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PICTOU
Birthplace of New Scotland

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March 8, 2019

Attached is a formal response from the Town of Pictou regarding the Northern Pulp Nova Scotia, Replacement Effluent Treatment Facility Project.

Thank you for your consideration of the identified concerns.

James Ryan
Mayor

Town of Pictou

Response to

Northern Pulp Nova Scotia
Environmental Assessment Registration Document
Replacement Effluent Treatment Facility

Table of Contents

1. Town of Pictou Statement of Position:

The Town of Pictou hereby informs the Nova Scotia Department of Environment that it can not support the Northern Pulp Nova Scotia plan for the Replacement Effluent Treatment Facility. Additional risk, however small, to the domestic water supply is unacceptable.

2. List of Concerns to be Addressed:

A. The plan creates additional risk to the Town water supply by the on-land portion of the proposed transmission pipe carrying treated effluent to Caribou Harbour.
B. The limited information in the Environmental Assessment Registration Document regarding the potential for increased (new) toxins and/or odours produced as a result of the re-location of the Activated Sludge Treatment (AST) facility to Abercrombie Point, the burning of sludge in the power boiler, and the venting of air as part of the transmission of warm effluent through the Town of Pictou.
C. Economic effects of potential disruption(s) to tourism traffic to and from the (Caribou, NS – Wood Island, PEI) ferry terminal during the construction phase of both the on-land and under water portions of the effluent pipe.

3. Context for Responding:

The Town of Pictou is a community of approximately 3200 residents located on the north shore of Pictou Harbour approximately three kilometers from the Northern Pulp Nova Scotia facility. The Trans-Canada Highway (TCH) 106 runs through the west end of the Town and proceeds to the Northumberland Ferry Terminal at Caribou Harbour. The Harvey A. Veniot Causeway connects the Town of Pictou to Abercrombie Point where Northern Pulp is located.

For 52 years Northern Pulp and its previous owners have provided a reliable and, depending with whom you speak, a greatly appreciated source of income for many members of the community through direct employment at the processing facility and the integrated forestry and trucking industries. The mill and its air emissions are visible from most (all) locations in the Town of Pictou. In November 2017, Pictou Town Council passed a Resolution to request

consideration for Federal oversight of the Northern Pulp project and that there be 'no harm to the Northumberland Strait fishery' (Appendix F, Pg. 1)

In the 1990s The Town of Pictou created the Pictou Waterfront Development Corporation with the goal of improving the waterfront/downtown district while promoting the tourism sector. The signature attraction for the development was the construction of a full-size replica of the *Ship Hector*. The $10M project was completed with financial support from the Atlantic Canada Opportunities Agency (ACOA), the Province of Nova Scotia and the Town of Pictou. The Pictou Waterfront has since been and is expected to continue to be significant focus of economic interest within the Town.

Pictou is the home of Advocate Printing and Publishing, AECON Fabco (Shipyard), CMS Steel Pro Mechanical. Council continues to embark on projects promoting the Town as the service and entertainment centre for Pictou West and a tourist destination.

Within the past 15-20 years the Town of Pictou, with financial support from Provincial and Federal governments, has completed several significant additions and upgrades to important infrastructure ensuring the comfort and security of residents and visitors. This work is aimed at ensuring long term sustainability and compliance with health and safety standards.

Construction and commissioning of a municipal Wastewater Treatment Facility for the Town of Pictou and surrounding area took place in 2011. The facility processes one hundred percent (100%) of the Town's sewage and, unfortunately, a large portion of the storm water. Our tests reveal one hundred percent (100%) compliance in achieving standards for effluent and the development of a storm water plan for the Town is now underway so future wastewater needs can be met. We are extremely proud of our advances in service to the community and the protection of our environment.

The Town of Pictou has, in the past, consistently experienced issues associated with water discolouration and mineral build-up in the distribution pipes. A new 'state of the art' Water Treatment Plant was commissioned in October 2019 to centralize water treatment and distribution while removing high levels of manganese and iron from the supply. We are very pleased that initial scientific testing and a positive public response indicate great success as we continue to upgrade our infrastructure to ensure safe and reliable water for home and commercial use.

4. Environmental Assessment Concerns (In Order of Significance):

A. Risk of Ground Water Contamination

The proposed on-land portion of the pipe carrying treated effluent to Caribou Harbour will cross both the Pictou wellfield which is completely within the Town of Pictou boundaries, and, the Caribou wellfield which is situated completely within the boundaries of the Municipality of Pictou County. Both wellfields are located within the delineated boundary of the Caribou/Pictou Watershed protected area identified of in Figure 1 of Appendix D (Pg 6).

The Town has been granted Permits from the Province of Nova Scotia to draw approximately half of the Town's potable water from wells within the Caribou wellfield and the rest from the Pictou wellfield. A total of approximately 600K cubic meters are pumped annually from eight active wells. Limits for water extraction from the various wells can be found in Table 2 of the Permit (Appendix B, Pg. 8). As part of the permitting process, the Caribou/Pictou Source Water Protection Committee was formed, and the Pictou/Caribou Source Water Protection Plan was completed (Appendix D). This plan identifies risk and best management practices for mitigating risk should accidents occur.

Residents of the Town of Pictou depend on the groundwater drawn from the Pictou/Caribou watershed for their drinking water. The Caribou and Pictou wellfields are the only viable sources of potable water and it would be safe to conclude that without this dependable source of water there could be no town. It is the Town's position that we can not be supportive of any activity that would add additional risk to our water supply regardless of the many references to 'insignificant' risk in the Environmental Registration Document. More specifically, we cannot support the planned construction of a pipe carrying the treated effluent containing 'residual contaminants' (Registration Document, Pg. 32) along TCH 106. In the original Source Water Protection Program from 2005 the hydrologist representing *ADI Limited* identified a 'Zone of Influence' which shows the extent of the sand and gravel aquifer where surface water could affect the Town water supply (Appendix A, Pg. 4). A large stretch of TCH 106 is situated well within the aquifer and, therefore, we should assume that any accidental spills in the area could be harmful to our citizens.

It should also be noted that, as a 'General Term' within the Town's Permit To Withdraw Water, the Town has indemnified the Province against our (the Town) actions in causing 'damage resulting from the activities performed pursuant to this Approval' (Appendix B, Sec. 3(v)).

B. Additional Air Emissions and Odours Associated with the AST (Activated Sludge Treatment) and Transmission of Effluent

The Pictou West area, including the Town of Pictou is the recipient of a significant portion of the air emissions from the mill operations as shown in (Appendix E, Figures 1 and 2, Pages 3 and 5). As a result of this, residents and visitors alike have complained about the emissions including concerns for the long term effects on their health. Numerous studies suggest that higher levels of certain illnesses are evident in the area. For many years, dining and accommodation operators have also expressed concern about lost revenue as the result of odours associated with the air emissions from the mill.

Despite significant improvements to overall emissions with the recent construction of the Precipitator Unit, emissions and associated odours continue to affect the Town on a regular basis.

With the relocation of the Activated Sludge Treatment (AST) Facility to Abercrombie Point we are concerned that new odours, similar to those that have been a problem around Boat Harbour since the mill was made operational, might have a tendency to 'drift' in the Town's direction. Additional contaminants in the emissions from the Power Boiler when the sludge from the new treatment facility is incinerated will also be of concern. The Environmental Assessment fails to provide comfort that particulate emission and odours will be handled to the Town's satisfaction.

An additional concern exists regarding the proposed venting along the on-land portion of the effluent pipe. It is our understanding the vent must be placed at a high point in the transmission line which could be between the Harvey A. Veniot Causeway and the Pictou Rotary. If this is to be the case, we expect that there could be additional odours from the warm treated effluent at that location. Also, should any unintended blockages of the pipe occur beyond that point, it could be concluded that the vent would provide a release point for effluent until the flow is stopped. It is important to note that his point is within the Town limits and is above the Pictou Wellfield.

C. Potential Economic Effects of the Pipe Construction Phase on the Economy

The Town of Pictou is located approximately eight kilometers from the ferry linking Nova Scotia to Prince Edward Island. This is a major entry and exit point to Nova Scotia where approximately 20 000 vehicles use the ferry each year between April and December.

Our community is, not only, a service centre for the Pictou West area but also a stopping place for travellers and a tourist destination. Many of the Town's businesses and tourist attractions are seasonal operations and depend on the high traffic volumes from May to October.

The timeline for construction outlined in Table 5.4-1 (Registration Document, Pg. 82) indicates that land clearing, construction and watercourse construction for the land portion of the pipe will take place from November 2019 until possibly September 2020 and the Marine portion from April 2020 to October 2020.

Should travellers choose to avoid the Northumberland or TCH 106 due to construction, financial impacts would be felt by the businesses and seasonal operators in the Town and the surrounding area.

5. Appendices:

Appendix A: Source Water Protection Program (Prepared by ADI Limited, September 2005)

Appendix B: NSE Approval to Withdraw Groundwater from Pictou and Caribou Wellfields (Approval No: 2002-026956-R01, June 21, 2013)

Appendix C: NSE Permit to Operate a Water Supply System (Approval No: 2012-080096-R02, March 4, 2016)

Appendix D: Pictou Caribou Source Water Protection Plan (2013, Revised in 2014 and 2017)

Appendix E: *Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia* (Hoffman, Guernsey, Walker, Kim Sherren, Andreou, 2017)

Appendix F: Correspondence on the Matter of the Effluent Treatment Facility Proposal(s).

- To: NS Minister of Environment, Federal Minister of Environment and Climate Change, Federal Minister of Fisheries and Oceans (December 2017)
- From: Canadian Environmental Assessment Agency (CEAA), (March 27, 2018)
- To: Mr. Bruce Chapman, General Manager, Northern Pulp Nova Scotia (October 24, 2018 and November 2, 2018)
- From: Mr. Bruce Chapman (October 26, 2018)
- To: Canadian Environmental Assessment Agency (CEAA) (February 24, 2019)

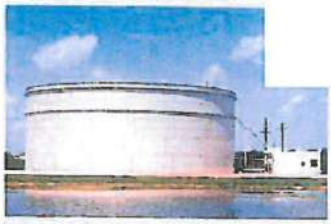
Appendix A

Source Water Protection Program

(Prepared by ADI Limited, September 2005)









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Oblique aerial view of the Town of Pictou looking north with the urbanized "Town" Well Field in the foreground and the forested area surrounding the "Caribou" Well Field in the background.

Source Water Protection Program
Town of Pictou

ADI Limited

File: (24) 3945-001.1
Date: September 2005

This report was prepared by ADI Limited for the account of the Town of Pictou.

The material in it reflects ADI Limited's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. ADI Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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Project No.:	(24) 3945-001.1	Date:	2005.Sept.22
Issue Status:	Final	Revision No.:	0
Prepared By:	Fred Baechler, M.Sc., P.Geo.		Fred Baechler
Reviewed By:	Matt Blais, B.Sc., CET		MBlais

1.0 INTRODUCTION

1.1 Location

The Town of Pictou is located along the Northumberland shore of Nova Scotia within the Municipality of the County of Pictou (Figure 1-1A). The Town encompasses some 8.14 km^2 within its political jurisdiction along the north shore of Pictou Harbour.

Pictou was first settled in 1767 with the Hector arriving in 1773. It was subsequently "founded" (1788), and given its name as the Shiretown of Pictou County in 1792. It became incorporated in 1873. Since that time, the Town's population has grown gradually to its present level of approximately 4000 people.

1.2 Goals of This Report

This report has been prepared for the Town of Pictou by ADI Limited (ADI) to meet the requirements of the Nova Scotia Department of Environment and Labour's (NSDEL) Source Water Protection Planning. This is now a condition of approval for all water works in the Province. Given historical work (Section 1.3) and ongoing studies (Section 1.4) this Protection Plan should be considered a continual "work in progress".

1.3 Background

The Town of Pictou was authorized to develop its water supply in 1888 and has been extracting groundwater for municipal services since 1901. Up until 1901, water was supplied from privately owned wells in the Town, which were not maintained in a sanitary condition. To overcome the danger of disease, the first council (1874) appointed a Superintendent of Wells and Pumps and requested aid from the provincial government. Subsequently, Chapter 120 of the Nova Scotia Acts in 1888 provided for supplying the Town with water. This authorized and empowered the Town Council to provide a sufficient supply of water for domestic, fire and other purposes. These early actions started what is now over 125 years of Development, Management and Protection of its water supply. *This foresight and list of accomplishments form a remarkable achievement for such a small community, and only a 1250 domestic user rate base.*

The first well field outside the Town, referred to as the Caribou Well Field, was constructed in the early 1900's. The first seven wells were drilled in 1901, followed by additional ones in 1907 (Smith-Grant) and 1943 (Footes Lane), all drawing from the bedrock aquifer. Although outside of urban activities, and easier to protect, it was within a different political

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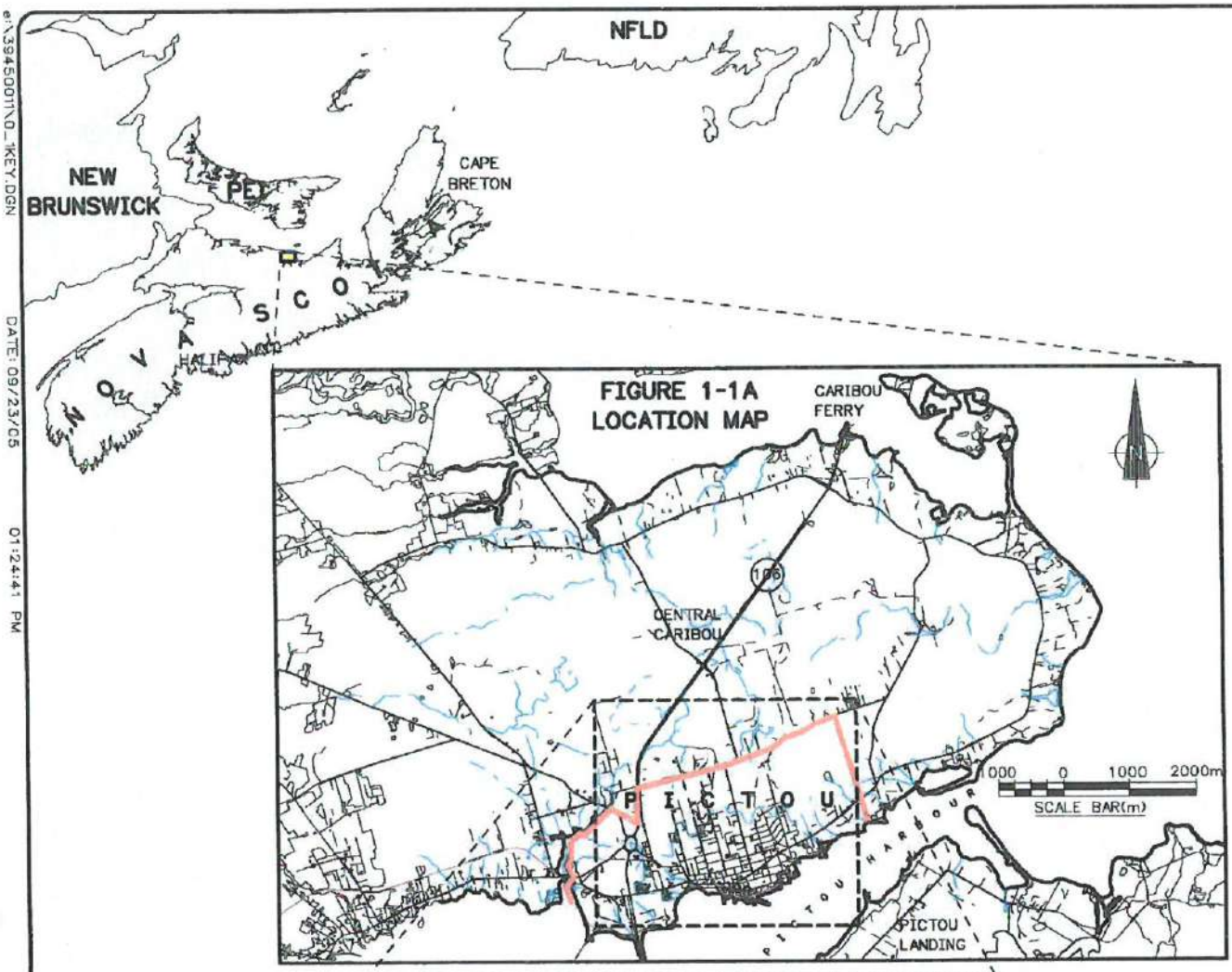
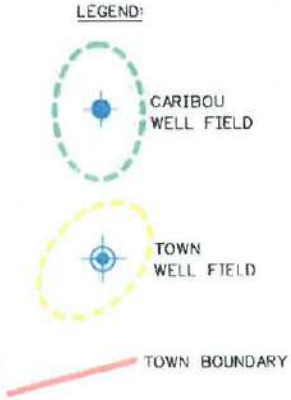
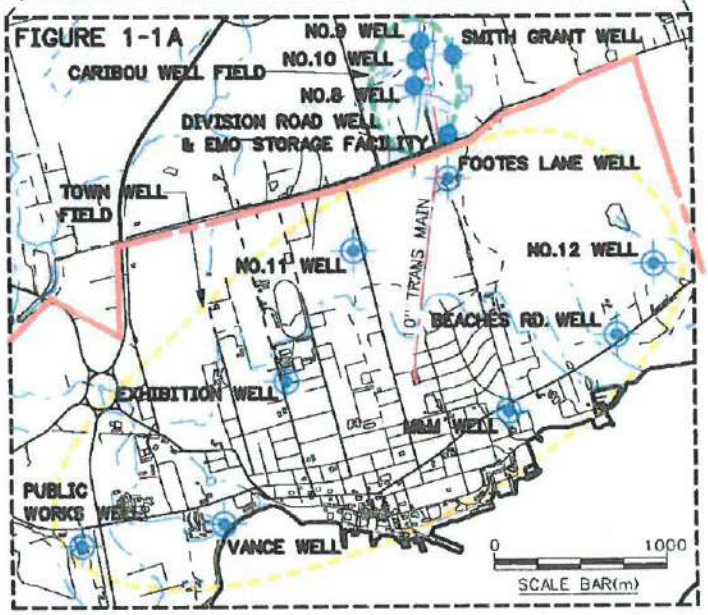


FIGURE 1-1B
LOCATION OF WELL FIELDS





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Proj. TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT

Dwg. LOCATION OF TWO WELL FIELDS SUPPLYING TOWN OF PICTOU

Drawn By: NEB		Proj. No. 3945-001.1	
Dwg Standards Chk. By:		Dwg. No. FIGURE 1-1	
Designed By: FEB		Date Last Modified: 05.AUG.25	
Design Chkd. By: FEB	Last Modified By: NEB	Rev. 0	

jurisdiction, a source of future problems. By the late 1960's the well field supplying the Town encompassed 14 active pumping wells, nine of which were on the vacuum system within the Caribou Well Field (Figure 1-1B).

The 1970's and 1980's saw a period of *Resource Evaluation and Well Field Expansion.* These technical studies culminated in two new production wells in the Caribou Well Field and delineation of additional target areas for future expansion.

The 1990's focused on *Well Field Protection*, long before it became the "thing-to-do" after the Walkerton tragedy in 2000. During this decade, the Town brought on a hydrogeologist for technical guidance. Numerous studies focused on delineating the extent and source of recharge supplying the Caribou Well Field aquifer, as well as assessing and mitigating potential risks; before NSDEL requested it in 2002. A three zone Well Head Protection Area (WHPA) was outlined with a listing of "permitted uses" and suggested "constraints".

This work culminated in a formal request to the Minister of NSDEL to designate lands surrounding the Caribou Well Field as a protected area in 2002. Unfortunately, this request was turned down.

The last five to eight years have been characterized as *Adaptive Management.* This approach is "learn by doing", which manages multiple issues with action based on incomplete knowledge using the Pre-Cautionary Principle, supported by feedback through monitoring. requirements.

1.4 On-Going Studies

At the time of submission of the Surface Water Protection Program (SWP) a number of relevant studies and activities are ongoing, specifically:

1.4.1 Activities

The Town is maintaining their hydrogeological technical advisor, purchasing land around the Caribou Well Field, developing protection plans for the Urban Well Field, hiring summer staff, upgrading the distribution system, searching for additional supplies within the Town boundaries, expanding their digital database, working with the Pictou County District Planning Commission on land use constraints, addressing demand side management by installing water meters and requesting rate increases, as well as continuing to educate the public on water.

1.4.2 Studies

Groundwater under Direct Influence (GUDI): The Town is presently eight months into the one year assessment of NSDEL's Phase II level GUDI of surface water effort on 12 wells.

Distribution System: The Town is presently assessing and upgrading the distribution system, parts of which are over 100 years old. It has instituted an assessment of chlorine demands, potential for trihalomethanes (THMs) and haloacetic acids.

Additional Production Wells: Foresight necessitated assuming replacement wells would be a more efficient response to any GUDI problems which arise, if they can be positioned within Town boundaries and direct flow to the central reservoir for treatment. A test drilling/pump exploration program is underway to locate such supplies.

Water Sampling of Wells: As part of "due diligence" associated with the Adaptive Management Approach, the monitoring program supplying feedback on the Town's actions encompasses more than that required by the NSDEL permit. Along with "Source" and "Distribution" system monitoring, the Town has incorporated a "Source Protection" program, which monitors the "health" of the aquifers and allows us to reflect impacts of climate change into our strategies.

1.5 Report Outline

Building upon the background outlined above, the main body of the report initially summarizes the characteristics of the existing water system supplying the Town of Pictou (Section 2.0). The remaining sections follow NSDEL's five steps to Source Water Protection Planning namely:

Section 3.0	Delineate Source Areas
Section 4.0	Identify Potential Risks
Section 5.0	Develop SWP Strategies to Manage Risks
Section 6.0	Develop a Monitoring Plan
Section 7.0	Develop SWP Advisory Committee

The text for each section summarizes salient points. Support documentation can be provided upon request.

