for a detailed summary of potential commercial sources of contamination, for commercial sources in all four (4) zones.

Figure 6-3: Potential Commercial Sources of Contamination

Potential Commercial Source:
1043 Gabarus Highway

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
900L AST Oil

Operation Details:
Paint, degreasers, cleaning supplies stored onsite for auto body repair. Dust and debris may also be present onsite.

Potential Commercial Source:
1461 Gabarus Highway

Drinking Water Supply:
Private - Unknown

Sewage Disposal:
On-Site Septage

Fuel Storage:
900L AST Oil

Operation Details:
Oil stored onsite for auto repair. Numerous junk cars onsite, tires, oil containers, paint and other hazardous chemical containers.

Potential Commercial Source:
1541 Gabarus Highway

Drinking Water Supply:
Private - Unknown

Sewage Disposal:
On-Site Septage

Fuel Storage:
None

Operation Details:
Variety Store

Potential Commercial Source:
2001 Gabarus Highway

Drinking Water Supply:
Private -Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
900L AST Oil

Operation Details:
Vehicle repair garage, former gas station. All UST's removed in last five (5) years.

Potential Commercial Source:
345 Front Lake Road

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
900L Oil

Operation Details:
Welding Operation. Additional AST's onsite were reported empty.

Potential Commercial Source:
1901 George Street

Drinking Water Supply:
Private (*2) - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
900L (*3) Oil Tank

Operation Details:
Seasonal business, heats greenhouse using oil heat. No chemicals are used, only insecticidal soap.

Potential Commercial Source:
66 Hills Road

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
None

Operation Details:
Driving range, seasonal business.

Potential Commercial Source:
412 Hills Road

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
N/A

Operation Details:
15 of 400 acres is used as tree farm. Herbicides used on trees (manual). Some lots are shared with 428 Hills Road.

Potential Commercial Source:
428 Hills Road

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
N/A

Operation Details:
15 of 400 acres is used as tree farm. Herbicides used on trees (manual application). Some lots are shared with 412 Hills Road.

Projection: UTM Zone 20N
Datum: NAD83
Source Layers: Cape Breton Regional Municipality
Project No. 05-4594
May 2006

6.4 Transportation – Potential Sources of Contamination

Transportation routes throughout the protection zones, zone of contribution and the zone of jurisdiction attribute to the potential for contamination in the form of dangerous goods transport and fuel oil releases from accident related incidents. Other potential contaminate is road salt for de-icing transportation routes in freezing conditions.

Within the one year protection zone only one transportation route exists. Middle Lake Road passes through the center of the zone extending from Ormand Crescent to Middle Lake (3.46 km); however access is controlled by CBRM. Traffic along Middle Lake Road is limited to CBRM utility vehicles and/or service vehicles for maintenance and servicing of production wells and monitoring of observation wells.

A section of 0.65 km through Ormond Crescent passes through the northern most tip of the ten year protection zone. This poses a minor threat in that traffic is limited to local usage. However, it has been observed that there is a substantial amount of traffic produced by an increased flow of trucks leading from the burrow pit. The majority of trucks exit Ormond Crescent to the north onto Route 22.

Route 22, also known as the Louisbourg Highway, passes 3.16 km through the northeast area of the ten year protection zone. Figure 6-4, displays the most recent traffic volume records obtained from the Nova Scotia Department of Transportation and Public Works and indicated Route 22 has an annual average daily traffic volume of 4,920 vehicles (2002). A review of traffic accident data for Route 22 shows no elevated occurrences of motor vehicle accidents.

Refer to Figure 6-4 for potential transportation sources of contamination for traffic volumes along major routes potentially posing a threat in both dangerous goods transport and an accidental fuel oil release.

Figure 6-4: Potential Transportation Sources of Contamination

1.5km East of Route 327 (Gabarus Highway)

1993 : 15,000 AADT*

1996 : 19,000 AADT

1999 : 19,300 AADT

2002 : 20,100 AADT

1km North of Dutch Brook (Gabarus Highway)

1994 : 3680 AADT*

1996 : 4500 AADT

1999 : 4480 AADT

2000 : 4350 AADT

2002 : 3340 AADT

1km East of Route 327 (Gabarus Highway)

1993 : 350 AADT*

1km North of Morrison Road

1993 : 4680 AADT*

1996 : 4820 AADT

1999 : 5580 AADT

2002 : 4920 AADT

0.5km East of Route 22

1993 : 630 AADT*

100m South of Route 22

2002 : 1050 AADT*

AADT = Annual Average Daily Traffic. The average number of vehicles passing the count location in a 24 hour period, averaged on the basis of one year.