2.0 EXISTING SYSTEM

The groundwater supply for the Town presently comprises 13 wells encompassed with two well fields identified as the "Caribou" and "Town" Well Fields (Figure 1-1B). Presently, the demand ranges from 950 to 1040 Lpm for a population of about 4,400.

The Pictou Water Utility was issued an operating permit for the Town of Pictou's Water Supply by the NSDEL on 19 March 2003: Approval No. 2001-024443.

The Caribou Well Field is located north of the Town Boundaries, within the basin-shaped, central part of the Pictou Peninsula. It is presently comprised of five active pumping wells (No's 8, 9 and 10, as well as Smith-Grant and Division Road wells). This comprises approximately 45% of the present total Town demand.

The Town Well Field is located within the Town of Pictou's political boundaries. It is presently comprised of eight active pumping wells. They include Footes Lane, Public Works, Exhibition, Vance, M and M, Beeches Road, No. 11 and No. 12. All were constructed between 1942 and 1969, except for No.'s 11 and 12, which were brought on line in 1989 and 1996 respectively.

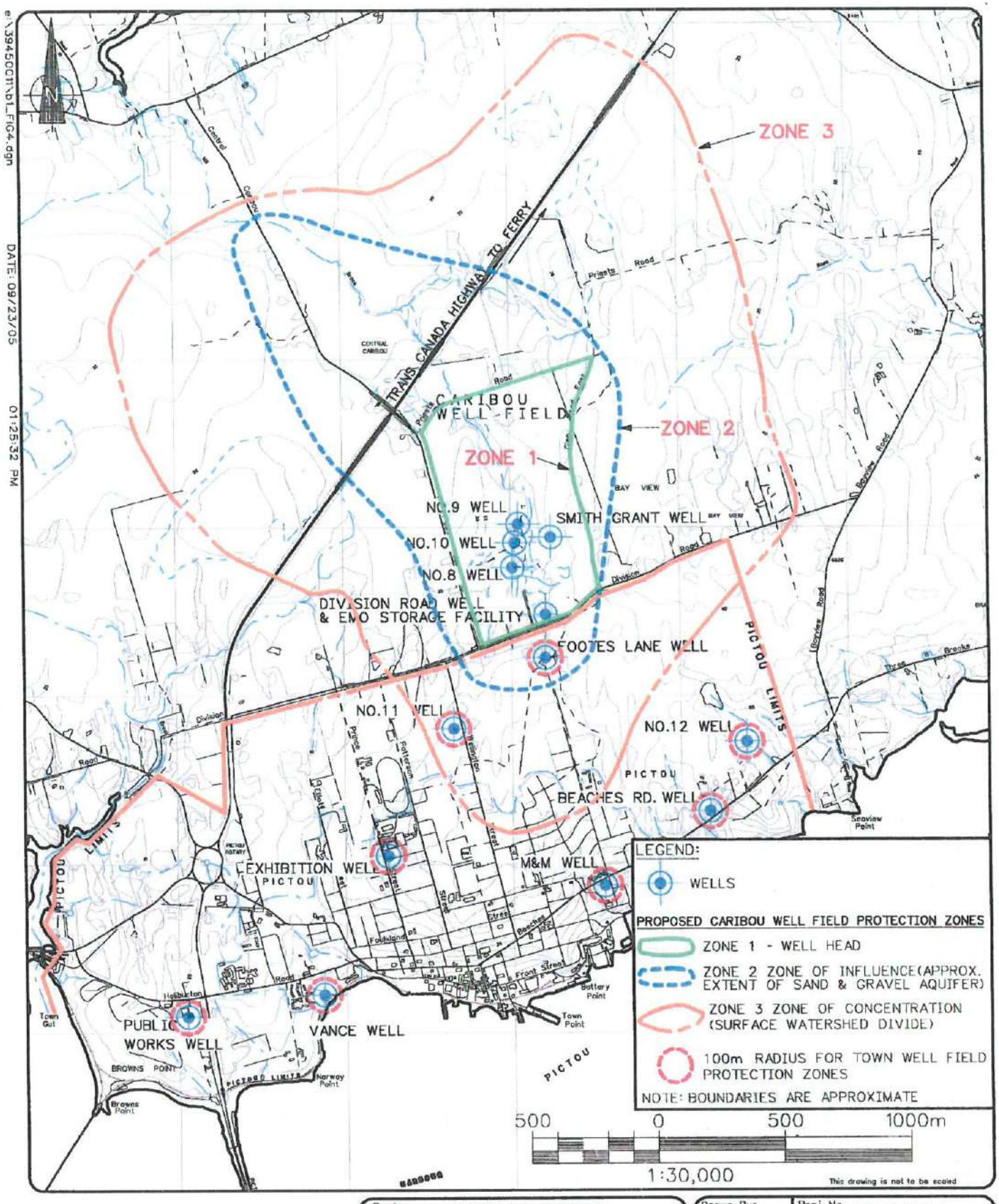
3.0 DELINEATION OF SOURCE AREAS

This section initially summarizes the present state of knowledge of the physical and chemical characteristics of the hydrological cycle within which the extractions are occurring; support documentation can be provided if so required. This forms the technical base upon which the delineation of Source Water Protection areas is based, as outlined in Section 3.2.

3.1 Conceptual Model for Ground and Surface Water Flow Fields

Climatologically, the area experiences a humid continental climate. A water balance analysis indicates slight water deficits in June, July and August, with moisture surplus creating Spring and Fall groundwater recharge periods. Longer term trends note gradual declining precipitation and elevated air temperature since the early 1990's, suggesting less water available for recharge.

Physiographically, the Town and its well fields are located within the Pictou peninsula (Figure 1-1A), bounded to the northeast and south by salt water of the Northumberland Straits and Pictou Harbour.



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Proj. TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT

Dwg. CARIBOU WELL FIELD PROTECTION ZONES - 2001

Drawn By: NEB	Proj. No. 3945-001.1
Dwg Standards Chk. By:	Dwg. No. FIGURE 3-1
Designed By: FEB	Date Last Modified: 05.SEP.09
Design Chkd. By: FEB	Last Modified By: NEB / Rev. 0

Hydrogeologically, the Peninsula is positioned with a "Lowland Setting" consisting generally of a glacial till over bedded sedimentary rock. The Caribou Well Field extracts water from the Upland Aquifer Complex, combining both a surficial sand/gravel, as well as a bedrock aquifer. The Town Well Field draws water from the bedrock aquifer.

There are three Hydrostratigraphic Units (HUs), which control water flow to the well fields, including the Pictou (bedrock) HU, Sand and Gravel (S/G) HU and the Till HU. The Pictou and S/G HUs can be defined as a Class 1 Aquifers, utilizing NSDEL's classification (Shawinigan Eng. Ltd., 1980). The Till HU is an aquitard, which semi confines the Pictou HU.

Hydrological analysis has keyed to the Caribou Well Field, given the surficial nature of the S/G aquifer, and its susceptibility to the introduction of contaminants from streamflow. A tributary of Mill Brook, identified as Beaton's Brook, extends through the middle of the well field, draining from south to north. Of the four inflow streams, only one is perennial, primarily since it over lies the S/G aquifer, which provides base flow during the summer. All channels disappear upon entering the central core of the S/G aquifer in the lowland area surrounding the production wells, and continuing through almost to Priest Road. This is expected to be a function of recharge into the S/G aquifer.

3.2 Source Water Protection Areas

3.2.1 Approach

Delineation of SWP's for a groundwater source requires detailed hydrogeological analysis of the aquifers transmissivity (T) and storage coefficient (S) in order to delineate drawdown cones and travel times. However, most of the production wells became operational prior to requirements for pump testing and cannot be turned off to allow for testing, due to demand on the system. Therefore, T and S values for every well are not available and delineation of Well Head Protection Zones based upon travel times is not possible. At this stage the conceptual/analytical model summarized in Section 3.1 has been used to aid in delineating protection area coupled with the Pre-Cautionary approach; numerical modelling has not been incorporated to date.

3.2.2 Caribou Well Field

For the Caribou Well Field, a three zone WHPA was tentatively outlined utilizing existing information (Figure 3-1). Zone 1 (Well Head) was based upon existing roads, and the historical approach by the Town in acquiring land. Zone 2 (Zone of Influence) was based

upon the known limits of the S/G aquifer. Zone 3 (Zone of Contribution) was delineated using surface watershed boundaries.

3.2.3 Town Well Field

Three wells have been pump tested to date. Pump testing of No. 12 production well provided a T of 15 to 22 m^2/d with a storage coefficient of 1 x 10^{-4} to 1 x 10^{-5}, representing a semi-confined aquifer with leakage. Assuming these values are representative of the Pictou HU, an average continuous pumping rate over 30 days of 250 to 295 Lpm creates a 1 metre drawdown some 3 km radius from the pumping well, assuming equivalent porous media approach applies. At the 100 metre radius, drawdown is in the order of 1.5 to 5 metres. The 100 metre radius has been applied to each well to delineate Zone 1 of a WHPA, the extents of which is shown on Figure 3-1. Zone 2 and 3 would be encompassed by the 3 km radius. It was this zone that an intensive study was undertaken to assess land use and potential sources of contamination.

4.0 RISK IDENTIFICATION

4.1 Caribou Well Field

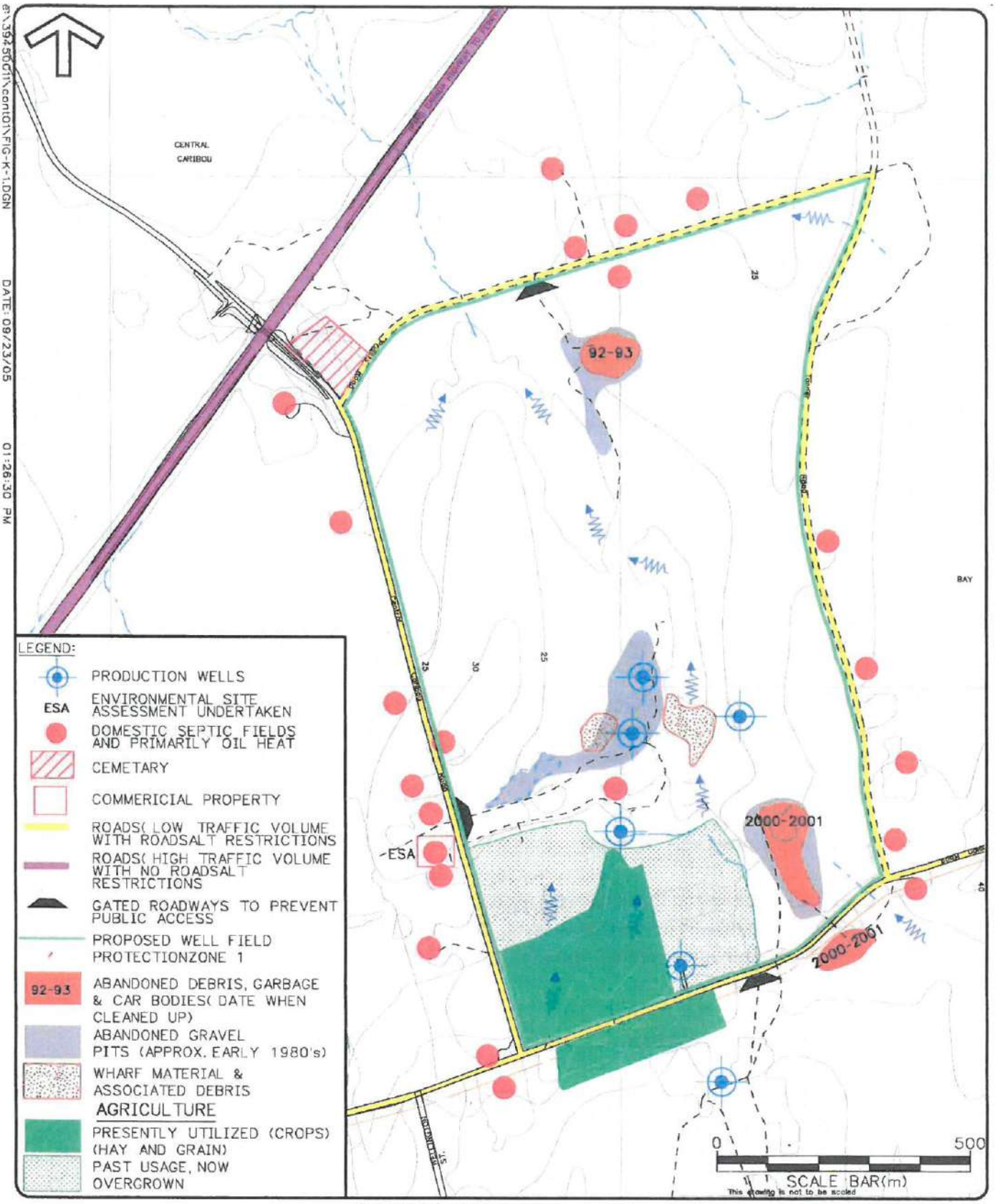
Review of aerial photographs and field assessment of WHPA Zone 1 identified a number of potential risks as summarized below and on Figure 4-1.

4.1.1 Sand and Gravel Pits

Extraction of sand and gravel for aggregate from the S/G HU in the southeast corner and north boundary occurred historically from the early 1900's until the late 1970's. Although operations have ceased, indiscriminate disposal of various municipal wastes and auto bodies has sporadically continued to present. In 1985, the Town barricaded all access roads into Zone 1. Debris was gradually removed from 1987 to present and continues as necessary.

4.1.2 Waste Disposal

In approximately 1959, burnt creosote timbers from a fire on the Pictou Wharf were disposed of in the core of the Well Field, adjacent to Production Wells No.s 9 and 10. Concern expressed with leaching of PAHs into the S/G HU prompted NSDEL to undertake an investigation; sampling indicated no problems were being created. Monitoring wells were installed within the S/G HU between the disposal area and the wells by the Town in 2000.



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Proj. TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT

Dwg. **CARIBOU WELL FIELD-ZONE 1 INVENTORY OF POTENTIAL CONTAMINANT SOURCES AS OF AUGUST 2001**

Drawn By: NEB	Proj. No. 3945-001.1
Dwg Standards Chk. By:	Dwg. No. **FIGURE 4-1**
Designed By: FEB	Date Last Modified: 05.AUG.25
Design Chkd. By: FEB	Last Modified By: NEB / Rev. 0

There was no visual or analytical evidence of PAHs. Some of the surficial materials were removed by the Town in 1998.

4.1.3 Septic System

One septic field is present for the Fraser household in proximity to the No. 8 Production Well. The Town removed the old tank/field bed system and installed a new approved system at its expense during the summer of 2001. One septic bed is in use just north of the gated roadway along Central Caribou Road. This private residence has its own well and the Town has no access to validate the condition of either.

4.1.4 Abandoned Wells

The Town located and securely capped all of the known test holes and monitoring wells from previous hydrogeological investigations. This was to prevent contamination from entering the aquifer by transmission through open abandoned wells and deteriorated casing

4.1.5 Domestic Dwellings

A total of 38 private lots are present in Zone 2, but immediately adjacent to Zone 1. Each home is supported by its own drilled well water supply utilizing primarily the Pictou HU and on-site septic systems. Of these, 22 have been identified as of primary or secondary priority for Environmental Site Assessments (ESAs) to document past and present activities.

4.1.6 Agricultural Activities

Land use is present in the southwest corner of Zone 1, adjacent to Division Road and No. 8 Production Wells. The land is utilized for crop production utilizing standard acceptable agricultural practices. Manure spreading is not undertaken within 150 metres from each well head.

4.1.7 Forestry Activities

The forest within Zone 1 has been extensively harvested in the past. While little harvesting work has been conducted within the past 30 years, a significant amount of wood was harvested by clear cutting 20 to 40 years ago, for forestry as well as sand and gravel extraction. The abandonment of the latter since the 1970's has resulted in the regeneration of stands of pioneering species such as white birch, grey birch, poplar, white spruce, eastern larch (tamarack) and alder, generally with a high hardwood component. The abandonment

of agricultural land has also contributed to development of similar stands of pioneering species, usually with a greater softwood component.

4.2 Town Well Field

Since the wells are spread far apart, an investigation was undertaken within the 100 metre radius of each site to identify risk factors. To date, four well sites have been assessed as summarized below. Investigations are on-going for the remaining four sites.

4.2.1 No 12 Production Well

The pump house is on land owned by J.R. MacDonald of Far East Construction with the well parcel under easement to the Town.

There are four residential lots within the 100 metre radius of the well. There are no records of homes or subsurface facilities dating back at least to 1970. A quarry is present 300 metres north of the well used in the past to extract building stone, it is presently abandoned. The base of the quarry drains to the southeast corner, where a pond remains during dry periods some 320 metres from the well.

It would appear that most of the properties were wooded prior to construction of the homes, therefore, historical land use issues do not appear to present an issue of concern.

Garbage was noted scattered throughout all properties including car parts, beer bottles, cans, scrap metal and miscellaneous items. There is a small amount of household garbage in the northeast corner of the quarry; garbage has been removed in the past. Two power poles exist at 60 and 120 metres south from the well that have been treated with tar.

Two homes apply manure to their gardens some 110 to 130 metres from the well but do not use pesticides/insecticides/herbicides. Annual use of "roundup" as a lawn application was confirmed on one property, as well as use of a compost pile 125 metres from the well.

All homes are on individual septic tanks/fields at distances of 90, 125, 130 and 140 metres from the production well, primarily down-ground-surface gradient. The systems are older than 30 years; maintenance is unknown. Two of the homes are heated with oil and have on-site storage tanks. No chemicals are stored at any of the sites. Each dwelling has at least one abandoned water well, not in use since central water was brought in; one house has three wells. None have been abandoned according to well construction regulations. Negotiations are on-going with homeowners to ensure compliance.

A major transportation corridor, Beeches Road, is present 160 metres downgradient, which is salted.

4.2.2 No. 11 Production Well

This well is located in a rural residential area, just west of Wellington Street. There are no homes within the 100 metre radius of the well. The Town owns the building lot around the pump house encompassing approximately 0.39 hectares.

There are five nearby lots, two of which are empty. The land directly north and south of the well is vacant residential property. No historical land use was documented for the last 20 years, although 1971 aerial photos indicate land was used to grow hay. There are no surface or subsurface facilities (i.e., storm/sanitary sewers, power/communication lines) adjacent the site.

All lots within a 100 metre radius are in the R2 Zone, rural residential. There are few restrictions on land use activity, i.e., permitted to keep agricultural animals if this is subordinate to residential use. However, the land to the east across Wellington Street is the H_20 Zone which has more restrictions.

One house nearby is heated with oil; pesticides/insecticides/herbicide or fertilizers are not used. The house is on a septic system installed in 1979 less than 100 metres from the well; maintenance of the system appears to be poor. At least two abandoned wells are in the vicinity. One rusted vehicle full of garbage is within 70 metres of the pump house.

The site lies between Patterson and Wellington Streets some 280 and 110 metres respectively from the well head; both are paved and salted with no curb/gutter. They are not used for transporting goods, the only transport truck traffic would be for local oil supply.

Surface facilities include two power poles 17 and 90 metres from the well.

4.2.3 Beeches Road Production Well

The Town owns a rectangular area around the pump house of approximately 0.25 hectares, positioned adjacent Beeches Road. The next closest street is Sea Birch Drive, a residential road 160 metres directly north and upgradient.

Most of the lots within a 100 metre radius of Beeches Road well are in the R1 Zone, residential. There are more restrictions on land use activity in the R1 zone versus R2, i.e.,

not permitted to keep agricultural animals even if this is subordinate to residential use. Other zones in the proposed protected area are W-waterfront and R2. Currently, there are no by-laws protecting the wells in town. There are no restrictions in the entire town on pesticide/herbicide/insecticide use.

The well is located in a residential area. There are nine residential homes and a golf course within the 100 metre radius. Previous land use noted farming in the area. The homes are located between 50 and 160 metres from the well head. All are on Town water and sewer but some are expected to still have remnants of old well and septic systems. With the exception of one, all are heated with oil. There is no recorded residential use of pesticides/herbicides/ insecticides; some use compost piles. There is no known chemical storage.

The club house for a golf course is 375 metres from the well head, with the course used since 1922. It operates off its own 63 metre deep well and on-site septic system; with oil used for heating. Herbicides/pesticides and fungicides are applied twice per year on greens and fairways. Runoff from the course comes within 100 metres of the well, and considering surface gradients, will run to Pictou Harbour.

The pump house is 3.8 metres off Beeches Road, which is paved with no curb/gutter and large ditches on each side of the road. It is a main road with relatively a large amount of traffic, but is not used for transporting goods.

A small first order stream runs within metres of the well head draining south into Pictou Harbour.

Garbage was noted scattered throughout the woods, including car parts, beer bottles, cans, scrap metal, etc.

4.2.4 M and M Production Well

The pump house is located in a residential area off Beeches Road along Union Street. The Town owns a small rectangular area around the pump house.

There are 23 residential homes within the 100 metre radius of the well. Most of the lots within the 100 metre radius are in the R1 Zone, residential. Other zones are I - Institutional and C2 - neighborhood commercial. Most lots have small wartime houses built in the early 1940's, all have been connected to town water and sewer. Most are heated with oil. No pesticides/herbicides/insecticides are used; there is no known chemical storage.

Beeches Road (some 30 metres upgradient of the well) has moderate traffic, but not used for transporting goods. Union Street may be a route for shipping supplies to the shipyard and servicing oil tanks. Both are salted.

The pump house is surrounded by a parcel of land owned by East End Grocery Store, which has been in operation since the 1940's. The building is 10 metres upgradient from the well with a rental unit upstairs and a hairdressing shop next door. The building is heated with oil, pesticides, etc., are not used, no chemicals are stored.