750 375 0 750 1,500 2,250 3,000

Meters

Projection: UTM Zone 20N
Datum: NAD83
Source Layers: Cape Breton Regional Municipality
Project No. 05-4594
May 2006

6.5 Utilities – Potential Sources of Contamination

With the exception of the Middle Lake Road Wellfield production wells, there are no potential utility sources of contamination within the one year protection zone. There are two (2) potential sources within in the ten year zone, the Canadian Broadcast Corporation (CBC) broadcasting tower, and the former Sydney water pump house.

In addition, the Nova Scotia Power Corporation runs a powerline line corridor through the northwest corner of all four (4) zones. It is policy of the Nova Scotia Power Corporation that no herbicides or pesticides be used on corridor land running through protected watershed jurisdictions. As well, the treatment of power poles is also prohibited in watershed areas. Vegetation with potential for interfering with power lines are monitored and maintained as required.

The Sydney water treatment plant is located within the zone of contribution and poses a threat due to the on site storage of chemicals and various products used in the water treatment process. Chemicals are carefully stored and managed on site by CBRM water treatment plant operators and staff.

Potential utility sources of contamination also exist throughout the zone of jurisdiction. A maintenance depot for the district school board provides services to a fleet of vehicles and stores various products potentially harmful to a water course.

Refer to figure 6-5 for potential utility sources of contamination.

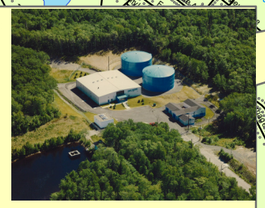
Figure 6-5: Potential Utility Sources of Contamination

Potential Utility Source:
Cape Breton Regional Municipality Water Treatment Plant

Drinking Water Supply:
Municipal

Sewage Disposal:
On-site Septage

Operation Details:
Water Treatment Plant



Potential Utility Source:
CBC Broadcasting Tower

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-site Septage

Fuel Storage:
20 000L AST,
Unknown Contents

Operation Details:
Tower is used to broadcast media. Small dumpsite located at the back of property, consists of metal and scrap debris.

Potential Utility Source:
Former Middle Lake Pumping House

Drinking Water Supply:
None

Sewage Disposal:
None

Fuel Storage:
None

Operation Details:
Site is a former pump house for Sydney water, also located here is the former intake for the water treatment plant, along with a small dump site of scrap metal and debris.

N

750 375 0 750 1,500 2,250 3,000
Meters

Projection: UTM Zone 20N
Datum: NAD83
Source Layers: Cape Breton Regional Municipality
Project No. 05-4594
May 2006

6.6 Recreational – Potential Sources of Contamination

There is evidence of recreational use of the protected zones in that there are obvious impacts within the area due to all-terrain-vehicles and snowmobile use. Recreational use can potentially cause contamination to surface run-off from an accidental fuel oil release, debris associated with littering and the potential for forest fires particularly during dry periods. As previously stated, hunting activities have been observed throughout the wellfield on numerous occasions in the past and present.

Figure 6-6: Potential Recreational Sources of Contamination

Potential Recreational Source:
1748 Gabarus Highway

Drinking Water Supply:
Private - Drilled

Sewage Disposal:
On-Site Septage

Fuel Storage:
None

Operation Details:
Recreational facility. One building on-site, base ball field, playground, picnic tables.

Potential Recreational Source:
ATV's, Snowmobiles,
Dirt Bikes etc.

Trails exist in and around the protected zones, as well as the zone of contribution.

Potential concerns may include hydrocarbon spills from filling tanks, damage to vegetation and soil, among other things.

Projection: UTM Zone 20N
Datum: NAD83
Source Layers: Cape Breton Regional Municipality
Project No. 05-4594
May 2006

7.0 Municipal Planning Strategy

The Council of the Cape Breton Regional Municipality adopted the recently implemented municipal planning strategy of the Cape Breton Regional Municipality on August 25, 2004. The strategy became effective as of September 17, 2004.

The municipal planning strategy addresses the Sydney Groundwater Supply as an environmental issue (Part 9. Environmental Issues).

The municipal planning strategy states that approximately 65,000 of the 109,000 residents (2001 Census of Canada) of the Cape Breton Regional Municipality are provided with drinking water supplied by the Regional Municipality's water utility. The following table outlines the communities of the Cape Breton Regional Municipality and associated water supply sources.