An existing storm drain and sewer line are positioned 90 and 60 metres from the well head respectively.

The new DND facility just south of the well head was constructed in 1992. An environmental site assessment prior to construction noted no contamination. Surface run off from the parking lot is controlled by curb and gutter and discharges to the existing Town storm drain system. The facility is heated by oil with a state-of-the-art, outside tank facility.

5.0 SOURCE WATER PROTECTION STRATEGIES

A total of 14 strategies have been developed to manage the risks outlined above, including:

- Land Use Planning
- Emergency Response
- Land Acquisition
- Forestry Management
- Inspection/Enforcement
- Building/Maintaining a Database
- Ecosystem Approach
- Public Education
- Counter Terrorism
- Road Maintenance
- Planning for Impact of Climate Change
- Personnel and Training
- Demand Side Management
- Best Management Practices

A summary of each is provided below, details can be provided for regulatory perusal only, if so required.

5.1 Land Use and Planning

The goal of land use planning was taken as the development of a practical, cost-effective means of managing land use activities within the Town of Pictou's well fields, to ensure the long-term viability of the water supply.

In so doing, it is recognized that since some of the land is privately owned, this will require balancing the rights and responsibilities of private citizens and Municipal Governments with the long-term costs and benefits of an uncontaminated water supply. As more data become available in the future, it may be possible to reduce any constraints while maintaining the same risk. In essence, science will never know all there is to know. Rather than allowing the unknown or uncertainty to paralyse us, we must apply the best of what we know today and at the same time be flexible enough to allow for change and for what we do not yet know.

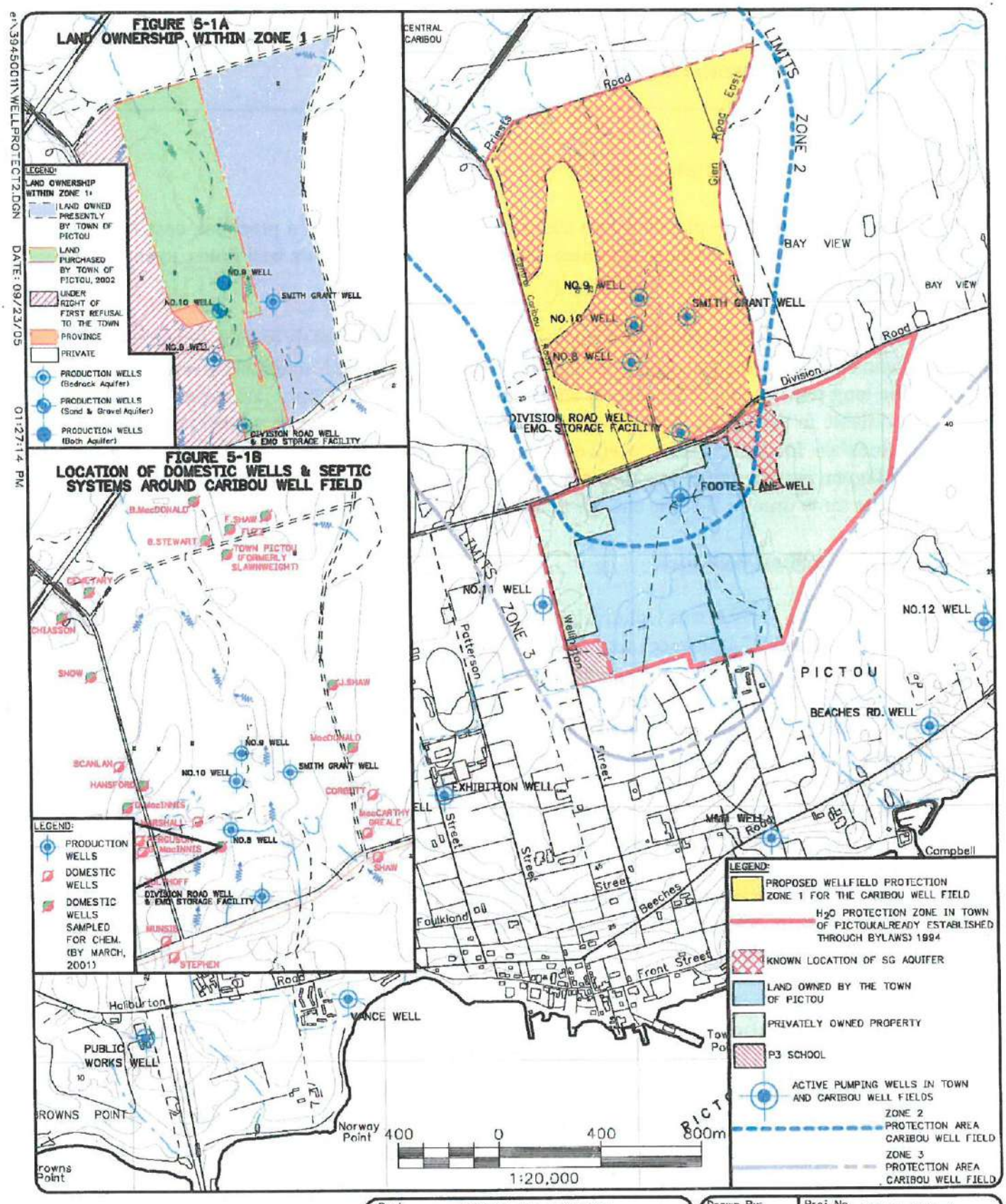
5.1.1 Caribou Well Field

A three zone WHPA was tentatively outlined (Figure 3-1), including Zone 1 (Well Head), Zone 2 (Zone of Influence) and Zone 3 (Zone of Contribution). This was based upon protecting the Caribou aquifer, rather than a residence timing around a well head. A listing of "permitted uses" and "constraints" was developed for 10 land use activities within Zone 1 including: Residential/Industrial/ Commercial and Institutional, Waste Disposal, Agriculture, Forestry, Transportation/Power/Communication Corridors, Mining/Pits/ Quarries, Pest Control Products and Biocide Restrictions, Soil Erosion and Sedimentation Control, Cemeteries and Recreational. Uses and constraints within Zones 2 and 3 were to be governed by existing County, Provincial and Federal Regulations.

Aquifer monitoring suggests no noticeable impact of operational pumping of the Caribou Well Field in either the bedrock or S/G aquifers along the outer ring roads, where the domestic wells are located (Figure 5-1B). Therefore, the well field extraction is not mining the resource.

5.1.2 Town Well Field

A portion of the Town is still predominately under rural land use. An H_20 Protection Zone (Figure 5-1) was established in this area by the Town Council, then approved by the Minister in June 1994. Zoning By-laws were developed to protect the groundwater resources by placing constraints on land use within this zone. As noted in Figure 5-1, the H_20 zone also protects that portion of Zones 2 and 3 for the Caribou Well Field, which are positioned within the Towns' political boundaries.



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Proj. TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT

Dwg. WELLFIELD PROTECTION ZONES

Drawn By: NEB	Proj. No. 3945-001.1	
Dwg Standards Chk. By:	Dwg. No. FIGURE 5-1	
Designed By: FEB	Date Last Modified: 00.06.05	
Design Chkd. By: FEB	Last Modified By: NEB	Rev. 0

Over the last decade, work has gradually been undertaken to provide additional land use protection. Starting in the summer of 2001, production well sites had begun to be inspected to develop short and long-term protection strategies.

5.2 Best Management Practices

On privately owned land, the Town will suggest, demonstrate and, where necessary, financially support the use of Best Management Practices, as exemplified by activities in the Caribou Well Field.

1. For homeowners who agreed to support the request for designation, the Town Council agreed to share the costs of required upgrades in fuel storage, on-site septic disposal and other matters on a 50% basis to a total of $2,500.00 per home.

2. Upgrades to the on-site septic system on the Fraser property were paid for by the Town. In addition, a new fuel containment structure was installed at the Town's expense.

3. An ESA was carried out on the former North Shore Ballast property in proximity to Production Well No. 8.

4. A total of 13 domestic wells surrounding Zone 1 have been sampled for inorganic water chemistry at least once, at the Town's expense.

5. Agricultural land use is present in the southwest corner of Zone 1 WHPA for the Caribou Well Field adjacent to Division Road and No. 8 Production Wells. The land is utilized for crop production. Discussions with the farmer in 2001 resulted in his acceptance not to spread manure within 150 metres of the two wells.

To demonstrate the Town's willingness to meet its own targets imposed on private citizens it has undertaken upgrades in areas it has responsibility for, as exemplified by work undertaken to date in both well fields:

Exhibition Well: A nearby sewer line was upgraded to ensure no leaks could occur in close proximity to the well head. An open ditch was collected with piping to divert road wash runoff to a location 65 metres northwest of the well head.

Public Works Well: Underground oil storage tanks were removed and changed to aboveground systems. A french drain system was installed to divert chlorides and/or oil away from the well head. The salt storage was placed on an asphalt pad.

Vance Well: A new service line was installed in 1991, just north of the well head. An abandoned septic field bed at the former Odd Fellows building was abandoned and connections made to a new sewer in 1995.

The Caribou Well Field: The Town located and securely capped/abandoned a number of test holes and monitoring wells installed during previous hydrogeological investigations to prevent aquifer contamination.

5.3 Emergency Response Plan

As a part of the Town's Emergency Response Plan, a number of procedures and equipment have been put in place to enable Town staff to quickly respond to accidental spills that could potentially affect the production wells.

In summary, these activities include storage of "soak-up" products and disposal bags at selected well sites, as well as information on well sites and contact numbers distributed to local petroleum delivery vehicles. The Town's Public Works Department is equipped with a vacuum operated sucker truck to lift and remove any floating products. Water Utility staff are trained in Transportation of Dangerous Goods to ensure their ability to react in the appropriate manner in event of a spill. The Watershed Emergency Response Plan will become part of the Emergency Measures Organization Response Plan for the Town of Pictou and the Municipality of the County of Pictou.

5.4 Counter Terrorism Plan

Given the results of September 11, 2001 counter terrorism plans have been formulated to assess the risks to all three attributes crucial to water supply, namely: quantity of water on demand, delivered at sufficient pressure and safe for any use. Presently, the utility is assessing its vulnerabilities and prioritizing them for necessary security improvements.

Overall, a groundwater supply is more difficult to contaminate, given its slow transport rate and natural attenuation. All well heads are enclosed in locked structures and checked daily by Town personnel. Additional activities have been put in place, or are under development, but are not for discussion in a public environment.

5.5 Land Acquisition

5.5.1 Caribou Well Field

The Town purchased the land on which the former well-vacuum system was situated between 1907 and 1916. Arrangements were made with the major land owner within Zone 1 of the WHPA for this Well Field to purchase their land when it became available.

In 2001, the Town purchased one 1.34 hectare property within Zone 1 and in 2002, acquired 19.87 hectares. Figure 5-1A outlines the 68% of Zone 1 presently owned by the Town. The additional land is under right of first refusal for the Town.

Production Wells No. 9, 10 and Division Road are located on land purchased by the Town in 2002. Production Well No. 8 is on land for which rights for water were purchased from the Fraser Estate on September 12, 1907.

5.5.2 Town Well Field

A H_20 Protection Zone was established within a portion of the Town limits in June 1994. It encompasses a portion of the Town boundaries still under predominately natural land use, effectively covering the topographic high, or groundwater recharge area for the Bedrock aquifer underlying the Town itself.

In 2001, the Town purchased an additional 18.5 hectare piece of property within this zone to provide additional protection. Figure 5-1 outlines the 47.5 hectare or 52% of the H_20 area now owned by the Town. In the summer of 2005, the Town acquired an additional 2.17 hectacres, not shown on Figure 5-1.

The Zone encompasses, however, only one of the production wells, Footes Lane. A very small portion of land around each of the other Town well heads is owned by the Town, the rest is privately owned. There is no intention at this stage of purchasing additional land around each until the results of the GUDI testing and assessment of the new production well are known.

5.6 Road Maintenance

Consultation between the Pictou Water Utility and Nova Scotia Department of Transportation and Public Works has lead to cessation of the use of highway salt on Division Road for one kilometre east and west of the Caribou Well Field. This also included Central Caribou Road

along the west boundary. The other two boundary roads are gravelled surface and not normally salted. Dust suppression products are discouraged on secondary gravel roads within the Caribou Well Field

The Town has agreed to maintain the access road (private lane) into the Caribou Well Field to ensure that non-contaminated products are used for road maintenance work.

Illegal dumping and quarrying sites along woods roads within the Caribou Well Field have been curtailed by preventing access. Off-road motorized recreational vehicles will be prohibited on Town owned lands and discouraged within the Caribou Well Field's WHPA Zone 1.

Risk identification (Section 4.0) noted numerous paved roads surrounding most of the Town wells. Discussions are presently on-going to determine how best to address road salting and road wash runoff to storm sewer issues.

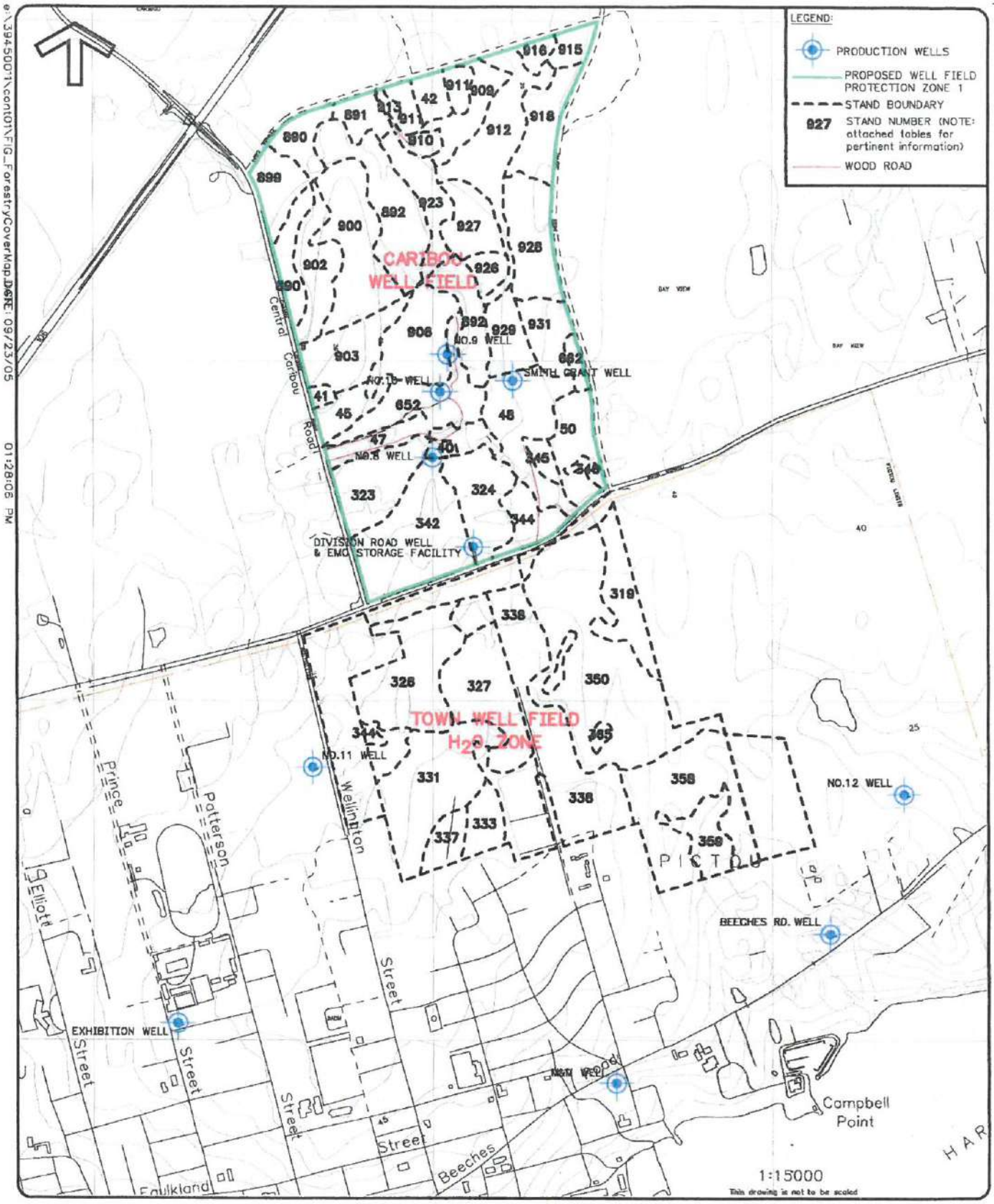
5.7 Forestry Management Plan

Century Forestry Consultants Ltd. was contracted by the Town to develop a Forestry Management Plan for Zone 1 of the WHPA area of the Caribou Well Field and the H_20 Zone within the Town boundaries (Figure 5-2). The following forms a summary of the reports. Details are available for the regulators upon request.

5.7.1 Caribou Well Field

The block contains approximately 126 hectares in total. The area is occupied by 104 hectares (82%) forested land and 22 hectares (18%) non-forested. The most dominant cover types within the block are mixed wood and softwood, which each comprise 29 hectares. Hardwood cover types make up the next most significant portion of productive forest at 23 hectares or 18% of the landmass. There is a significant proportion of non-productive forest land within the block at 23.5 hectares or 19% of the landmass. Agricultural land covers 19 hectares (15%) and residential lands occupy 3 hectares (2%).

Very little in the way of serious insect and disease problems or blow down were found throughout the block.



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Proj. TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT

Dwg. FORESTRY COVER MAP

Drawn By: NEB	Proj. No. 3945-001.1
Dwg Standards Chk. By:	Dwg. No. FIGURE 5-2
Designed By: FEB	Date Last Modified: 05.AUG.26
Design Chkd. By: FEB	Last Modified By: NEB / Rev. 0

5.7.2 Town H_20 Zone

The plan includes approximately 73 hectares containing the Town's H_2O Zone along with a small portion outside of the zone. The area is split in ownership between the Town (41 hectares) and a private woodlot owner (32 hectares). The land base of this block is occupied by 57.5 hectares of forested land (78%) and 11 hectares of abandoned farm land (22%).

Forest cover types are divided into softwood, mixed wood and hardwood. Hardwood occupies the largest portion of the forest at 29.5 hectares (51%), followed by mixed wood cover types at 19 hectares (33%) and softwood at 9 hectares (16%). Immature stands make up the largest portion (40%) and occur on Town owned land. Regenerating stands cover 30% as a result of a recent harvest on privately owned land. There are no over mature stands. Very few serious insect or disease problems were encountered throughout the block.

5.7.3 Management Plans

The basis of the Forestry Management Plan is the understanding that the forest is a dynamic entity, continually changing as trees grow and die with the overall structure of the forest evolving through a number of stages. Because the forest is dynamic, it must be continually monitored for changes which have occurred as a result of significant influences, often unpredictable in nature.

The operators of the plan must be committed to acting decisively when the need arises, while staying the course on the overall plan, its long-term principles and goals, and its short-term objectives. If the management principles, management recommendations and the operating recommendations are followed, it is possible to conduct forestry activities while protecting the Town's most valuable natural resource - its water supply.

Put in the context of strategic planning, long-term management principles and goals must support the mission of maintaining water quality and quantity. A total of four Management Principles and 26 Management Recommendations and six Operating Recommendations based upon Best Management Practices of the day were outlined to guide decisions that affect the future structure of the forest by guiding (limiting and encouraging) activities conducted on the ground. The Principles are summarized below.

> *MANAGEMENT PRINCIPLE 1.0 - Forest related activities should encourage the establishment and growth of long-lived species such as red spruce, white pine, eastern hemlock and red oak.*

MANAGEMENT PRINCIPLE 2.0 - Forested areas should maintain a tree cover of not less than ten (10) feet in height and not less than fifty (50) percent stocking.

MANAGEMENT PRINCIPLE 3.0 - The forest should be maintained in a healthy, actively growing state.

MANAGEMENT PRINCIPLE 4.0 - Forestry activities should be conducted so as to minimize disturbance or pollution to the forest floor and the underlying soil.

5.8 Adaptation for Climate Change

At present, the operational concept in how the utility is adapting to climate change is to assume the climate is warming, whether due to man-made and/or natural factors. The results will be seen more in terms of extremes, i.e., floods, droughts.

The actual impact of this change in climate on groundwater resources is less clear. Baechler (2003) noted that deep groundwater supplies were less susceptible to on-going changes in climate over the last 15 years than surface waters.

The nearest Environment Canada Climate Stations most representative of the well field were selected in consultation with personnel of the Atlantic Climate Centre. These were determined to be Lyons Brook and Caribou.

Since 1998, the Town received the data on a monthly basis to assess monthly and seasonal trends in precipitation and temperature. Longer term trends have been established by updating a moving decadal analysis (Figures 5-3). To date the "warm" years experienced over the last portion of the 1990's have resulted in declining precipitation and rising air temperature.

The Atlantic Climate Centre was also requested to undertake a water balance analysis to better define Fall and Spring Groundwater recharge periods (Figure 5-3).

To quantify the impact of climate change on groundwater resources within the two main aquifers, two automated groundwater level recorders have been installed to monitor changes in head levels (Figure 5-4). No large scale long-term trends are apparent in the data to date.