Table 7-1 CBRM communities and associated water supply sources

COMMUNITY	SOURCE OF SUPPLY	DAILY CONSUMPTION
Sydney (Includes Sydney River, Coxheath, Westmount, Whitney Pier)	Sydney Wellfield	3.35* migpd
Glace Bay	Sand Lake MacAskill Brook Dam	2.8 migpd
Northside	Pottle Lake	4.5 migpd
Donkin	Donkin Dam Schooner Pond	18,000 igpd
Port Morien	Sand Lake	14,000 igpd
Birch Grove	John Allen Lake	13,000 igpd
Louisbourg	Kelly Lake	450,000 igpd
New Waterford	Waterford Lake Kilkenny Lake	1.7 migpd

**Daily 2004 data from Sydney WTP.*

In the past, Sydney River was the sole source of treated water to the communities of Sydney River, Coxheath, and Westmount. The Sydney River watershed posed many problems and threats to potential contamination of the water supply due to land use activities within the area. Land use types include manufacturing, forestry, mining activity, commercial developments, and agricultural activity. However, land use is predominantly private dwellings with an overwhelming majority serviced by on-site sewage disposal systems.

Since June 4, 2004 the Coxheath pump house was deactivated and those areas of the CBRM were supplied with treated water from the Sydney Wellfield. This significantly reduced watershed management responsibilities to the largest watershed landmass in the municipality.

As stated in the municipal planning strategy, removing the Sydney River watershed dramatically alleviates the problems associated with any public water supply watershed management plan. The area of the CBRM landmass affected is significantly reduced. With this change in water supply sources, the municipality is left with a more manageable total landmass comprised of privately owned lands in the public water supply watersheds.

However, although Sydney River does not supply the communities of Coxheath, Sydney River and Westmount, it continues to be the water supply source for the Sysco pump house servicing the Sysco work site and numerous domestic buildings and establishments.

The CBRM's public water supply management plan consists of six components:

1. A land acquisition program;
2. Zoning provisions pursuant to the Municipal Government Act;
3. Watershed prescription under the Environment Act;
4. A wastewater management plan for existing development;
5. Public education; and
6. Liaison with other levels of government.

The following sections focus on these components and provide comments and recommendations as part of the groundwater protection strategy.

7.1 Land Acquisition

The Sydney Wellfield produces an average of approximately 3.35 MIGD comprising 25 percent of the treated water provided to CBRM residents. The associated watershed area of the Sydney

Wellfield accounts for 4,645 acres of landmass. Ownership of lands within the watershed area includes the Cape Breton Regional Municipality, the provincial government, the federal government and private landowners.

Land acquisition has been considered a primary focus of watershed protection for the municipality. Although ownership of all lands within the watershed area is perhaps the most effective method of protection, it is unattainable to acquire all privately owned parcels. A land acquisition program has been included as part of the public water supply management plan whereby privately owned parcels are placed in a hierarchy of development potential ranging from very possible to highly unlikely.

Dillon has included a map showing privately owned parcels of land with associated development potential (Figure 5-1). This map incorporates factors as outlined in the Municipal Planning Strategy. Factors include:

- Determining which parcels of land have the acreage capable of being developed within the watershed;
- Whether or not the parcel is fronting on a public street/road and whether or not the public street/road is within the watershed;
- The probability the soil will facilitate reasonable compliance with Department of the Environment's on-site sewage disposal regulations;
- Whether or not this Regional Municipality intends to utilize and maintain each source as a public water supply watershed in the long term for future use; and
- Whether or not ownership is known.

7.2 Zoning

Zoning has been established throughout all watersheds of the Cape Breton Regional Municipality. Zoning allows the Municipality to protect the watershed area by regulating land development. Although watershed areas are zoned to prevent land use activities and land development, primary industries already existing within the watershed are regulated rather than prohibited. Also, residential development is condoned however stipulations include that lots must be relatively large in comparison to the standards of the Department of the Environment and Labour and development may occur only along existing public streets/roads.

7.3 Designation as Protected Water Areas under the Environment Act

The Environment Act uses the term "watercourse" and it is defined as the "bed" and "shore" of every natural waterbody as well as the water in them and it includes all groundwater (Guide, March 1996)

According to the Environment Act, Part X: Section106, designation of a protected water area includes:

(1) The Minister, when requested by an operator of a water works or proposed water works, may designate an area surrounding any source or future source of water supply for a water works as a protected water area.

(2) The operator of a water works or proposed water works named in a designation made pursuant to subsection (1) shall

  (a) give notice of the designation of the area as a protected water area by publishing the notice in a newspaper having circulation in the county or counties in which the area is located and in the Royal Gazette;

  (b) have the notice of designation recorded at the registry of deeds and the land registration office in the county or counties in which the area is located; and

  (c) post signs in the area indicating that it has been designated a protected water area.