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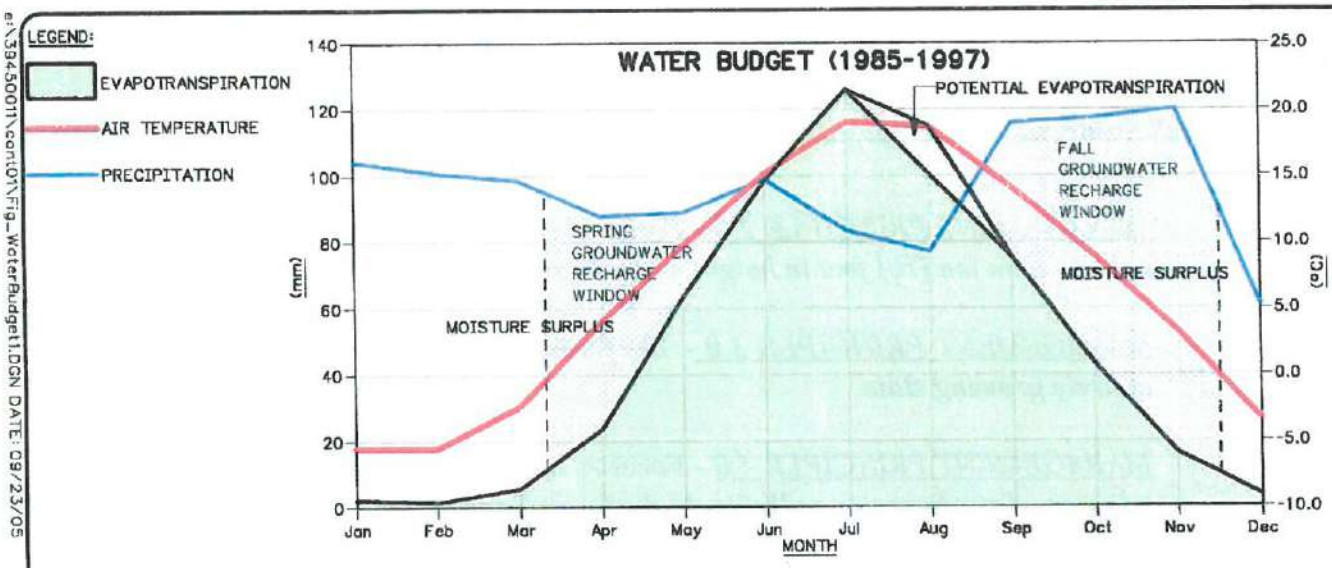

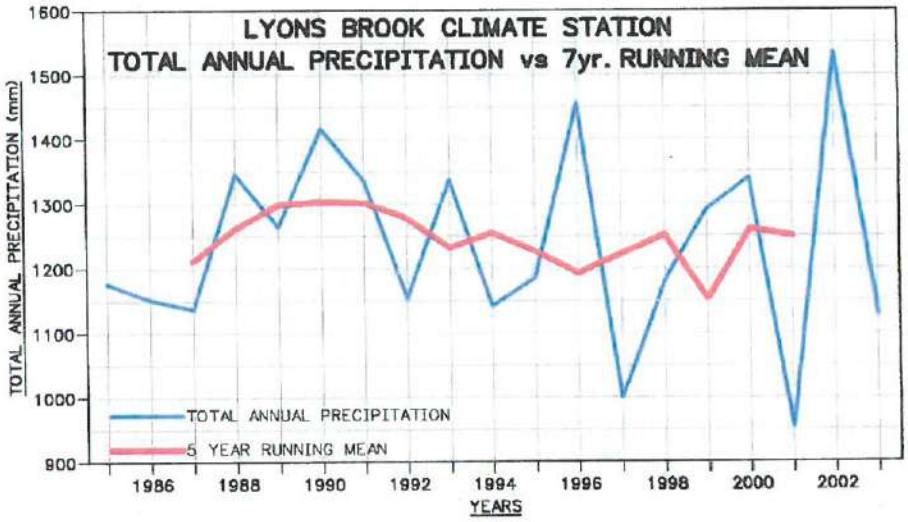

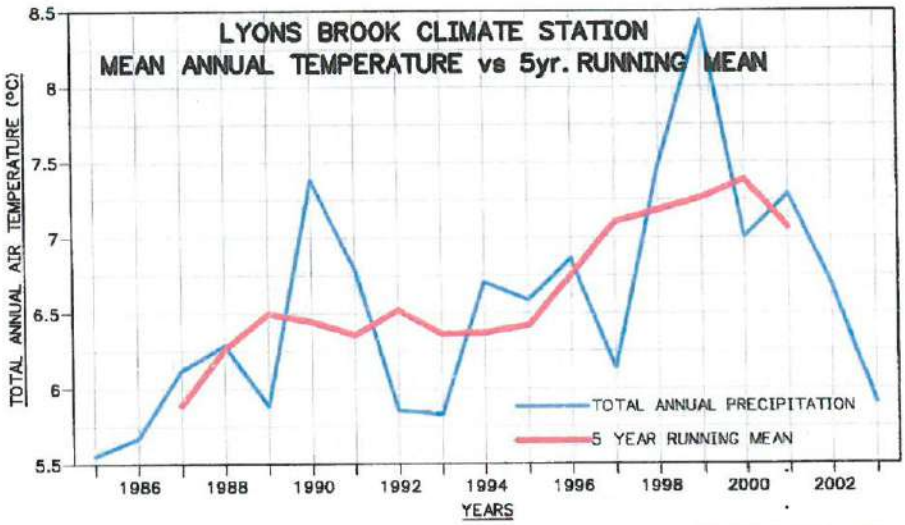

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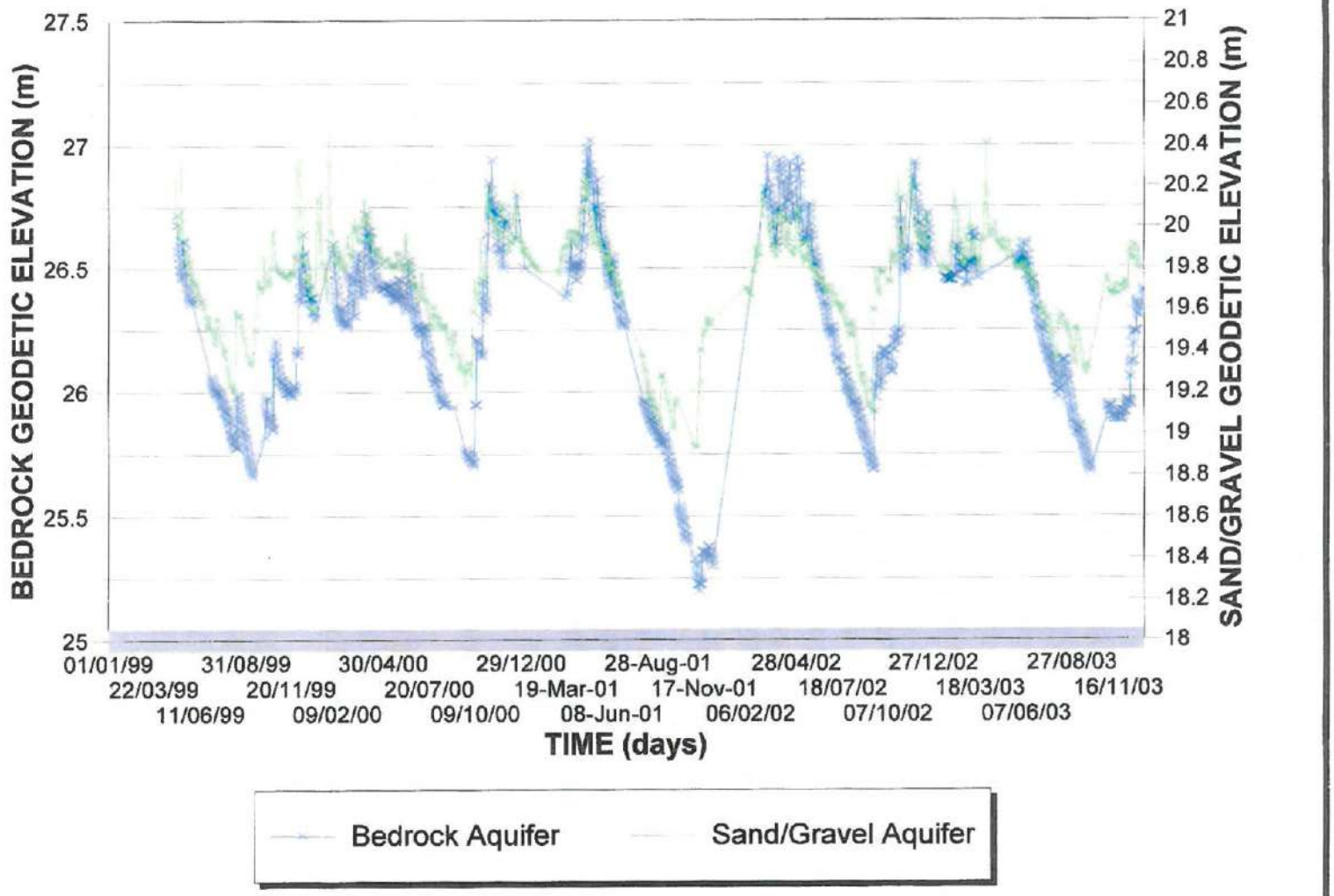
Proj. TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT

Dwg. CLIMATIC TRENDS AND WATER BUDGET

Drawn By: NEB	Proj. No. 3945-001.1
Dwg Standards Chk. By:	Dwg. No. FIGURE 5-3
Designed By: FEB	Date Last Modified: 05.SEP.09
Design Chkd. By: FEB	Last Modified By: NEB / Rev. 0

FIG.5-4: 5 YEAR HYDROGRAPH
BEDROCK and SAND/GRAVEL AQUIFERS



5.9 Public Education Program

Given the critical nature of the groundwater resources and the importance of public education and consultation, a range of activities have been on-going since 1991.

In 1996, ADI and Town staff held a public open house to provide the residents with detailed information about groundwater in general, and about the development of the aquifer in the immediate Caribou Well Field area. Prior to this Public Open House, the Town notified all affected landowners again by letter and advertised in the Pictou Advocate newspaper of this "Open House" information session. Seventeen interested persons attended. A second, well publicized open house was held on March 13, 2000, less than five people attended.

Meetings were held twice with the owners of the Fraser property, located in the middle of the well field during 1999 and 2000 to discuss the proposed land use guidelines and their impact on them. Modifications were made to the plan to accommodate some of their concerns. Town representatives presented information on preliminary land use constraints to a public open house on December 6, 2000. Town representatives met with the core of the Caribou Well Field Community Ad Hoc Committee on Land Use in February 2001.

A continuous display of educational information on the Town's water supply and water related issues was established, and made available to the public. The Director of Public Works continues to discuss the well field and the groundwater aquifer in this area with any interested persons

5.10 Inspection/Enforcement

Staff visit each production well site daily to record production and inspect for security violations. A weekly inspection of the perimeter of the watershed is undertaken to note any unauthorized use of Town lands.

For those private lands, especially in the County, the Town strongly believes it is the responsibility of the NSDEL to undertake a weekly to bi-weekly inspection visit of lands within WHPA Zones 2 and 3 for the Caribou Well Field and enforce existing environmental legislation as required.

5.11 Development of a Hydrogeological Model for the Well Fields

The Town has committed to acquire and fund the collection of additional technical information on the ground and surface water resources forming the Well Fields and

Protection Zones. These data have been used to continually update the database and refine the hydrogeological model. This allows for a more comprehensive understanding of the occurrence, quantity and quality of the water resources. When sufficient data has been collected to form a satisfactory conceptual model, consideration will then be given to development of a computer numerical model for the groundwater flow field, the impact of the pumping wells and groundwater stream interaction.

The intention is to undertake affordable, practical program each year over the long-term to obtain information pertinent to answering specific operation/protection issues as they arise. The overriding concept is "It is difficult to protect what you don't understand".

This commitment includes the hiring of a summer student each year to aid in these investigations, while providing practical experience to upcoming qualified students.

5.12 Building and Maintaining a Database

A computerized map of the well field and environs has been established by ADI using MICROSTATION. The base was developed with existing LRIS digital mapping at a scale of 1:10,000. This base allows for development of the technical figures presented in this report, as well as large scale colour overlays for public presentation.

Information being collected on wells, GUDI, chemistry, etc., is entered into EXCEL spreadsheets, which are being maintained at two sites to prevent loss of data. This database includes information such as water levels, water chemistry, pumping rates and volumes, streamflow, subsurface lithographic logs, etc. This forms the basis for presenting updated information in the annual reports to NSDEL.

5.13 Demand Side Management

The Town recognizes that Demand Side Management (controlling demand) is as important as Supply Side Management (finding new water sources) in managing its water supply. This not only reduces the demand on the system, but also supplies additional revenues to undertake additional monitoring and investigations as so required.

A recent investigation on usage in the Town by ADI noted that the average residential water consumption in Pictou is high, with a residential usage of approximately 380 litres/person/day. This is compared with average Canadian residential water demands in 1996-1997 of 72 to 76 litres/person/day. The Atlas of Canada reported in 1999 that average per capita water demand in Nova Scotia ranged from 160 to 320 litres/person/day.

Domestic users are presently unmetered. There are 1251 such users currently being charged a quarterly rate of $41.25. Schools pay $291.50 per quarter. A total of 116 commercial services are metered based upon service size. A total of 16 sprinkler systems are billed at $110/yr. The above rates were set out and agreed to by the Board of Public Utilities as of January 1, 1986. Recently the Town has made a submission to the Board for a new rate structure based upon domestic metering.

5.14 Ecosystem Approach

A relatively new system is being employed in source water protection in specific Ontario communities identified as the Ecosystem approach. This approach is grounded in ecological science and a belief that human decisions should be made with due regard for essential ecological process, biodiversity and sustainable uses. It acknowledges the importance of human needs while at the same time confronting the reality that the capacity of our world to meet these needs in perpetuity has limits and depends on the functions of ecosystems.

In essence, it combines what was already covered with the above strategies for land use management, forestry management, adaptation for climate change and Public Education Program. The Town is considering other ways to incorporate this strategy into Source Water Protection Planning and is watching its implementation in Ontario with interest.

6.0 SOURCE WATER PROTECTION ADVISORY COMMITTEE

The Pictou Watershed Management Committee was established in 1993 to guide future initiatives designed to protect the Town's water resource and to pursue the designation for the Caribou Well Field. Participation included a member of the Pictou County Council, since the designated land in question was positioned within the County. The Committee also included a hydrogeological technical advisor from ADI. In 1993, the Town contacted each identified landowner within the boundaries of the survey and advised them of the Town's proposal to protect the groundwater resources within the well field. Out of the 74 separate landowners, only 14 responded by mail or telephone.

The Town pro-actively commenced a public consultation program. Two newsletters were sent out to property owners within the proposed protection area identifying the watershed management committee and its long-term goals. In 1996, they invited the residents to a public open house and requested their input and ideas.

The Management Committee has held ongoing meetings with NSDEL, a representative from the Pictou Planning Advisory Committee and the Warden of Pictou County since 1994.

On going participation from the Pictou County District Planning Commission has included the preparation of the Caribou Well Field Protection Project Status Report and a draft Joint Land Use By-Law between the Town of Pictou and the Municipality of the County of Pictou.

As part of the requirement for designation, the Town developed a Terms of Reference in 2002 for a Town of Pictou Watershed Advisory Committee for the Caribou Well Field. Given that designation is not possible at this time, it is the Town's intent to build upon those guidelines to develop a Source Water Protection Committee that would be responsible for "advising" on both well fields. The key components of the mandate for the committee are expected to include:

1. It exists by the authority of the Council of the Town of Pictou and will act as an advisory body to Council. However, individuals still retain the ability to address Town Council directly on issues relating to the well fields.
2. On-going contact with the Committee shall be provided for by the Town of Pictou's Administrative offices.

3. The committee has an advisory mandate only, and is not responsible for managing the day-to-day operations of the Pictou Water Utility.

4. Its mandate is to provide assistance and suggestions with regard to:
   - Land use activities that have an impact on the water supply;
   - Providing for public comment and education on specific matters;
   - Making recommendations regarding remedial measures aimed at correcting, or minimizing harmful effects on the water supply; and
   - Maintaining an appropriate emergency response protocol to respond to any crisis, which might affect the water supply.

5. All meetings shall be open to the public and press, or as allowed under the municipal Government Act

6. Membership shall be comprised of at least
   - The mayor for the Town of Pictou
   - The Warden for the Municipality of Pictou County
   - The Chair of the Planning Advisory Committee
   - A member of Municipal Council for Pictou County

- A member at large representing the Town of Pictou
- A member of the Ad Hoc Committee representing the Municipality of Pictou County. This member shall be a land owner who occupies a dwelling year round within Zones 1, 2 or 3 of the WHPA for the Caribou Well field; and
- Technical and support staff may be present when requested and agreed to by the Committee.

7.0 MONITORING PLAN

As part of "due diligence", the water supply monitoring program established by the Utility encompasses more than that required by the NSDEL permit. It involves both "Source" and "Distribution" System monitoring. The key components are located on Figure 7-1.

The Town draws groundwater from the Pictou (bedrock) aquifer and the Caribou (S/G) aquifer. The monitoring program entails head levels and chemistry from background wells within the aquifer. This includes two automated head level recorders, as well as monthly head levels on up to 35 observation wells, with periodic chemical analysis.

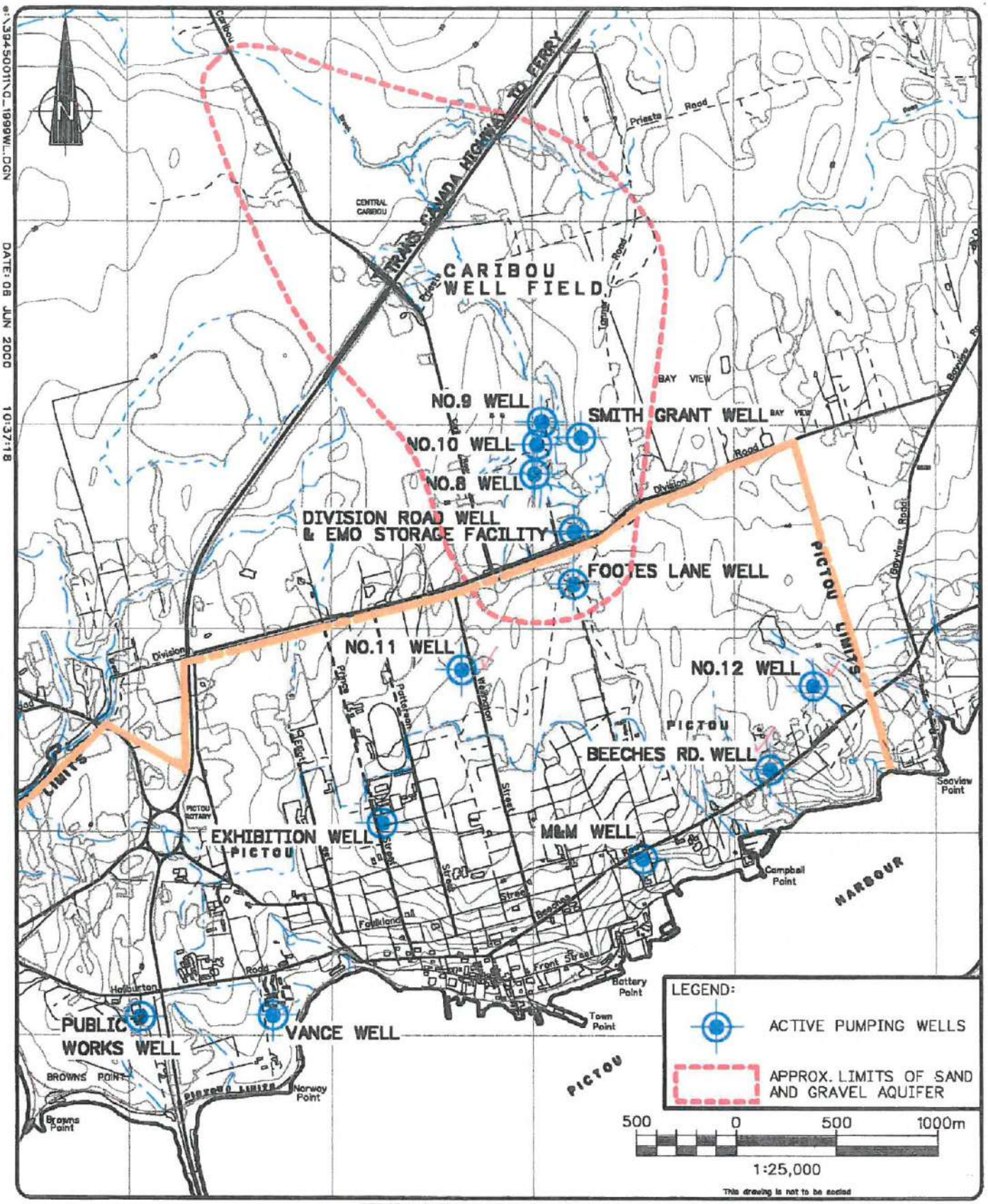
Environment Canada's Lyons Brook and Caribou weather stations provide real time weather data on temperature and precipitation. NSDEL's Durham groundwater level recorder provides historical head level data on the Pictou Aquifer.

Staff visit each production well daily to record production and chlorine levels at each injection site. Tri-monthly chemical analyses are conducted on raw and treated samples for iron and manganese, where treatment is provided. Weekly sampling is undertaken for bacteria at various locations. The water level is continuously monitored in the reservoir.

Annual monitoring reports are submitted to NSDEL as a requirement of the approval to operate.

External monitoring wells to Caribou aquifer are in place and monitored, designed around aquifer protection, not necessarily well head protection. To date, there are no monitoring wells positioned around any of the Town's production wells to forewarn of contaminant incursion.

The costs/benefits of utilizing a SCADA system to aid in data collection is presently being assessed.



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ADI Limited
Sydney, NS, Canada
Engineering, Consulting, Procurement and Project Management

Charlottetown, Moncton, Saint John, Truro, Halifax, Sydney
Port Hawkesbury, St.John's, Fredericton and Salem, NH

Proj.	TOWN OF PICTOU GROUNDWATER RESOURCE MANAGEMENT
Dwg.	PUMPING WELLS, 1999

Drawn By: NEB	Proj. No. 3945-01.1	
Dwg Standards Chk. By:	Dwg. No. 2	
Designed By: FEB	Date Last Modified: 00.06.05	
Design Chkd. By: FEB	Last Modified By: NEB	Rev. 0

TOWN OF PICTOU - TOWN WELL FIELD
WELL HEAD PROTECTION - URBAN WELLS
CHECK LIST FOR EVALUATION OF EACH WELL

DRAFT 1 JUNE 18/02 - for review and comment

NOTES ON METHOD OF APPROACH

√ includes wells, but not storage tank or distribution system
√ assesses principally Zone 1 - assumes between 150 - 300 m radius around each well head - until refined by analysis of drawdown cone(incorporates all properties within that zone therefore extent of zone not circular but determined by property boundaries).
√ historical perspective goes back 100 years
√ Will result in a report on each well, with appendices including interview forms, photos, maps etc.

← fax an example

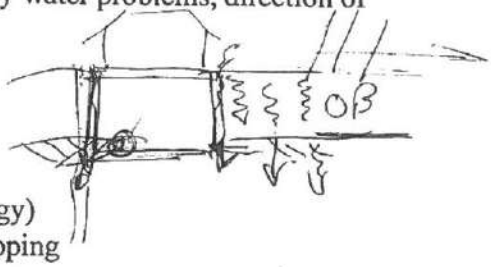
A - FACILITY EVALUATION (pumphouse and property)

√ Extent, shape, size of Town owned land around well head
√ Pump House Construction (size, structure, building materials)
√ facilities contained within Pump House (treatment, chemicals etc)
√ Signage ←
√ access restriction :1)personnel, rodents, 2) vehicles, 3) back flow preventers, 4) well cap, 5) link with distribution system(seepage collars), and 6) airborne.
√ Well Construction details(casing, annular seal, drive shoe, age, total depth)
√ Wastes (type, nature of disposal)
√ Level and type of surveillance, inspection frequency, alarms ←
√ History of land use on site - prior to well installation
√ Presence of groundwater monitoring program at perimeter of drawdown cone
√ Groundwater chemical/quality monitoring of Production Well
√ Direction which on-site drainage is transported to
√ Remoteness (distance to existing structure, access to site, distance to nearest road and sidewalk/trail)
√ Distance to and height above sea level
√ Distance and direction to nearest watercourse

B- LAND USE IN PROPOSED PROTECTION AREA

√ present land use - all types (domestic, commercial, industrial, parks etc) with description and photos
√ past land use (historical research, air photos, interviews)
√ Subsurface facilities - storm/sanitary sewers, power/communication lines, wet wells, drains from homes (need age and construction details if possible)
√ Surface facilities(power, communication poles, transformers, grounding etc)
√ vegetation (trees, lawns, gardens etc.)
√ surface drainage patterns (natural and man-made)

√ present property ownership, names, contact numbers, address
√ road network - location ,construction , curb and gutter, age, direction of roadwash runoff, culverts, AADT's if available, truck/tanker traffic (and type of chemicals), accident rates, de-icing materials and volume
√ land use policies/restrictions
√ any previous history of blasting
√ buildings (description, presence of basements and any water problems, direction of roof gutter drainage etc.)



C - HYDROGEOLOGIC SETTING

√ Overburden (type, thickness, presence of fill, pedology)
√ bedrock (lithology, structure - from well log and mapping
√ hydrostratigraphic units
√ pumping rates and water levels
√ water chemistry from pumping well (looking for signs of contamination or trends)
√ surface watersheds (upstream of well site)
√ groundwater water watershed (upstream of well site)
√ Sewersheds (for storm and sanitary sewers passing well head)
√ location and description of any other wells (i.e. drilled wells, geotechnical boreholes, sumps, wet wells etc)

D - CONTAMINANT SOURCE INVENTORY

√ Nature of contaminant(chemical, biological, physical, radiological etc)
√ Nature of release (point or non-point, surface or subsurface release, continuous or time related, volume)
√ i.e. - fuel handling and storage(LUSTs)
- road wash runoff
- storm/sanitary sewers
- fertilizer/pesticides/herbicides/insecticide application
- material handled by tanker trucks
- roof wash runoff

√ Identify toxicity of contaminant to man(acute, chronic, carcinogenicity, mutagenicity etc)
√ Characterize pertinent Properties(solubility, density viscosity vapour pressure etc)
√ Characterize Relationship to Water(dissolved, colloidal, LNAPL, DNAPL)
√ Identify what concentrations necessitate "Action"(Drinking Water Guideline)
√ Identify whether contaminant is presently analyzed for in Pumping well and what concentrations are found

E - HAZARD ASSESSMENT

Natural and human disasters that can create major emergencies specific to each well - doesn't include general ones that would in all likelihood impact all wells (i.e. earthquakes, hurricanes etc.

Appendix B

NSE Approval to Withdraw Groundwater from Pictou and Caribou Wellfields

(Approval No: 2002-026956-R01, June 21, 2013)

NOVA SCOTIA
Environment
Environmental Monitoring and Compliance

JR 83, New Glasgow
Nova Scotia
B2H 5G6

902 396-4191 t
902 396-1765 f
www.gov.ns.ca

Our File Number: 95100-30-PIC-2002-026956R01

June 20, 2013

Mr. James Chisholm
Town of Pictou
40 Water St
PO Box 640
Pictou, NS
B0K 1H0

Dear Mr. Chisholm:

RE: Approval to Withdraw Groundwater - Town of Pictou; Approval No. 2002-026956-R01; Authorization No. 3889

Enclosed please find Approval # 2002-026956-R01 issued to the Town of Pictou to withdraw groundwater from wells within the Town Wellfield and the Caribou Wellfield, located at or near Pictou and Central Caribou, Pictou County, Nova Scotia.

You will be invoiced an annual user fee based on the approved withdrawal volumes. You will also be invoiced for an annual approval administration fee. These fees are subject to review and adjustment by the Minister and you will be invoiced annually.

This Approval or a copy is to be kept on-site at all times. All personnel involved in the project must be made fully aware of the terms and conditions of this Approval. The terms and conditions are shown as attached and it is the Approval Holder's responsibility to ensure that they are followed. Failure to comply with the terms and conditions is an offence under the *Environment Act*.

It is the Approval Holder's duty to advise the Department of any new and relevant information respecting any adverse effect that results or may result from the approved activity, which comes to the Approval Holder's attention after the issuance of the Approval. This is required under Section 60 of *the Environment Act*.

If the activity is altered, extended or modified beyond the description given in this Approval, please reapply as a new Approval may be required.

Despite the issuance of this Approval, the Approval Holder is still responsible for obtaining any other authorization which may be required to carry out the activity, including those which may be necessary under provincial, federal or municipal law.

Should you have any questions, please contact Bonnie MacDonald, Northern Region, Pictou Office at (902) 396-2426.

Yours truly,

Jennifer D McDonald, M.Sc., P.Geo.
Regional Hydrogeologist

cc: B MacDonald
P McLeod
S Conrod, Town of Pictou

Elmas #: 2002-026956-R01

NOVA SCOTIA

Environment

APPROVAL

Province of Nova Scotia
Environment Act, S.N.S. 1994-95, c.1

APPROVAL HOLDER: Town of Pictou

SITE PID: 00812909

APPROVAL NO: 2002-026956-R01

AUTHORIZATION NO: 3889

EXPIRY DATE: June 20, 2023

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Withdrawal of groundwater from multiple wells within the Town Wellfield and Caribou Wellfield, located at or near Pictou and Central Caribou, Pictou County in the Province of Nova Scotia.

Administrator Penny McLeod
Penny McLeod

Effective Date June 21, 2013

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Environment

Approval Holder: Town of Pictou

Project: Withdrawal of Groundwater
Site: Pictou and Central Caribou, Pictou County
PID # 00812909

Approval No: 2002-026956-R01

Authorization No. 3889

File No: 95100-30-PIC-2002-026956A02

Average Withdrawal Volume: 2.26 million liters per day

Maximum Withdrawal Volume: 4.28 million liters per day

Reference Documents:

- Application dated April 3, 2013 and attachments.
- exp Services Inc. April 2013. *Application of Approval Water Withdrawal Production Well Foots Lane (No. 2) Town Wellfield.*
- exp Services Inc. November 1, 2012. *Memorandum: Pump Test Analysis PW #15 Addendum Report for NS Environment.*
- exp Services Inc. September 2011. *Town of Pictou: Application of Approval Water Withdrawal Production Well No. 15, Town Well Field.*
- CBCL Limited. November 2010. *Town of Pictou Water System Upgrades Pre-Design Report.*
- ADI Limited. July 2006. *Town of Pictou Application of Approval Water Withdrawal Well No. 14 - Town Wellfield*; ADI Report: (24)3945-001.1.
- ADI Limited. October 2002. *Town of Pictou Groundwater Wellfield Hydrological Budget Analysis*; ADI Report: (24) 3945-001.1.
- C.J. MacLellan and Associates Inc. March 12, 2004. *System Assessment Report for the Town of Pictou Water Works.*
- ADI Limited. February 2002. *Town of Pictou Caribou Wellfield Report for Designation as a Protected Water Supply*; ADI Report (24) 3945-001.1.
- ADI Limited. October 2001. *Town of Pictou Data Supporting Wellfield Water Withdrawal Permit*; ADI Report: (24)3945-001.1.

1.0 Definitions:

a) "Act" means the *Environment Act* S.N.S. 1994-1995, c.1 and includes all regulations made pursuant to the Act.

b) "Activity" means the withdrawal of groundwater from multiple wells within the Town and Caribou Wellfields, and associated works.

c) "Administrator" means the Manager of the Northern Region, Pictou Office of Nova Scotia Environment or the Manager's designate.

d) "Department" means the Northern Region, Pictou Office, of Nova Scotia Environment located at the following address:

Nova Scotia Environment
Environmental Monitoring and Compliance Division
Northern Region, Pictou Office (Granton)
20 Pumphouse Road
RR #3
New Glasgow
Pictou County, NS B2H 5C6

Phone: (902) 396-4194
Fax: (902) 396-4765

e) "Groundwater" means all water naturally occurring under the surface of the Province of Nova Scotia.

f) "Minister" means the Minister of Nova Scotia Environment.

g) "NSE" means Nova Scotia Environment.

h) "Watercourse" means
   i) the bed banks and shore of every river, stream, lake, creek, pond, spring, lagoon or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and
   ii) all groundwater;

2.0 Scope of Approval

a) This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to withdraw groundwater from multiple wells within the Town and Caribou Wellfields, situated at or near Pictou and Central Caribou, Pictou County.

b) This Approval supercedes previous Approval number(s) which is/are now null and void.

3.0 General Terms and Conditions

a) The Approval Holder shall construct the watercourse alterations in accordance with provisions of the:

i) *Environment Act* S.N.S. 1994-1995, c.1;
ii) Regulations, as amended from time to time, pursuant to the above Act;
iii) Standards, Policies, or Guidelines issued by Nova Scotia Environment, as amended from time to time.

b) The Activity shall be conducted in accordance with the details and specifications in the Application and attached appendices and the reference documents. **If there is a discrepancy between the reference documents and these terms and conditions, the terms and conditions of this Approval shall apply.**

c) Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

d) The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

e) This Approval is not transferable without the consent of the Minister or Administrator.

f) i) If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(2)(b) and 58(4) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

ii) Despite a cancellation or suspension of this Approval, the Approval Holder remains subject to the penalty provisions of the Act and regulations.

g) The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the Activity, including, but not limited to, an increase in withdrawal rates or the addition of production wells. The Approval holder shall obtain written authorization or amendment from the Administrator before implementing any change that would not comply with the Terms and Conditions of this Approval.

h) The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

i) Pursuant to Section 60 of the *Act*, the Approval Holder shall submit to the Administrator any new and relevant information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

j) The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

k) Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

l) The Approval Holder shall submit any monitoring results or reports required by this Approval to the Department. Unless specified otherwise in this Approval, All monitoring results shall be submitted within 30 days following the month of monitoring.

m) The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel directly involved in the watercourse alterations are made fully aware of the terms and conditions which pertain to this Approval.

n) Within one month of the issuance of this Approval, the Approval Holder shall designate in writing, to the Department, a contact for this Approval. If the contact should change, the Approval Holder shall immediately notify the Department in writing.

o) The Approval Holder shall, upon receipt of an invoice from the Minister of Nova Scotia Environment stating the amount owing, pay to the Minister of Finance the amount stipulated in said invoice. Said amount shall be in accordance with the schedule of fees established by the Minister of Nova Scotia Environment, as may be revised from time to time.

p) The failure of the Minister to insist upon a strict performance of a Term and Condition contained in this Approval shall not be deemed a waiver of any rights or remedies that the Minister may have and shall not be deemed a waiver of any subsequent breach of the Terms and Conditions of this Approval.

q) This Approval does not give sole or exclusive rights to any watercourse or water resource, and the Minister reserves the right to use and to allow others to use the watercourse or water resource and the water therein.

r) The Approval Holder may not alter or use the watercourse or water resource so as to:

   i) prejudice any riparian or other rights, should any such rights exist, of a person lawfully in possession lands abutting the watercouree or water resource;
   ii) cause damage or nuisance to adjacent or abutting lands.

s) The Approval Holder shall not place a pecuniary value on or claim any pecuniary value for the rights granted by this Approval, over and above the amounts, if any, paid to the Minister by the Approval Holder for the rights.

t) The Approval Holder shall maintain a culvert, bridge, dam, sluice, flume, conduit, well or other structure built or used in or on the watercourse or water resources so that it does not cause an adverse effect. This conditions survives the expiry or cancellation of this Approval.

u) The Approval Holder shall conform to a direction of the Minister or an Administrator concerning the maintenance or rehabilitation of a watercourse or water resource or the maintenance, rehabilitation or removal of a culvert, bridge, dam, sluice, flume, conduit, or structure used or maintained in and on the watercourse or water resource. The Approval Holder shall, pursuant to an Approval where required, remove a culvert, bridge, dam, sluice, flume, conduit or other structure and any equipment or personal property built, used or maintained in and on the watercourse or water resource at the end of the useful life of the culvert, bridge, dam, sluice, flume, conduit or structure. In the event the Approval Holder fails to remove a culvert, bridge, dam, sluice, flume, conduit or other structure or equipment or personal property, the Minister may, without any liability, remove or demolish the same in whatever manner the Minister deems necessary and the Approval Holder shall reimburse the Minister for all expenses and costs of such removal or demolition. This condition survives the expiry or cancellation of this Approval.

v) The Approval Holder shall indemnify and save harmless the Minister and an employee, servant or agent of the Department against any loss, cost or damage resulting from the activities performed pursuant to this Approval. Such indemnity shall include, but not be restricted to, all losses, costs or damages occasioned by the improper or faulty relocation of a watercourse or water resource or the improper or faulty construction of, repair, alteration or addition to any culvert, bridge, dam, sluice, flume, conduit or other structure in or on the watercourse or water resource, or by any trespass, negligence or wilful act of the Approval Holder or any employees, agents, contractors or guests of the Approval Holder.

w) This Approval shall enure to the benefit of and be binding upon the Minister, the Minister's successors, assigns and authorized representatives and upon the Approval Holder, and the heirs, administrators, executors and assigns of the Approval Holder.

x) The Minister and all persons designated as Inspectors pursuant to the *Environment Act* shall have free access at all times to the Activity and to land under control of the Approval Holder to ensure these Terms and Conditions are being fulfilled.

y) Nothing in this Approval relieves the Approval Holder of the responsibility for obtaining and paying for all licences, permits, approvals or authorizations necessary for carrying out the work authorized to be performed by this Approval which may be required by municipal by-laws or provincial or federal legislation. The Minister does not warrant that such licences, permits, approvals or other authorizations will be issued.

4.0 Approved Withdrawal

a) The location and construction of the production wells covered by this Approval is restricted to those shown in Table 1.

b) The maximum pumping rate, average pumping rate, 30 day withdrawal volume and annual withdrawal volume for each individual well and the total wellfield shall not exceed the values shown in Table 2.

c) The Department may amend the approved withdrawal limits specified in Table 2. The Approval Holder will be notified in writing of any changes to the approved withdrawal limits.

Table 1 - Well Construction Information

Production Well	Date Completed	NSE Well Log Number	Well UTM Coordinates		Well Total Depth (m)	Casing Depth (m)	Diameter (mm)	Screen Description
			Easting	Northing				
Beaches Road	1945	-	-	-	156	-	203	none
Division Road	1974	740136	523052	5060347	152	13	203	none
Exhibition	1972	-	-	-	117	10	203	none
Footes Lane 2	2012	121531	522960	5059950	87	15.2	203	none
M&M	-	-	-	-	152	82	184	none
Public Works	1982	-	-	-	188	-	203	none
Smith Grant	1908	-	-	-	103.6	-	203	none
No. 8	-	-	-	-	49	6.8	203	none
No. 10	1985	-	-	-	5.4	4.2	162	4.2-5.1
No. 11	1989	891346	522465	5059463	86	13	203	none
No. 12	1998	980944	524144	5059632	87	25.6	203	none
No. 14	2005	050084	521084	5057969	67	19.2	203	none
No. 15	2009	090257	523942	5059682	99	18	203	none

Table 2 - Approved Withdrawal				
Production Well	Pumping Rate (litres/day)		Withdrawal Volume (litres)	
	Maximum [1] (over 3 days)	Average [2] (Over 30 days)	30 day [3]	Annual[4]
Beaches Road	393,120	230,400	6,912,000	84,096,000
Division Road	264,880	164,160	4,924,800	59,918,400
Exhibition	164,160	79,200	2,376,000	28,908,000
Footes Lane 2	326,880	230,400	6,912,000	84,096,000
M&M	228,960	144,000	4,320,000	52,560,000
Public Works	228,960	164,160	4,924,800	59,918,400
Smith Grant	228,960	129,600	3,888,000	47,304,000
No. 8	131,040	93,600	2,808,000	34,164,000
No. 10	817,920	194,400	5,832,000	70,956,000
No. 11	228,960	129,600	3,888,000	47,304,000
No. 12	681,120	331,200	9,936,000	120,888,000
No. 14	524,160	367,200	11,016,000	134,028,000
No. 16	326,880	326,880	9,806,400	119,311,200
Total Wellfield[5]	**4,280,000**	**2,260,000**	**67,800,000**	**824,900,000**

Notes:

1 Pumping rate shall at no time exceed the maximum based on actual rate averaged after 3 days.

2 Average allowable pumping rate is based on the demonstrated water needs of the applicant and sustainable yield.

3 30 day withdrawal volume = Average pumping rate multiplied by 30 days.

4 Annual withdrawal volume = Average pumping rate multiplied by the number days pumped per year (i.e. 365).

5 Total well field is based on the previous approved withdrawal limits and current demand; it is not a sum of the approved limits for all production wells.

5.0 Flow Monitoring

a) Well production flow meters shall be installed, maintained and monitored separately for all production well(s).

b) The Approval Holder shall keep daily well production records for each well to include water usage volumes. Data shall be tabulated within a spreadsheet program.

6.0 Groundwater Withdrawal Records

a) The Approval Holder shall maintain monitoring records for:
   i) pumping flow rates;
   ii) duration of pumping;
   iii) total withdrawal volumes;
   iv) water quality;
   v) changes in use; and
   vi) reported effects of the withdrawal on other groundwater users.

b) These records shall be maintained on Site for a period of ten years and are to be available for review immediately upon request by the Department.

7.0 Well Interference Remedy

a) If production causes interference problems with any existing well supplies, the withdrawal rates shall be reduced and/or the problem rectified by the Approval Holder in accordance with an action plan acceptable to the Department.

8.0 Well Decommissioning

a) Any new or existing well located at the Site that is required to be decommissioned by the Minister or is not used or maintained for present or future use shall be decommissioned in accordance with the *Well Construction Regulations* and Water Well Decommissioning Guidelines. This condition survives the expiry or cancellation of this Approval.

9.0 Water Level Monitoring

a) The Approval Holder shall collect manually, or with electronic data loggers, water levels in all production wells on at least a weekly basis. Data shall be tabulated within a spreadsheet program.

b) The Approval Holder shall collect manually, or with electronic data loggers, water levels in dedicated observation wells on at least a semi-annual basis. Data shall be tabulated within a spreadsheet program.

c) The water level monitoring data is to be maintained on Site for a period of ten years and is to be available for review immediately upon request by the Department.

10.0 Groundwater Withdrawal Reporting

a) The Approval Holder shall submit the following records to the Department on an annual basis:
   i) production records for each well (i.e. groundwater withdrawal volumes), in comparison with approved withdrawal limits;
   ii) a summary of any occurrences during the year that may have resulted in potential hazards or changes to the water supply (nearby land development, new wells or pumps installed, wells abandoned, contaminant spills etc.);
   iii) a description of any water conservation measures implemented;
   iv) a summary of any effects reported by other groundwater users in the area;

b) The records shall be incorporated as part of the annual report for the Municipal Water Works Approval and submitted to the Department on or before April 1 following completion of the calendar year being reported upon.

c) Data submissions completed for the requirements of this Approval does not remove the Approval Holder from meeting any other registration, reporting, data maintenance and compliance requirements such as those specified in the Guidelines for Monitoring Public Drinking Water Supplies or other regulatory guidelines.