Designation of a public water supply as a protected water area pursuant to the Environment Act allows the municipality to regulate human activity.

The Middle Lake Road Wellfield watershed area is classified as a protected water area pursuant the Environment Act as it is zoned as a Public Water Supply Watershed (PWS) Zone.

7.4 Wastewater Management Planning

As stated in a previous section, the elimination of the domestic dwellings, commercial and industrial businesses of Sydney River from the overall watershed area of the municipality greatly reduces the responsibilities associated with wastewater management. As outlined in the one year and ten year protection zones of the Sydney groundwater supply, residential dwellings, commercial and industrial businesses within these zones are minimal. It is the intention of the municipality to implement an on-site sewage disposal system monitoring and maintenance

program for all landowners within the zone of contribution/watershed area of the Sydney wellfield.

7.5 Public Education

It is the responsibility of the Municipality to ensure that landowners and users within the protection zones and watershed areas are notified and aware that their activities can have adverse effects on the treatment and overall quality of the municipal water supply. It is the intention of the municipality to provide notification in the form of signage to be placed directly within the watersheds.

At this point, Dillon recommends that the municipality provide signage at all access points to within the wellfield and throughout the perimeter of the protection zones. Also, it is the intention of the municipality to provide regularly received literature to landowners that land is within the protected zones for the groundwater supply.

7.6 Cooperation with Other Levels of Government

The Municipality has a role to be a liaison among the levels of government associated with protecting the watershed areas. Several government departments have an involvement with a groundwater protection strategy. Departmental agencies throughout the province offer jurisdictional responsibility for forest management, agricultural management, and regulation of developments and activities potentially impacting a waterbody. The Municipality has a role to play in providing a partnership amongst these agencies by advising them of the extent of the watershed and the developments within these watersheds and also ensuring that best management practices are adhered.

8.0 Land Use By-laws

The Council of the Cape Breton Regional Municipality adopted the recently implemented land use by-law of the Cape Breton Regional Municipality on August 25, 2004. The strategy became effective as of September 17, 2004.

The following is stated in Part 54 – Public Water Supply Watershed (PWS) Zone in the Land Use By-Law of the Cape Breton Regional Municipality:

Section 1 PWS Uses Permitted

Development Permits shall only be issued in the PWS Zone for the 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 single detached 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 existing on the date this Land Use By-Law came into effect.

Amendments to the existing Land Use By-Law should provide for a re-evaluation of the existing protection watershed zone to include the groundwater supply zone of contribution and the one and ten year protection zones.

9.0 Groundwater Supply Protection and Management

9.1 Emergency Response Plan

The emergency response plan for the Middle Lake Road Wellfield groundwater supply describes a “predetermined communications and action sequence that will be implemented immediately to cope with an event of potential but uncertain occurrence”. Advanced planning reduces confusion during the initial stages of an emergency and provides direction in making major decisions.

The emergency response plan is structured such that certain individuals and groups have designated responsibilities to conduct specific procedures in the event that an emergency should occur. These groups include the CBRM, the local fire department, and various regulatory agencies. It is a stand alone document, to be distributed to all persons/parties who have been assigned specific responsibilities within the plan. A copy of the plan can be found in Appendix A.

9.2 Groundwater Resource Monitoring Plan

In order to assess the quality and quantity of the groundwater resource, it is necessary to construct a groundwater resource management instruction manual. The manual is designed to be a separate document describing the process for carrying out a regularly scheduled water level and groundwater sampling program and subsequent data management upkeep, analysis and reporting.

The manual located in Appendix B outlines the requirements and protocol involved to conduct a quality control monitoring sampling program.

10.0 Summary and Recommendations

10.1 Summary

In 1996, water quality concerns prompted the City of Sydney to use the groundwater alternative as a water source. The Middle Lake Road Wellfield provides the source water for Sydney water supply with sufficient water yield and stable water quality, which meets the limits of the Guidelines for Canadian Drinking Water Quality (GCDWQ) with the exception of manganese and iron. The groundwater bodies are not only an important source of public water supply, but they provide aquifers having favourable hydraulic properties, such as filtration and self-cleaning, which play valuable roles in water supply systems. Aquifers are used as conduits for distribution of water and as places to store water. Also, due to the nature of the groundwater body, it is very difficult to be recovery once the groundwater is contaminated or polluted.