11.0 Site Specific

a) If salt water intrusion problems occur as evidenced by changes to water level or water quality effects, the Approval Holder shall notify the Department immediately and the withdrawal rate shall be reduced and/or the problem rectified to the satisfaction of the Department.

b) i) The Approval Holder shall review the safe yield estimates for the following production wells: No. 12, No. 14, No. 15, and Footes Lane 2 after the collection of one year of operational data with No. 15 and Footes Lane 2 added to the system.

ii) A report outlining the results of this review shall be submitted to the Department within 18 months of Well No. 15 and Footes Lane 2 being connected to the system. The report shall included recommended updates to the safe yields and withdrawal rates specified in Table 2, as applicable. Approved withdrawal limits specified in this Approval may be amended by the Department pending the results of this review.

ii) The items referenced in 11 b) i) and 11 b) ii) shall be completed by a qualified Hydrogeologist, licensed to practice by the Association of Professional Geoscientists of Nova Scotia (APGNS) or the Association of Professional Engineers of Nova Scotia (APENS).

Appendix C

NSE Permit to Operate a Water Supply System

(Approval No: 2012-080096-R02, March 4, 2016)

NOVA SCOTIA
Environment

APPROVAL

Province of Nova Scotia
***Environment Act*, S.N.S. 1994-95, c.1, s.1**

APPROVAL HOLDER: Town of Pictou

APPROVAL NO: 2012-080096-R02

EXPIRY DATE: February 16, 2026

Pursuant to Part V of the *Environment Act*, S.N.S. 1994-95, c.1, s.1 as amended from time to time, approval is granted to the Approval Holder subject to the Terms and Conditions attached to and forming part of this Approval, for the following activity:

Operation of non-GUDI and medium risk GUDI wells with natural filtration credit, greensand filters, and UV and chlorine for primary and secondary disinfection, water distribution system and associated works, located at or near 40 Water St, Pictou, Pictou County in the Province of Nova Scotia.

Administrator Penny McLeod
Penny McLeod

Effective Date March 4, 2016

TERMS AND CONDITIONS OF APPROVAL

Nova Scotia Environment

Approval Holder: Town of Pictou
Project: Water Supply System Serviced by non-GUDI and Medium Risk GUDI wells with Natural Filtration Credit, Greensand Filters, and UV and Chlorine for Primary and Secondary Disinfection

40 Water St
Pictou, Pictou County

Approval No: 2012-080096-R02

File No: 94600-30

Reference Documents:

- Application dated February 2, 2015 and attachments.
- E-Mail Correspondence between NSE and the Town dated October - December 2015.
- Town of Pictou. August 2014. Water Utility Operating Manual.
- K. Slaunwhite. July 30, 2014. Approval No. 2012-0800096 Compliance Update.
- K. Slaunwhite. September 16, 2013. Corrective Action Plan for Approval No. 2012-0800096.
- B. McDonald. March 31, 2013. System Assessment Report for Town of Pictou.
- K. Slaunwhite. March 2013 - June 2014. Quarterly Update Reports for Approval No. 2012-0800096:
  - Quarterly Update #1. March 15, 2013.
  - Quarterly Update #2. June 14, 2013.
  - Quarterly Update #3. September 16, 2013.
  - Quarterly Update #4. December 17, 2013.
  - Quarterly Update #5. March 14, 2014.
  - Quarterly Update #6. June 20, 2014.
- CBCL Limited. July 2011. Town of Pictou Phase I - Water Treatment Upgrades
- GUDI Assessment Reports:
  - CJ MacLellan and Associates Inc. March 12, 2004. System Assessment Report and Step 1 GUDI Assessment.
  - ADI Limited. November 2006. Step 2 GUDI Report.
  - ADI Limited. June 2009. Step 3 GUDI Report.
- exp Services Inc. September 2011. GUDI Natural Filtration Credits.
- Source Water Protection Plan (Draft). No date. Received via e-mail October 26, 2015.

1. **Definitions:**

a. "Act" means the Environment Act S.N.S. 1994-1995, c.1, s.1 and includes all regulations made pursuant to the Act.

b. "Administrator" means a person appointed pursuant to Section 21 of the Act.

c. "Associated Works" means all the piping, valves, instrumentation, controls, electrical works, etc., required for the operation of the Facility and Water Supply System.

d. "CT" means disinfectant residual in mg/L multiplied by the contact time in minutes.

e. "Contact Time" denoted as T_{10} is an effective contact time for disinfection in minutes and represents the time when 10% of the water passes the contact unit; that is 90% of the water remains in the unit and will be exposed to longer disinfection within the unit. T_{10} can be established by tracer studies or calculated using theoretical hydraulic detention times multiplied by an appropriate baffling factor listed in the "Treatment Standard for Municipal Surface Source Water Treatment Facilities" or "Treatment Standards for Municipal Groundwater Source Water Treatment Facilities".

f. "Continuous monitoring" is sampling or flow through analysis equipment that creates an output signal a minimum of once every five minutes.

g. "Department" means the Northern Region, Pictou Office, of Nova Scotia Environment located at the following address:

Nova Scotia Environment
Environmental Health and Food Safety Division
Northern Region, Pictou Office (Granton)
20 Pumphouse Road
RR #3
New Glasgow
Pictou County, NS B2H 5C6

Phone: (902) 396-4194
Fax: (902) 396-4765

h. "Facility" means the medium risk GUDI wells, greensand filters, Chlorine for primary disinfection, Chlorine for secondary disinfection and associated works.

i. "GCDWQ" means the latest edition of "Guidelines for Canadian Drinking Water Quality".

j. "Grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled.

k. "Groundwater under the direct influence of surface water " or "GUDI" means any water beneath the surface of the ground with:

   i. significant occurrence of insects or other macro-organisms, algae, organic debris, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*; or

   ii. significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

l. "GUDI well" means a well that has been classified as GUDI based on the "Protocol for Determining Groundwater Under the Direct Influence of Surface Water" and has been accepted as such in writing by the Regional Hydrogeologist.

m. "Inadequately disinfected" means water that does not meet the required contact time.

n. "Log reduction" means a negative of the base 10 logarithm of the fraction of pathogens remaining after the treatment process.

   log reduction = log removal by physical treatment + log inactivation by disinfection

   where log removal by physical treatment is equal to the credit assigned to the filtration technology indicated in the Department's "Treatment Standard for Municipal Surface Source Water Treatment Facilities", as amended from time to time; and

   log inactivation by disinfection is equal to the inactivation which shall be calculated as defined by the Department's "Treatment Standard for Municipal Surface Source Water Treatment Facilities" or "Treatment Standard for Municipal Groundwater Source Water Treatment Facilities", as amended from time to time.

o. "Maximum day demand" means the highest daily use rate during the year.

p. "Minister" means the Minister of Nova Scotia Environment.

q. "MPA testing" means Microscopic Particulate Analysis which analyses for significant numbers of large macro-organisms, algae, and surrogate indicators of surface water.

r. "Non-GUDI well" means a well that has been classified as non-GUDI based on the "Protocol for Determining Groundwater Under the Direct Influence of Surface Water" and has been accepted as such in writing by the Regional Hydrogeologist.

s. "NSE" means Nova Scotia Environment.

t. "QA/QC" means quality assurance and quality control.

u. "Quarterly sampling" means samples taken once per quarter with no less than 45 days interval between sampling events.

v. "Site" means the structure used by the operator in overall direct responsible charge to maintain and store documents and records required by this approval.

w. "Total trihalomethanes" means the level of total trihalomethanes as defined by the latest edition of the GCDWQ.

x. "Water Supply System" means the Facility and all auxiliaries/associated works for the collection, treatment, storage and distribution of water from the source of supply to the service connection of the ultimate consumer.

y. "Water Withdrawal Approval" means an approval from Nova Scotia Environment for the withdrawal of water from a surface or groundwater source. For clarity, this approval was also formerly known as a "water rights", "water licence", "water permit" or "water authorization".

2. Scope of Approval

a. This Approval (the "Approval") relates to the Approval Holder and their application and supporting documentation, as listed in the reference documents above, to operate the Water Supply System.

b. This approval relates to aspects of the application and reference documents necessary to meet the operational, environmental, and public health requirements of the Water Supply System.

c. This Approval supercedes previous approval number 2012-080096-R01, which is now null and void.

3. **General**

a. The Approval Holder shall operate the Water Supply System in accordance with provisions of the:

i. *Environment Act* S.N.S. 1994-1995, c.1, s.1 as amended from time to time;
ii. Regulations, as amended from time to time, pursuant to the above Act.

b. The Water Supply System shall be operated in accordance with the details and specifications in the Application and attached appendices and the reference documents. **If there is a discrepancy between the reference documents and these terms and conditions, the terms and conditions of this approval shall apply.**

c. Any request for renewal or extension of this Approval is to be made in writing, to the Department, at least ninety (90) days prior to the Approval expiry.

d. The Minister or Administrator may modify, amend or add conditions to this Approval at anytime pursuant to Section 58 of the Act.

e. This Approval is not transferable without the consent of the Minister or Administrator.

f. i. If the Minister or Administrator determines that there has been non-compliance with any or all of the terms and conditions contained in this Approval, the Minister or Administrator may cancel or suspend the Approval pursuant to subsections 58(A)(1) and 58(A)(2) of the Act, until such time as the Minister or Administrator is satisfied that all terms and conditions have been met.

ii. Despite a cancellation or suspension of this Approval, the Approval Holder is at all times subject to the penalty provisions of the Act and regulations.

g. The Approval Holder shall notify the Department prior to any proposed extensions or modifications of the Water Supply System, including process changes or waste disposal practices which are not granted under this Approval. Written approval from the Administrator may be required before implementing any change.

h. Pursuant to Section 60 of the Act, the Approval Holder shall submit to the Administrator any information respecting any adverse effect that actually results, or may potentially result, from any activity to which the Approval relates and that comes to the attention of the Approval Holder after the issuance of the Approval.

i. The Approval Holder shall immediately notify the Department of any incidents of non-compliance with this Approval.

j. The Approval Holder shall bear all expenses incurred in carrying out the environmental monitoring required under the terms and conditions of this Approval.

k. Unless specified otherwise in this Approval, all samples required to be collected by this Approval shall be collected, preserved and analysed, by qualified personnel, in accordance with recognized industry standards and procedures.

l. Unless written approval is received otherwise from the Administrator, all samples required by this Approval shall be analysed by a laboratory that meets the requirements of the Department's "Policy on Acceptable Certification of Laboratories" as amended from time to time.

m. Notwithstanding the above item, the following parameters may be analysed at the Facility or a laboratory that is not certified.

Alkalinity*, Aluminium Residual*, Chloramines, Chlorine Dioxide Residual, Chlorine Residual, Colour, Conductivity*, Fluoride Residual*, Hardness*, Iron*, Manganese*, Methane*, Free Ammonia (as N)*, Ozone Residual, pH, Temperature, Total Organic Carbon, Turbidity and UV Absorbance.

* These parameters must have a QA/QC component that includes quarterly confirmation by an accredited laboratory.

n. The Approval Holder shall ensure that this Approval, or a copy, is kept on Site at all times and that personnel involved in the Water Supply System operation are made fully aware of the terms and conditions which pertain to this Approval.

4. Spills or Releases

a. All spills or releases shall be reported in accordance with the Act (Part VI) and the *Environmental Emergency Regulations*.

b. Spills or releases shall be cleaned up in accordance with the Act.

5. Operations - General

a. The Water Supply System has been classified as a **Class II Water Treatment Facility** and a **Class II Water Distribution Facility**.

b. In accordance with the *Water and Wastewater Facilities and Public Drinking Water Supplies Regulations*, the Approval Holder shall place the responsibility for the operation, repair and maintenance of the Water Supply System under the overall direct responsible charge of an operator who holds a valid Operator Certification Certificate of a classification rating that is equivalent to or greater than the classification rating applied to the Water Supply System.

c. Notwithstanding Clause 5(b) above, if the Approval Holder cannot meet the requirement of Clause 5(b), the Approval Holder shall work towards satisfying Clause 5(b) in accordance with a transition plan approved by the Administrator. The transition plan shall be submitted to the Administrator within 90 days of being unable to satisfy Clause 5(b). This plan shall be subject to review and acceptance by the Department.

d. The Approval Holder shall ensure the contingency plan for the Water Supply System:
   i. meets the minimum requirements of the Department's "Water Utility Standard Operating Procedures and Contingency Plan Guidance", as amended from time to time.
   ii. is reviewed and updated on a yearly basis, if required. The Approval Holder shall document in the annual report what modifications were made to the plan, if any, and how the plan was communicated to their staff.
   iii. A copy is maintained on Site at all times and is available to the Department upon request.
   iv. All employees are apprised of the contingency plan.

e. When it is necessary to use a by-pass, the Approval Holder shall immediately notify NSE, identify the anticipated period of time that the by-pass system will be in service and initiate a Boil Water Advisory as stated in the "Guidelines for Monitoring Public Drinking Water Supplies". The Approval Holder shall maintain the boil advisory until otherwise advised by Nova Scotia Environment.

f. The Approval Holder shall take immediate preventive or corrective action, using methods that are acceptable to the Department, when results of an inspection or sampling results identify conditions which are currently or may result in an adverse effect to the environment or public health.

g. The Approval Holder shall protect the Water Supply System from

contamination due to cross-connections. If repairs, construction or maintenance are required, the Approval Holder shall ensure that the necessary work meets the requirements of the latest revision of CSA B64.10/B64.10.1.

h. The Approval Holder shall demonstrate that any Water Supply System component in contact with treated water has been disinfected after construction, repair or maintenance in accordance with ANSI(American National Standards Institute)/AWWA (American Water Works Association) C651 - Disinfection of Water Mains, ANSI/AWWA-C653 - Disinfection of Water Treatment Plant, and ANSI/AWWA C652 - Disinfection of Water Storage Facilities or the latest revisions.

i. The Approval Holder shall ensure that all chemicals used in the treatment process and all materials contacting the water are of "food grade" quality and meet both the AWWA quality criteria as set out in AWWA standards and the ANSI safety criteria as set out in ANSI standard NSF/60 (for chemical additives) or NSF/61 (for materials). A copy of the appropriate NSF certification is to be kept on Site and is to be available for review immediately upon request by the Department.

j. The Approval Holder shall discontinue use of any chemical found to have adverse effects on finished water quality limits as prescribed in the GCDWQ or this Approval.

k. i. The Approval Holder shall ensure that the emergency notification procedures are reviewed and updated on a yearly basis. The Approval Holder shall document in the annual report what modifications were made to the emergency notification procedures and how the procedures were communicated to their staff.

ii. A copy of the emergency notification procedures are to be maintained on Site at all times and are to be available to the Department upon request.

iii. All employees shall be apprised of the emergency notification procedures.

l. i. The Approval Holder shall ensure a comprehensive operations manual is kept up to date.

ii. A copy of the operations manual is to be kept on Site at all times and is to be available for review immediately upon request by the Department.

iii. All employees shall be apprised of the operations manual.

m. A set of current engineering drawings, shall be retained on Site by the Approval Holder for as long as the Water Supply System is in operation. These drawings shall be made available to the Department upon request.

n. The Approval Holder shall establish procedures for receiving and responding to complaints including a reporting system which records and documents what steps were taken to determine the cause of complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

o. The Approval Holder shall establish security measures to assure the safety of the Water Supply System.

p. The Approval Holder shall maintain a written list of the name of each laboratory utilized, and the parameters analysed by each laboratory, and shall submit this list to the Department upon request.

6. **Source Water Protection**

a. On or before May 2, 2016, the Approval Holder shall submit the updated Source Water Protection Plan to the Department for review and acceptance.

b. On or before June 30, 2016, the Approval Holder shall submit an updated implementation schedule for the Source Water Protection Plan to the Department for review and acceptance.

c. The Approval Holder shall implement the accepted Source Water Protection Plan, required under Condition 6 (b), in accordance with the accepted schedule.

d. The Approval Holder shall review and update the Source Water Protection Plan and implementation schedule on a yearly basis, if required. The Approval Holder shall document in the annual report the status and activities of the Source Water Protection Plan and modifications made to the Source Water Protection Plan or implementation schedule, if any.

e. If directed by NSE, the Approval Holder shall modify the updated Source Water Protection Plan or implementation schedule to the satisfaction of the Department.

7. Water Quality Requirements - Performance and Limits

a. General Requirements

i. The treated water shall meet the health-related concentration limits for the substances listed in the "Guidelines for Canadian Drinking Water Quality" (GCDWQ), latest edition unless stated otherwise in this Approval. These are described in the guidelines as Maximum Acceptable Concentration (MAC).

ii. For the medium risk GUDI wells (No. 8, No. 10, Smith Grant, Public Works, Beeches Road, and M&M), through a combination of natural filtration, UV, and chlorination, the treatment facility shall meet the following treatment efficiencies:

(1) Treatment shall be sufficient to ensure 99.9% reduction of *Giardia* cysts and *Cryptosporidium* oocysts (3-Log Reduction);

(2) Treatment shall be sufficient to ensure 99.99% reduction of viruses (4-Log Reduction); and

(3) Natural filtration is assigned a 1-log reduction credit for *Giardia* and *Cryptosporidium*.

(4) Primary disinfection shall address a minimum of 2-log inactivation for *Giardia* and *Cryptosporidium* and 4-log inactivation for viruses. CT/IT values shall be calculated in accordance with the Nova Scotia Treatment Standards for Municipal Drinking Water Systems, 2012.

iii. For the non-GUDI wells (No. 11, No. 12, No. 14, No. 15, Division Road, Exhibition, and Footes Lane 2), using both the natural filtration and disinfection processes, the treatment facility shall meet the following treatment efficiencies:

(1) Treatment shall be sufficient to ensure 99.99% reduction of viruses (4-Log Reduction); and

(2) Primary disinfection shall address a minimum of 4-log reduction for viruses. CT values shall be calculated in accordance with the "Nova Scotia Treatment Standards for Municipal Drinking Water Systems" (2012).

iv. The treated water shall be treated to minimize corrosion of the water distribution and/or plumbing systems.

b. **Primary Disinfection Requirements**

i. Primary disinfection through the use of chlorine, ultraviolet light or an alternate disinfection method which is acceptable to the Department, shall contribute a minimum of 2-log reduction for *Giardia* and *Cryptosporidium* and 4-log inactivation for viruses for each GUDI well or if water from individual GUDI wells is combined, for the combined flow. The disinfection log inactivation shall be based on CT values which shall be calculated as defined by the Department's "Treatment Standard for Municipal Surface Source Water Treatment Facilities".

ii. Primary disinfection through the use of chlorine shall contribute a minimum of 4-log inactivation for viruses for each non-GUDI well or if water from individual non-GUDI wells is combined, for the combined flow. The disinfection log inactivation shall be based on CT values which shall be calculated as defined by the Department's "Treatment Standard for Municipal Drinking Water Systems" (2012).

iii. System-wide redundancy shall apply - individual disinfection units shall be configured to apply primary disinfection at all times to ensure that inadequately disinfected water does not enter the distribution system. A well shall shut down automatically when the monitoring system detects inadequate disinfection.

iv. Each disinfection unit shall be designed to meet the rated design flow capacity of the wells or combined wells.

v. Disinfection equipment shall be operated in such a manner as to prevent inadequately disinfected water from being distributed.

vi. Continuous monitoring of the primary disinfection process is required with measurements taken at no more than five minute intervals.

vii. The Facility shall be equipped with instrumentation capabilities to notify operations staff if the disinfection process fails to operate properly.

viii. In the event of an emergency situation where inadequately disinfected water enters the water distribution system, the Approval Holder shall issue a boil water advisory and immediately notify the Department as required by the "Guidelines for Monitoring Public Drinking Water Supplies".

ix. UV Light Requirements

(1) UV systems shall provide a minimum dosage of 40 mJ/cm^2 at all points within the reactor at all times when water is passing through the treatment process provided that the water quality characteristics indicate that this is a sufficient dosage.

(2) Water flow shall be stopped or directed to waste, or another method of disinfection shall be used, during the minimum design warm-up period for the UV unit.

(3) UV disinfection unit shall be equipped with UV sensors reading calibrated UV intensity.

(4) The system shall be equipped with an alarm notification and shutdown procedures in the event of:
- high temperature in the reactor, lamp, ballast or transformer;
- high flow rate that causes dose to fall below design specifications;
- low UV dose;
- low UV intensity;
- UV has shutdown;
- or any other emergency situation.

(5) UV lamp operation shall be monitored in a manner that ensures bulb replacement can be accomplished prior to reaching the maximum lamp life expectancy.

(6) The Approval Holder shall receive written verification from an independent third party that the manufacturer's system will continually meet the 40 mJ/cm^2 requirement and provide this information to NSE immediately upon request.

x. On or before May 2, 2016 the Approval Holder shall submit standard operating procedures (SOPs) for the disinfection process to the Department. The SOP's shall be implemented and communicated to all operations staff and documented in the operations manual required by Clause 5(l) above. The procedures and a log indicating the date and method of communication to staff shall be made available to NSE upon request.

xi. The SOPs shall indicate the design ranges for achieving the required log inactivation by disinfection, for example:
- CT: lowest temperature, highest pH, lowest chlorine, minimum contact time.

- IT: UV intensity, UV transmittance, flow rate.

xii. The Approval Holder shall maintain a log of events when operational conditions are outside the design ranges for achieving the CT/IT. These records shall be made available to NSE immediately upon request. Log inactivation shall be calculated during every such event.

xiii. When operational conditions are outside the design ranges, the Approval Holder shall immediately notify NSE, investigate the cause and take necessary corrective action. CT/IT shall be calculated during every such event.

c. **Secondary Disinfection and Residual Monitoring Requirements**

i. Secondary disinfection through the use of chlorination shall be used to maintain a chlorine residual in the water distribution system.

ii. The disinfection process shall be operated in such a manner as to ensure that the following minimum chlorine residual value is achieved throughout the water distribution system at all times:

- 0.20 mg/L free chlorine residual.