Realizing the significant value of this groundwater resource, this groundwater protection strategy was developed and updated to secure the integrity of this water supply long into the future. This strategy is intended to not only protect the investment in identifying, confirming and developing this aquifer, but it recognizes that the cost to replace or rehabilitate the water supply, should it

become impacted by human activities, is considerably higher than the costs of preventing or managing associated risks. This is especially true in this instance for the wellfield and the protected watershed area.

Groundwater delay time zones as the basis to define specific protection zones were delineated by using a numerical model, VISUAL MODFLOW. The main advantage of numerical modelling is that it can combine variations in hydrogeology and pumping condition. Data sets previously derived from pumping tests and subsequent aquifer analysis, which included the use of MODFLOW, recordings from pumping wells, and measurements from the monitoring well network were incorporated into VISUAL MODFLOW. The model was utilized in transient mode to establish various delay time of the groundwater flow.

The one-year and ten-year delay time protection zones are within the protected watershed area. The Cape Breton Regional Municipality provides ownership and controls much of the property within these protection zones. The intent of this strategy is to minimize risks to the water supply through appropriate land use controls that recognize the need to assess and balance the many aspects of groundwater protection. With the application of digital mapping based on the Geographic Information System (GIS), a technical assessment included determination of historical and current land use and identification of associated potential sources of contamination within the protection zones.

Within the one-year and ten-year zones, the primary land use is that it belongs to a protected watershed area. The primary source of potential contamination of the protection zones is the transportation of fuel and dangerous goods along Route 22; the secondary source is associated with the above ground fuel storage tanks located on Ormond Cresent. Road salt might be another potential source of contamination therefore cautious use in these zones should be prescribed. Activities associated with the burrow pit are a potential source of industrial contamination.

The zone of contribution is a protected public water supply watershed zone and is primarily owned by CBRM. Although a land acquisition program has been designed, it is unattainable to acquire all privately owned parcels. Therefore, the monitoring of on-site sewage disposal systems for all land owners should be implemented. The amendments to the existing Land Use By-Law should be re-evaluated based on the protected zones given in this groundwater protection strategy.

Public awareness to protect a groundwater resource is a persistent and significant program. Cooperation and understanding from the public, residents, businesses, government agencies and environmental groups is critical for this strategy implementation.

The groundwater protection strategy is a significant document for identifying and minimizing potential risks associated with contamination of the groundwater resources. However, some risks will always exist. The Emergency Response Plan is drafted and updated to address these potential risks. This plan is prepared to respond to an event such as a hazardous material spill along Route 22 or a fuel oil spill that presents a risk to the water supply. In this plan key contacts, communication and actions in an emergency situation have been presented. Parties with designated responsibilities include CBRM, the local volunteer fire department, local emergency measures organizations, local equipment and service providers and various regulatory agencies etc. The Groundwater Resource Monitoring Plan is intended to ensure the monitoring of groundwater quality and quantity. The sampling frequency and processes have been prescribed in this plan. The Emergency Response Plan and Groundwater Resource Monitoring Plan should be periodically reviewed and updated.

10.2 Recommendations

The groundwater protection strategy should be implemented to ensure compliance with regulations and criteria issued by the Nova Scotia Environment and Labour. This strategy includes the associated "Emergency Response Plan" and the "Groundwater Resource Monitoring Plan", as well as the specific recommendations regarding amendments to the land use controls. In point form, this study strongly recommends the following:

1. Re-evaluate amendments of the existing Municipal Planning Strategy and Land Use By-Law based on the protected zones presented in the groundwater protection strategy.
2. Make every effort, where possible, to reduce road salting within the protected zones.
3. Implement the Emergency Response Plan such that all designated parties are adequately prepared to respond to an emergency situation.
4. Continue to implement continuously the Groundwater Resource Monitoring Plan to monitor the integrity of wells, water levels and groundwater quality.
5. Ensure that all petroleum storage tank systems within the protection zones meet or exceed applicable regulations.

6. Communicate with the owner/operator of the gravel/borrow pit the importance of storage and handling of petroleum products on site; Control access to the gravel/borrow pit such that it is not at risk of being used as a refuse disposal area.
7. Designate those responsible to oversee monitor compliance within the protection areas. This could be in the form of an Advisory or Management Committee, separated from the existing community liaison committee.
8. Provide information on the groundwater protection strategy to private landholders within the protection zones.
9. Provide information to the general public concerning the vulnerability of the groundwater supply and the measures undertaken for its protection.
10. Revise and update Emergency Response Plan and Groundwater Resource Monitoring Plan every 24 months.

11.0 References

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Appendix A

Emergency Response Plan

Appendix B

Groundwater Resource Monitoring Plan