The disinfection process shall be operated in such a manner as to ensure that the maximum chlorine residual delivered to consumers does not exceed the following values:

- 4.0 mg/L free chlorine residual.

iii. Continuous online monitoring of the chlorine residual is required for finished water at each location where water enters the water distribution system from an individual well or combined wells, with measurements taken at no more than five minute intervals.

iv. Continuous on-line monitoring of the chlorine residual is required for the water entering the distribution system and leaving any water storage structure within the water distribution system, with measurements taken at no more than five minute intervals.

v. Monitoring of the water distribution system for chlorine residual is required. Unless specified otherwise in this approval, sampling and testing frequency is the same as for bacteriological sampling requirements as stated in the "Guidelines for Monitoring Public Drinking Water Supplies".

d. **Turbidity Requirements:**

i. Continuous raw water turbidity monitoring (with measurements taken at no more than five minute intervals) is required at the wellhead prior to disinfection for the medium risk GUDI wells (i.e., Public Works, M&M, Beeches Road, No. 8, No. 10, and Smith Grant).

ii. Continuous (with measurements taken at no more than five minute intervals) or daily grab raw water turbidity monitoring is required from each non-GUDI well or combined flow from non-GUDI wells entering the distribution system (i.e., No. 11, No. 12, No. 14, No. 15, Division Road, Exhibition, and Footes Lane 2).

iii. Turbidity levels entering the distribution system from individual wells or combination of wells shall not exceed 1.0 NTU:

- in at least 95% of the measurements taken by grab sample for each calendar month; or

- in at least 95% of the time each calendar month if continuous monitoring is the method of turbidity measurement.

Iv. Notwithstanding clause 7(d)(iii), if the Approval Holder cannot meet the requirement of clause 7(d)(iii), the Approval Holder may request that a less stringent value apply provided the Approval Holder can demonstrate to NSE that the turbidity is not health-related and that the disinfection process is not compromised by the use of a less stringent value.

v. A turbidity value of 5.0 NTU or less shall be achieved on water distribution system sampling. Unless specified otherwise in this approval, sampling and testing frequency is the same as for bacteriological sampling requirements as stated in the "Guidelines for Monitoring Public Drinking Water Supplies".

vi. i. Where turbidity values of greater than 1.0 NTU are observed entering the water distribution system, from individual GUDI or non-GUDI wells or combined flow from non-GUDI wells, the Approval Holder shall investigate the cause and take corrective action as necessary and notify the Department.

ii. Where turbidity values of greater than 5.0 NTU are observed in the water distribution system, the Approval Holder shall investigate the cause and take corrective action as necessary and notify the Department.

e. **Greensand Filtration Requirements:**

i. The greensand filtration process shall be monitored and equipped with alarms and instrumentation to notify the Approval Holder of any problems that may compromise the disinfection process or result in a health-related drinking water guideline exceedence.

ii. Standard operational procedures for the greensand filtration process shall be developed, implemented and communicated to all operations staff and documented in the operations manual required by Clause 5(l) above. The procedures and a log indicating the date and method of communication to staff shall be made available to the Department immediately upon request.

iii. The standard operational procedures referenced in 7 e) ii) shall be submitted to NSE by May 2, 2016.

8. **Filter Backwash Water System - Performance and Limits**

a. Filter backwash water from the Facility shall be discharged to an approved location.

b. The Approval Holder shall submit an updated filter backwash plan to NSE for approval on or before June 30, 2016, for the independent wells and an interim plan for the wells that will be connected to the treatment plant. The filter backwash plan shall address the concerns identified in the 2013 System Assessment Report and shall include discharge locations and limits.

9. **Sludge Disposal**

a. The Approval Holder shall submit a plan for the ultimate disposal of solids from the waste treatment process to the Department for review and approval on or before June 30, 2016.

b. All solids from the waste treatment process shall be disposed in accordance with the approved sludge disposal plan.

c. Written approval is required from the Department to modify the sludge disposal plan.

10. **Upgrade Approvals**

a. The Approval Holder shall obtain from NSE a separate Approval for the construction of any proposed facilities required to meet the drinking water treatment standards and waste discharge requirements.

b. The Approval Holder shall submit an application for an amendment to this Approval if any new wells are to be connected to the existing Water Supply System. No additional wells shall be connected to the existing Water Supply System without prior written approval from the Minister.

11. **Production**

a. The Approval Holder shall comply with the Terms and Conditions of the water withdrawal approval for the Facility.

b. The Approval Holder shall report water withdrawal data in the annual report.

12. **Backup Water Systems**

a. When a backup water system is used for supplying water for human consumption, the Approval Holder shall immediately notify the Department and identify the anticipated period of time that the backup system will be in service.

b. For backup systems that do not meet the Nova Scotia Treatment Standards, the Approval Holder shall immediately initiate a Boil Water Advisory as stated in the "Guidelines for Monitoring Public Water Supplies". The Approval Holder shall maintain the boil advisory until otherwise advised by Nova Scotia Environment.

c. For backup systems that meet the Nova Scotia Treatment Standards, the backup water system may continue to operate as under normal conditions until the main water system is ready to be put back into service.

13. **Monitoring and Recording**

a. All monitoring shall be carried out as per the requirements of the *Water and Wastewater Facilities and Public Drinking Water Supplies Regulations* and the "Guidelines for Monitoring Public Drinking Water Supplies" as amended from time to time.

b. The Approval Holder shall monitor and sample the Water Supply System in accordance with a monitoring program approved by the Department and which meets the minimum requirements of Schedule A attached. In the case of a discrepancy between Schedule A and the approved monitoring program, the approved monitoring program shall apply.

c. Sampling shall be representative of the water distribution system.

d. i. On or before October 1, 2016, the Approval Holder shall undertake a review of sampling sites (post water upgrades) and submit to the Department for approval a recommended monitoring program for the Water Supply System for the current year. The proposed sampling plan shall address the items identified in the 2013 System Assessment Report and associated Corrective Action Plan.

ii. On or before October 1 of each year, the Approval Holder shall recommend to the Department the monitoring program for the Water Supply System for the following year highlighting any changes and the reason for the change. Any existing monitoring program shall remain in place until the recommended monitoring program is approved by the Department.

ii. The monitoring program shall include compliance monitoring, as required by this Approval, and process monitoring, response monitoring, special process characterization and optimization monitoring and source water characterization monitoring.

iii. The monitoring program shall meet the minimum requirements of the Department's "A Guide to Assist Nova Scotia Municipal Water Works Prepare Annual Sampling Plans", as amended from time to time.

iv. The monitoring program shall be acceptable to the Department.

v. The Approval Holder is responsible for implementing, on an annual basis, the monitoring program and subsequent revisions as approved by the Department.

vi. The Approval Holder shall not move, relocate or otherwise alter the location of the sampling locations indicated in the approved monitoring program without written permission from the Department.

vii. Following a review of any of the analytical results required by this Approval, NSE may alter the frequencies, location, and parameters for analyses required for this Approval or require other remedial action.

e. Any flow measuring devices and continuous water quality analysers and indicators with alarm systems shall be installed, maintained and calibrated as specified by the instrument manufacturer's instructions. Calibration logs for each instrument shall be maintained on Site and be available for inspection immediately upon request by the Department.

f. The Approval Holder shall establish a QA/QC program to validate the measurements obtained from continuous monitoring equipment and for all analysis conducted at the Facility or a non-certified laboratory.

g. The Approval Holder shall establish and conduct process control testing and sampling and record the results. Results are to be made available for inspection or review by departmental staff immediately upon request.

h. The Approval Holder shall establish and conduct source water protection testing and sampling and record the results. Results are to be made available for inspection or review by departmental staff immediately upon request.

14. Laboratory Reports and Water Quality Results

a. The Approval Holder shall submit copies of the laboratory certificate of analysis to the Department immediately upon request.

b. The Approval Holder will authorize and work with laboratories to electronically report water quality results to the Department upon implementation of an on-line drinking water quality surveillance program.

c. Electronic reporting shall not replace the Approval Holder's responsibility to immediately notify the Department when bacteria is present or an exceedance of a maximum acceptable concentration or interim maximum acceptable concentration for a health-related parameter listed in the "Guidelines for Canadian Drinking Water Quality" is detected.

15. Reporting

a. Reporting Upon Request

i. The Approval Holder shall keep records continually updated in such a way that weekly and/or monthly reporting of monitoring and sampling results can be immediately sent to the Department upon request.

b. **Annual Reporting**

ii. The Approval Holder shall prepare and submit to the Department, an annual performance report for the Water Supply System.

iii. The annual report shall be submitted on or before April 1 following the completion of the calendar year being reported upon.

iv. The annual report shall contain but not be limited to the following information on the form provided by the Department.

(1) a summary and discussion of the quantity of water supplied during the reporting period on a per month basis showing design values, maximum daily flow and average daily flow for each month and any other parameters or conditions specified in the Water Withdrawal Approval.

(2) a summary and interpretation of analytical results obtained in accordance with the monitoring and recording section of this Approval, including an explanation for any exceedance of the maximum acceptable concentration (MAC) or interim maximum acceptable concentration (IMAC) of health-related parameters listed in the "Guidelines for Canadian Water Quality", latest edition and the actions taken to address the exceedance.

(3) annual trend graphs for parameters that are continuously monitored.

(4) date and description of any emergency or upset conditions which occurred during the period being reported upon and action taken to correct them.

(5) any modifications to the contingency plan or emergency notification procedures including a description of how the information was communicated to staff.

(6) a list of the names of each laboratory utilized by the Approval Holder and the parameters analysed by each laboratory.

(7) an update on the status of the source water protection plan, including any modifications to the plan or implementation schedule, and a summary of activities taken to achieve the goals and objectives of the plan.

(8) all incidents of free chlorine residual below 0.20 mg/L in the water

distribution system shall be detailed with a description of any actions taken.

(9) verification that the operational conditions remained within the design range for achieving CT/IT; if operational conditions went outside the design ranges, provide CT/IT calculations and a summary of corrective actions taken.

(10) records of any violations of the conditions of this Approval and actions taken by the Approval Holder to correct those violations.

(11) any complaints received and the steps taken to determine the cause of the complaint and the corrective measures taken to alleviate the cause and prevent its recurrence.

(12) a review of the QA/QC program to validate the measurements obtained from continuous monitoring equipment and for all analysis conducted at the Facility or a non-certified laboratory.

(13) a list of each certified operator and their level of certification.

c. Immediate Reporting on Operation

i. The Approval Holder shall notify NSE immediately in the event of an incident that may adversely affect the quality of the water within the Water Supply System. Notification shall be made to a live person followed by fax or email. These incidents shall include but not be limited to: the presence of bacteria; inadequately disinfected water being directed to the water distribution system; sewage or other spills in the source water supply area; line breakage that may result in cross contamination; etc.

ii. The Approval Holder shall notify NSE immediately if any analytical results of any specific parameter exceed the maximum acceptable concentration (MAC) or interim maximum acceptable concentration (IMAC) of health-related parameters listed in the "Guidelines for Canadian Drinking Water Quality", latest edition.

iii. When bacteria are detected at the Facility or in the water distribution system the Approval Holder shall notify NSE immediately and undertake corrective action as outlined in the latest edition of the "Guidelines for Monitoring Public Drinking Water Supplies", as amended from time to time or other Policies or directives issued by NSE.

iv. If the chlorine residual in the water distribution system is less than 0.20 mg/L free chlorine, the Approval Holder shall notify NSE immediately and take immediate action to obtain the required residual.

16. **MPA Testing and Reporting**

a. MPA testing (of the raw water from each individual GUDI well) is required every two years in spring following a rainfall.

b. The Approval Holder shall immediately notify the Department if the GUDI status of a well changes and take any necessary corrective action.

c. MPA testing shall be conducted in accordance with Appendix A of the Nova Scotia Treatment Standard for Municipal Drinking Water Systems, Protocol for Determining Groundwater Under the Direct Influence of Surface Water.

17. **Records**

a. The Approval Holder shall keep the following records and water quality analyses:

i. All incidents of suspected and/or confirmed disease outbreaks attributed to the water system shall be documented and kept for a minimum of ten years.

ii. Bacteriological, chlorine residual and turbidity analyses shall be kept for two years.

iii. Chemical analysis shall be kept for 10 years.

iv. Annual water withdrawal records shall be kept for 10 years.

b. The Approval Holder shall also retain the following information for a period of three years:

i. calibration and maintenance records;

ii. continuous monitoring data.

c. A copy of project reports, construction documents and drawings, inspection

reports, shall be kept for the life of the Water Supply System.

18. **Site Specific Conditions**

a. i. The Approval Holders shall sample the following wells on a quarterly basis, to be analyzed for polycyclic aromatic hydrocarbons (PAHs): Well No. 10 and observation well No. GWMW 99-5.

ii. Any amendment(s) to the sampling program referenced in 19(a)(i) must be approved in writing by NSE.

b. The Approval Holder shall inspect all observation wells within the Town of Pictou Wellfield and Caribou Wellfield on an annual basis to evaluate the structural integrity of the wells and make repairs as necessary. All observation wells shall be properly capped with security measures in place.

SCHEDULE A		
SAMPLING REQUIREMENTS		
Non-GUDI and Medium Risk GUDI Wells, with Natural Filtration, Greensand Filtration, Disinfection and Water Distribution System		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
parameters as per the source water protection monitoring plan	In accordance with Step 5 of the Source Water Protection Plan and approved annual monitoring program	In accordance with Step 5 of the Source Water Protection Plan and approved annual monitoring program
water volume	continuous*	each individual well and combined flow; as per the Water Withdrawal Approval
temperature	daily grab or continuous*	CT control point
pH	daily grab or continuous*	water entering the distribution system; and as required by process monitoring if pH control is practised

SCHEDULE A		
SAMPLING REQUIREMENTS		
Non-GUDI and Medium Risk GUDI Wells, with Natural Filtration, Greensand Filtration, Disinfection and Water Distribution System		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
turbidity	<u>For GUDI Wells</u> continuous* <u>For Non-GUDI Wells</u> Daily Grab or continuous*	<u>For GUDI Wells</u> raw water at each individual GUDI well before pre-treatment and/or disinfection; and as requested by NSE. <u>For Non-GUDI Wells</u> from individual wells or the combined flow entering the distribution system; and as requested by NSE
turbidity within distribution system	weekly grab	distribution system sample points
backwash waste water	in accordance with the approved annual monitoring program to comply with discharge criteria	in accordance with the approved annual monitoring program to comply with discharge criteria
chlorine residual	continuous*	all locations where water enters the distribution system from individual wells or combined wells; storage tank outlet
	twice weekly grab, spread evenly throughout the week	distribution system sample points

SCHEDULE A		
SAMPLING REQUIREMENTS		
Non-GUDI and Medium Risk GUDI Wells, with Natural Filtration, Greensand Filtration, Disinfection and Water Distribution System		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
total coliform and E.coli (present/absent) **	twice weekly (spread evenly throughout the week)	all locations where water enters the distribution system from individual wells or combined wells; and distribution system sample points
parameters as per the corrosion control program	quarterly grab sample	select distribution sample points
lead	annual grab sample - during warmest month	select distribution system sample point(s)
total trihalomethanes	quarterly grab sample	select water distribution system sample point(s) representative of the longest retention time - generally furthest from the source
haloacetic acids	quarterly grab sample	select distribution system sample point(s)
parameters as per the process monitoring program	in accordance with the approved annual monitoring program	in accordance with the approved annual monitoring program
	UV monitoring	see 7(b), UV light requirements

SCHEDULE A		
SAMPLING REQUIREMENTS		
Non-GUDI and Medium Risk GUDI Wells, with Natural Filtration, Greensand Filtration, Disinfection and Water Distribution System		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
parameters as per the Guidelines for Monitoring Public Drinking Water Supplies (GMPDWS)	annually for GUDI wells; every two years for non-GUDI wells (Note - fluoride is a required parameter regardless of whether fluoridation is occurring or not because natural fluoride may be present)	raw water from each individual well; and treated water entering the distribution system
MPA testing	every 2 years, in spring following a rainfall	raw water from each individual GUDI well; in accordance with the Protocol for Determining Groundwater Under the Direct Influence of Surface Water.
unless specified otherwise in the approved monitoring program, all health-related parameters in the Guidelines for Canadian Drinking Water Quality, latest edition, having maximum acceptable concentrations (MACs)	every 5 years - timing for individual parameters may fluctuate (e.g. pesticides during application periods, etc.) (Note - algal toxins does not apply to groundwater supplies.)	raw water from each individual well; and treated water entering the distribution system except bacteria, THMs, HAAs, and lead which are to be taken in the distribution system
Viruses	as requested by NSE	raw water from each individual well; and water distribution system

SCHEDULE A		
SAMPLING REQUIREMENTS		
Non-GUDI and Medium Risk GUDI Wells, with Natural Filtration, Greensand Filtration, Disinfection and Water Distribution System		
PARAMETER	**MINIMUM FREQUENCY**	**LOCATION**
Giardia & *Cryptosporidium*	as requested by NSE	raw water from each individual well; and water distribution system

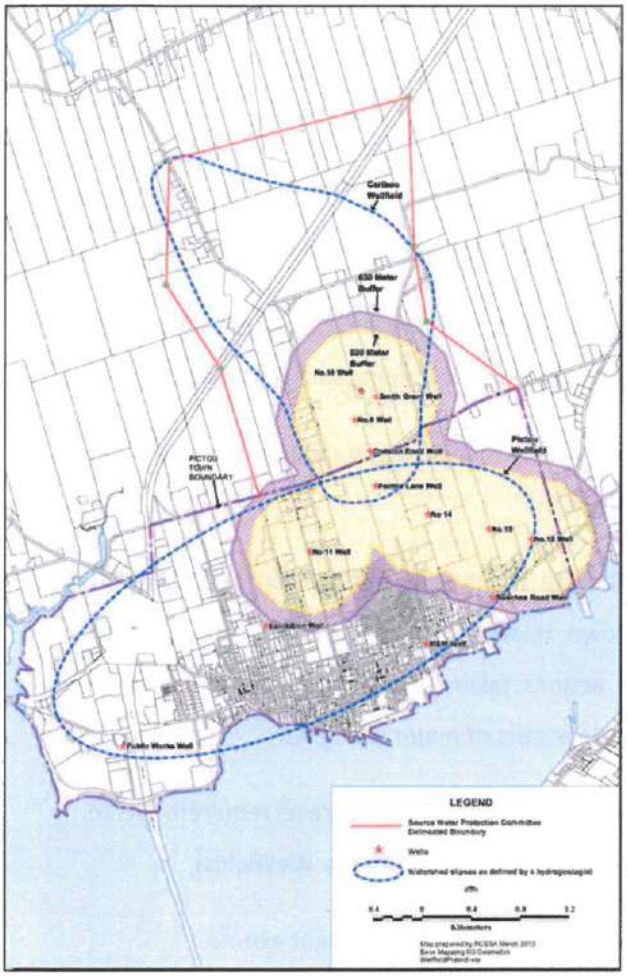
* Continuous monitoring - readings shall be taken a minimum of once every five minutes. Any report submitted to NSE shall include the maximum value for turbidity and the minimum value for residual chlorine recorded on the continuous monitoring equipment.

** The presence of coliform will require an immediate notification to NSE and resampling of the water.

Appendix D

Pictou Caribou Source Water Protection Plan

(2013, Revised in 2014 and 2017)



Pictou / Caribou Source Water Protection Plan

Approved: October 16, 2017

Revised: October 10, 2017

Prepared For

NOVA SCOTIA

Environment

Prepared By

Town of Pictou

Birthplace of New Scotland

Caribou Source Water Protection Committee

Members

REVISIONS

October 2017

REMO officer updated

January 2017

Minor Grammar Changes

Deleted Preamble – this section did not add value to the report and was captured in the Introduction.

Added Sections 3.7 and 4.7 to include "environmental risk" and how the source water protection committee can identify and respond. This changed the numbering the proceeding subsection headers.

3.7	To include reference to the sampling and monitoring standards the town has applied since the 2014 wellhead upgrades.
4.7	Added this section on Climate Change monitoring and mitigation strategies. Updated the status of current town related best practices to reflect recent upgrades. This describes current actions taken to monitor impact of climate change and suggested action plans in events of major droughts.
4.10	Include action plan to eliminate all chemical and minimize travel requirements to wells located in the connected wellfield (Caribou and Pictou Wellfields)
5.2	Added new program to address water conservation in drought events
	Included newly programmed alarms to notify if well parameter or water chemistry exceeds guidelines set by NSE or internally.
	Describe the impact and monitoring of centralized treatment on source water safety.

December 2014

Updated Figures and Table numbers to reflect new map

Section 4.4	Included graphic of Town sewer and water systems
Section 5.8	Created a risk management ranking system
Section 5.9	Renumbered Implementation Plan and included references to Utility EP and CP as well as REMO involvement

July 2013

General	Updated names of all provincial and federal government departments. Changed NSEL to NSE.
Table of Contents	Update Table to reflect changes in plan
Section 1.	Updated Introduction.
Section 1.1	Changed to Section 2.
Section 2.	Changed to Section 3.
Section 3.	Changed to Section 4.
Section 4	Changed to Section 5.
Section 5.	Changed to Section 6.
Section 3.	Updated map of delineated source water area.
Section 4.	Modified Table 1 to include type/category of potential risk.
Section 4.6	Changed Forestry to Forestry Operations
Section 5.4	Referenced all NSE pesticide regulations in second bullet.
Section 5.8	Included Tables 2. Modified table to identify status of activity, completion date, and the activities intended audience. Activities organized by risk management strategy (i.e. Education and Stewardship Initiatives, Best Management Practices, Emergency and Contingency Planning, Monitoring).
Section 6.2	Added Table 3. Table provides a status of monitoring activities, and recommended next steps.
APPENDICES	All Appendices updated include websites, names of provincial departments, and contact information.
APPENDIX II	Appendix II has been replaced with Wellfield Management Policy adopted by the Town of Pictou. Text from previous Appendix II has been incorporated into sections 1 and 2 of the document.

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LIST OF TABLES AND FIGURES

INTRODUCTION

Water is a provincial resource and regulated by Nova Scotia Environment (NSE) under the Environment Act. All Municipalities are required to obtain an approval from NSE to withdraw from water sources (i.e. groundwater and surface water) in Nova Scotia. The Town of Pictou (Town) holds water withdrawal approvals for both the Caribou and Pictou wellfields and an Approval to Operate (Approval) for their water treatment and water distribution system from NSE under the Activities Designation Regulation. The Approval details the operational conditions for the Town to ensure compliance with the Environment Act. Included are provisions for the Town to develop a source water protection plan (SWPP).

In 2002, NSE introduced its Drinking Water Strategy to ensure clean drinking water for all Nova Scotians. The main goal of a Water Utility is to provide safe, clean drinking water to its customers. Protecting the quality and quantity of the source water is a top priority for utilities as one-step in the multiple barrier strategy developed for the protection of drinking water quality in Nova Scotia.

The Town is located along the Northumberland shore of Nova Scotia. The Town's source of drinking water comes from two wellfields - one directly underlying the Town itself (Town Wellfield) and one to the north of the Town, referred to as the Caribou Wellfield. The Town Wellfield is bounded to the south by Pictou Harbour while the Caribou Wellfield extends from the Town boundary north into central Pictou Peninsula.

The Town's two wellfields utilize 13 wells. The Caribou Wellfield contains five wells (#8, #10, Division Road, Smith Grant and Footes Lane) while the Town Wellfield contains the remaining eight (#11, #12, #14, #15, Public Works, Exhibition, M&M and Beeches Road). All 13 wells are housed in structures constructed and maintained by the Town's water utility on lands owned by the Town and supply water to a population of 4,400.

The fundamental goal of the SWPP is to ensure the continued safety and quality of the Town's drinking water supply through protection of its source waters in the Town and Caribou watersheds. The procedures for development of the Plan are:

1) Form a Source Water Protection Advisory Committee (Committee);

2) Delineate a Source Water Protection Area Boundary;

3) Identify Potential Contaminants and Assess Risk;

4) Develop a Source Water Protection Management Plan; and

5) Develop a Monitoring Program to Evaluate the Effectiveness of a Plan.

This document provides details for source water protection through education and monitoring processes, and is not intended to form a basis for any regulation or watershed designation brought forth at a future time.

STEP 1: WATERSHED ADVISORY COMMITTEE

A Watershed Advisory Committee was appointed to develop a Source Water Management Plan and provide advice to Town and Municipality of the County of Pictou Councils, as well as the residents living in the area. The Watershed Advisory Committee consists of members representing a cross section of the various interested stakeholders such as the Water Utility, council members (Town and Municipality of the County of Pictou Councils), landowners, and land users. The Terms of Reference (Appendix I: Pictou / Caribou Source Water Protection: Advisory Committee - Terms of Reference) explains the details of operations and make-up of the Committee. The Wellfield Management Policy (Appendix II: Wellfield Management Policy) provides a framework for ensuring a co-ordinated effort by the Town and the Municipality of the County of Pictou representatives for protecting water quality and quantity for all residents served by the Town and Caribou Wellfields.

The goals of this committee are to:

1) Protect water quality and quantity for both Town and Municipality of the County of Pictou Residences;
2) Establish an effective SWPP; and
3) Develop a SWPP that enhances information sharing, promotes mutual respect and fosters open communications;

STEP 2: Delineating the Source Water Area

The source water area is determined as any lands inside the Town boundaries and those lands north of town included in the area shown in Figure 1: Source Water Area for the Town's water supply. The following geographical coordinates bind the source water area:

"From the intersection of Patterson St. and Division Rd. 343 degrees to Highway 106 at:

N45 42.101 W62 43.275

Then 327 degrees to N 45 42.470 W 62 43.618

Then 02 degrees to the Central Caribou Rd. at N 45 43.016 W 62 43.596

Then 76 degrees to Highway 106 at N45 43.289 W 62 42.078

Then 178 degrees to Glenn East Rd. at N 45 42.631 W 62 42.046

Then 171 degrees to N 45 42.305 W 62 41.969

Then to the Division Rd. at the eastern town boundary"

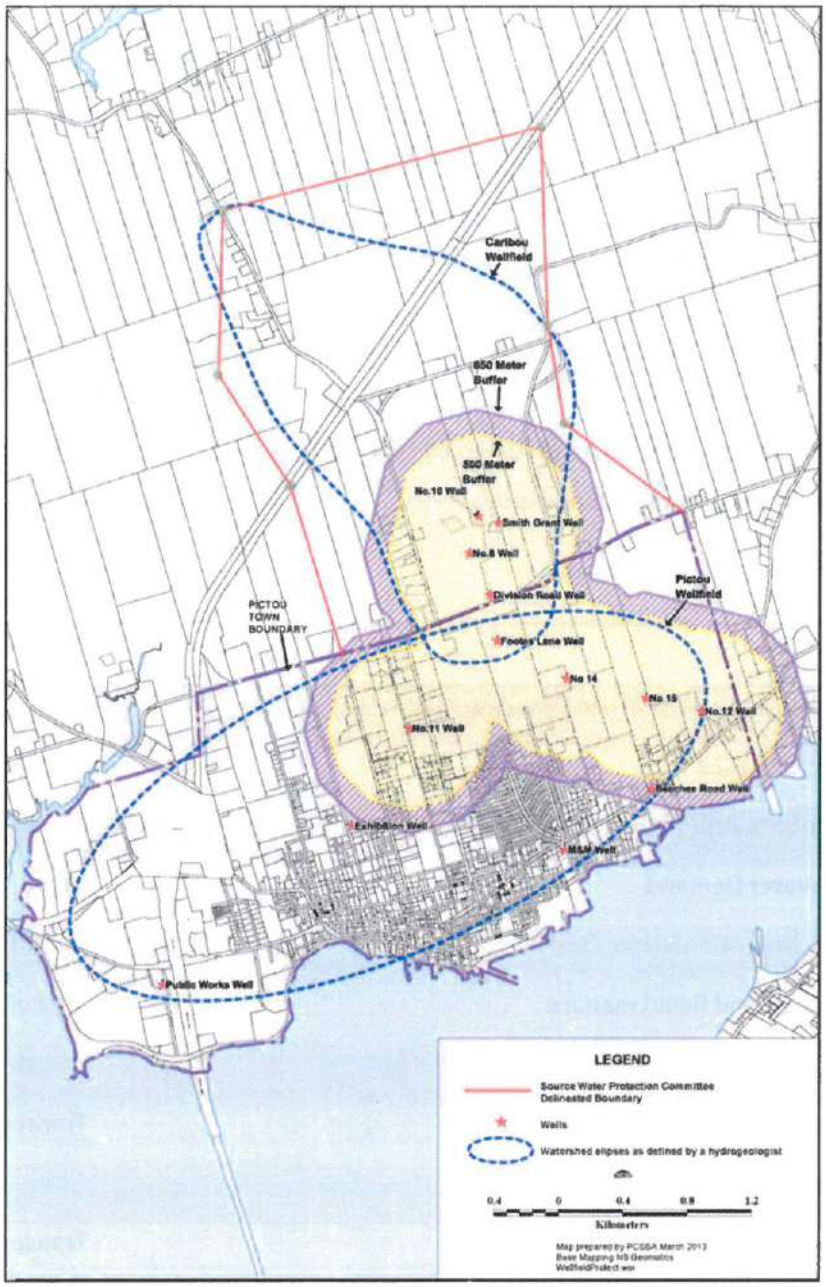

Figure 1: Source Water Area for the Town's water supply

The Pink shaded area is where privately owned domestic wells located within 650 m of a planned installation of a Town production well, with consent, will have an Hydrogeologist pre-assessment (Appendix II: Wellfield Management Policy). This boundary roughly represents the geological "bowl" of the source water area and is not a legal or surveyed description.

STEP 3: SOURCE WATER RISK IDENTIFICATION

The risks to water quality have been identified and are discussed with respect to the activity or land use. These activities include transportation, residential development, waste disposal, agriculture, industrial development, recreation and environmental. Potential risks associated with these activities are listed in Table 1: Potential Risks for Source Water Quality. These include pathogens, salt, petroleum products, pesticides, sediment and climate change.

These risks are grouped into activities or land uses in the following section to more easily apply selected management strategies. For example, residential risks might utilize educational initiatives. The implementation of an education program would cover several of the individual risks identified such as oil tanks, septic tanks and storage of pesticides.

Table 1: Potential Risks for Source Water Quality

Risk	Category
Changing Conditions of Wellfield including test well security	All
Well Drilling Activities	Utility / Residential
Creosote Timbers in Wellfield, above and below ground	Industrial
Increase in Water Demand	Utility
Salvage Yard impact on water quality	Industrial
Use of round-up and liquid manure	Agricultural
Forest clear cutting	Forestry Operations
Speed Zones	Transportation
Garbage Dumping	Other
Road Conditions	Transportation
Abandoned Sand and Gravel Pits	Industrial
Abandoned Wells	Utility / Residential
Septic Tank System malfunctions	Residential
Oil Tank leaks	Residential / Industrial / Commercial

Risk	Category
Transportation, fuel trucks, etc.	Transportation
Urban run-off and contaminants generated by Commercial, Residential & Recreational activities	Commercial / Residential / Recreational
Existing Commercial Activities	Commercial
Cemeteries	Other
Use of Pesticides	Agricultural / Residential
Forest or building fires	Forestry Operations
Climate Change	Environmental

3.1 Agriculture

Agriculture risks are considered low because of the limited activity in the watershed. Potential risks can exist and should be addressed to protect drinking water quality. Risks are primarily associated with pesticide/herbicide use and manure storage and spreading, i.e. biological and organic contaminates. Continued due diligence on the part of the farming community will ensure that any risks associated with agricultural operations will be managed appropriately.

3.2 Industrial and Commercial Activities

Industrial and commercial risks are mainly related to shops and services in the watershed area. Risks include chemical spills/leaks, septic system malfunctions, petroleum contamination, and contaminants generated from salvage yards.

The following commercial sites are potential sources of contaminants in the Town or Caribou Wellfields:

- Salvage Yard (petroleum products, chemicals, antifreeze)
- Abandoned Sand and Gravel Pit (direct pathway to groundwater)
- Gas Stations (petroleum products, antifreeze)
- Ship Yard (petroleum products, various chemicals)
- Print Shop (chemicals associated with inks and solvents)
- Metal Fabrication (petroleum products, various chemicals used in fabrication)
- Landscaping (pesticides/herbicides, organic materials)
- Concrete Plant (chemicals)
- Power Substations (herbicides, petroleum products)

3.3 Recreation

Recreation risks are mainly chemical and biological in nature. These include pesticide use on sports fields, the exhibition grounds, and chemicals used at various sports venues such as the arena and the pool.

Marinas also have potential risks as various potential contaminants are transported to and from the sites.

Garbage disposal and campfires are also additional recreation risks.

Finally, risks are sometimes associated with pet wastes. Pet owners should be encouraged to pick-up waste and dispose of it appropriately.

3.4 Residential Activities

The main risks identified in the Caribou and Town wellfields included those from septic systems, oil tanks, runoff, yard maintenance and household waste.

Septic systems are potential sources of microbial, inorganic, organic contaminants, pesticides and herbicides as well as pharmaceutical products. Septic systems are considered an elevated risk to water quality in some situations.

Oil tanks are a potential source of organic contaminants. Oil entering a watercourse or groundwater is both difficult and extremely expensive to remove. Accidental spills can occur in several ways. Fuel storage tanks can rust over time and develop holes in the tank. Fuel lines can leak or break if something falls on the line, such as snow or ice. Spills can also occur during fueling. Only certified fuel storage tanks should be used for fuel storage and the owner is responsible to inspect their tank for signs of deterioration or damage.

Residential runoff could contain pesticides, herbicides, as well as other chemicals used for household and landscaping maintenance.

Fire suppression could also create runoff contamination. Runoff should be contained if possible or remediated as soon as possible after the fire is extinguished.

The Town of Pictou also understands that residential sewage collection and water distribution could impact groundwater. To fully understand the area of influence, the map on the next page displays all water and sewer lines.

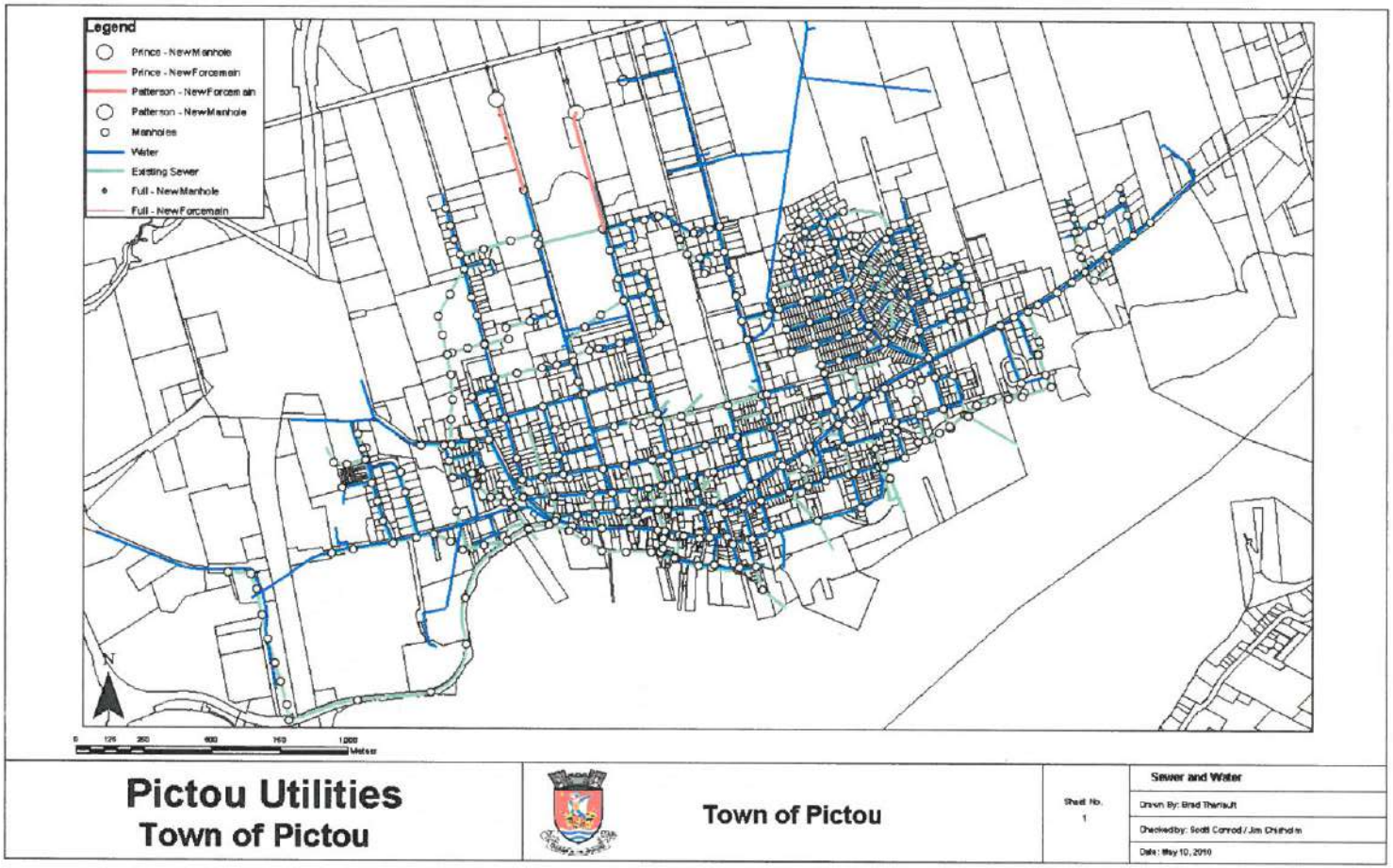

Figure 2: Town sewer and water mains

3.5 Transportation / Road Maintenance

Accidental spills resulting from transport of various materials (ex. petroleum products, chemicals used in commercial businesses or industrial processes in the area) are potential threats. The use of oil for residential heating and its transportation pose the greatest risk. Petroleum products (oil, gasoline and diesel) may enter watercourses and subsequently groundwater, because of automobile or transport accidents.

Contaminants could also be biological in nature. This could occur as in the case of a spill during the transport of septic sludge. Since accidents are always a possibility, these risks must be managed appropriately.

Road salt is a contaminant associated with winter road maintenance. Salt contamination can find its way into groundwater via ditches or direct infiltration and affect water quality.

Another risk associated with transportation is the high occurrence of excessive vehicular speeding on various roads through the watershed. Speeding is the leading cause of accidents and in a sensitive area like the Central Caribou Watershed, any increased potential for accidents should be addressed.

3.6 Forestry Operations

Risks associated with forestry operations include:

- wood harvesting and extraction;
- road construction and maintenance;
- pest and weed control; and
- fuel use, transfer and storage.

These are potential sources of pesticides and organic contaminants. A significant concern exists with respect to the long-term impact of clear cutting and the impact on changes in water table levels due to the loss of vegetative cover.

Forestry operations have been mainly mechanized clear cutting of various stands. Unfortunately, several properties were clear cut as a response to the uncertainty of regulations being proposed that were perceived to affect a landowner's ability to carry out forestry activities.

The selective harvesting of mature stands is a common practice in several watersheds in Nova Scotia. A forest management plan designed to protect water quality is the best way to minimize the impacts in the watershed.

Forestry operations utilize petroleum products for fuel and lubrication. Accidental spills can occur because of the use of these products and pose an elevated risk if the operation is within the recharge area for town or other individual wells. Accidental spills can occur during refueling or when hydraulic hoses break. Containers used for temporary storage of petroleum products can pose a risk to water quality if the containers are not properly constructed.

Other risks associated with forestry include fire and the suppressants utilized to control forest fires. Since the watershed is mainly covered by forest and that there are active forestry operations, there is a potential for fire and degraded water quality from the loss of forest cover and possibly from the use of chemical suppressants. In the case of large forest fires, the use of appropriate additives to water, or even the use of salt water is preferable to loss of cover.

The term "pesticide" is a generic term used to describe a variety of poisons used to kill plants (herbicides), insects (insecticides) and even fungus (fungicides). The use of pesticides in the watershed can potentially contaminate drinking water. Runoff from areas where these chemicals have been applied can enter groundwater and pose a human health risk.

3.7 Environmental

Global warming is inevitable, therefore and it is essential to consider this risk of it. Specifically, naturally occurring events, such as drought, will increase in frequency. The committee and Pictou Water Utility should consider these events as probable and should determine best practices for creating indicators and mitigating impact.

3.8 Other

The watershed committee has identified several other concerns that may affect water quality. A frequent problem in rural Nova Scotia is the uncontrolled and illegal dumping of garbage. Road networks through watershed lands provide the perfect access to remote locations where unconcerned individuals will simply

dump garbage regardless of the potential impacts. It is often the case that those that dump the garbage do not usually live in the watershed area. Illegal dumping can introduce various contaminants into the groundwater system depending on the nature of the garbage.

A legacy of past practices, i.e. creosote timbers that once were the structural framework of wharfs along the waterfront, are now buried in the middle of the Central Caribou Wellfield. While, in cooler temperatures, creosote is immobile, contamination of drinking water from the creosote remains a concern for Town and Municipality of the County of Pictou residents and should continue to be monitored over time.

The location of cemeteries is another concern for residents although they are considered a minor concern at this point. There are two cemeteries - one located on the fringes of the Caribou Wellfield and one is in the Town Wellfield. The main contaminant associated with cemeteries is formaldehyde in embalming fluid that leaches out during decomposition. Other contaminants can be associated with cemeteries as well, such as ammonia, nitrate, bacteria, viruses, etc. Continued monitoring is required to identify any changes in groundwater quality.

Although bio-solids are not in use at this time, the development of application methods in other areas suggests that they should be considered a potential risk, and their use in the source water area must be discouraged.

Refer to Table 4: Status of Effectiveness of Monitoring Land-use Activities.

Finally, the Town of Pictou water withdrawal is also considered a risk. To mitigate risks, the Town has installed state-of-the-art monitoring and controlling devices as well follow a rigorous sampling protocol defined by NSE. In 2016, the Town of Pictou did not have any Health Parameter exceedances.

STEP 4: RISK MANAGEMENT RECOMMENDATIONS

A SWPP contains a variety of management options that work together to effectively manage risks to water quality in a watershed. Management options fall into a variety of categories referred to as the ABC's of source water protection as outlined by the NSE guides to source water protection planning. They include Acquisition of land, By-laws, Best management practices (BMP's), Contingency plans, Designation and Education and stewardship.

Acquisition of Land: The acquisition of land by the Town gives direct ownership and control of portions of the source water area to the Town. This allows for a high level of protection of a source area due to direct control over the activities that can take place there. Targeted acquisition of specific parcels of land, as the need and opportunity arises are common practices in water supply areas throughout Nova Scotia. For more information please see Figure 3: Map of Town owned Land (brown).

Best Management Practices (BMP's): These standardized and widely accepted practices for activities and products are the most practical and effective means of preventing or reducing contaminants from reaching source water. BMP's have been developed for most activities, which occur in a wellfield. They can be applied to various aspects of residential development, including septic system and oil tank installation and maintenance, and construction activities. Most aspects of agriculture have operating BMP's in place through a variety of regulatory and market driven processes. Many of these practices are specifically designed to manage specific activities, which may affect water quality. BMP's are also in place for many industrial products, services, and activities related to motorized recreation and transportation.

Land Use By-laws – Municipal Planning Strategy: Development and implementation of a Municipal Planning Strategy (MPS) allows a municipality to develop land-use bylaws to manage development and control activities near sensitive areas. The Town has developed a MPS that covers the Town Wellfield, which outlines policies aimed at protecting water quality. There are no Municipality of the County of Pictou By-laws for the Caribou area.

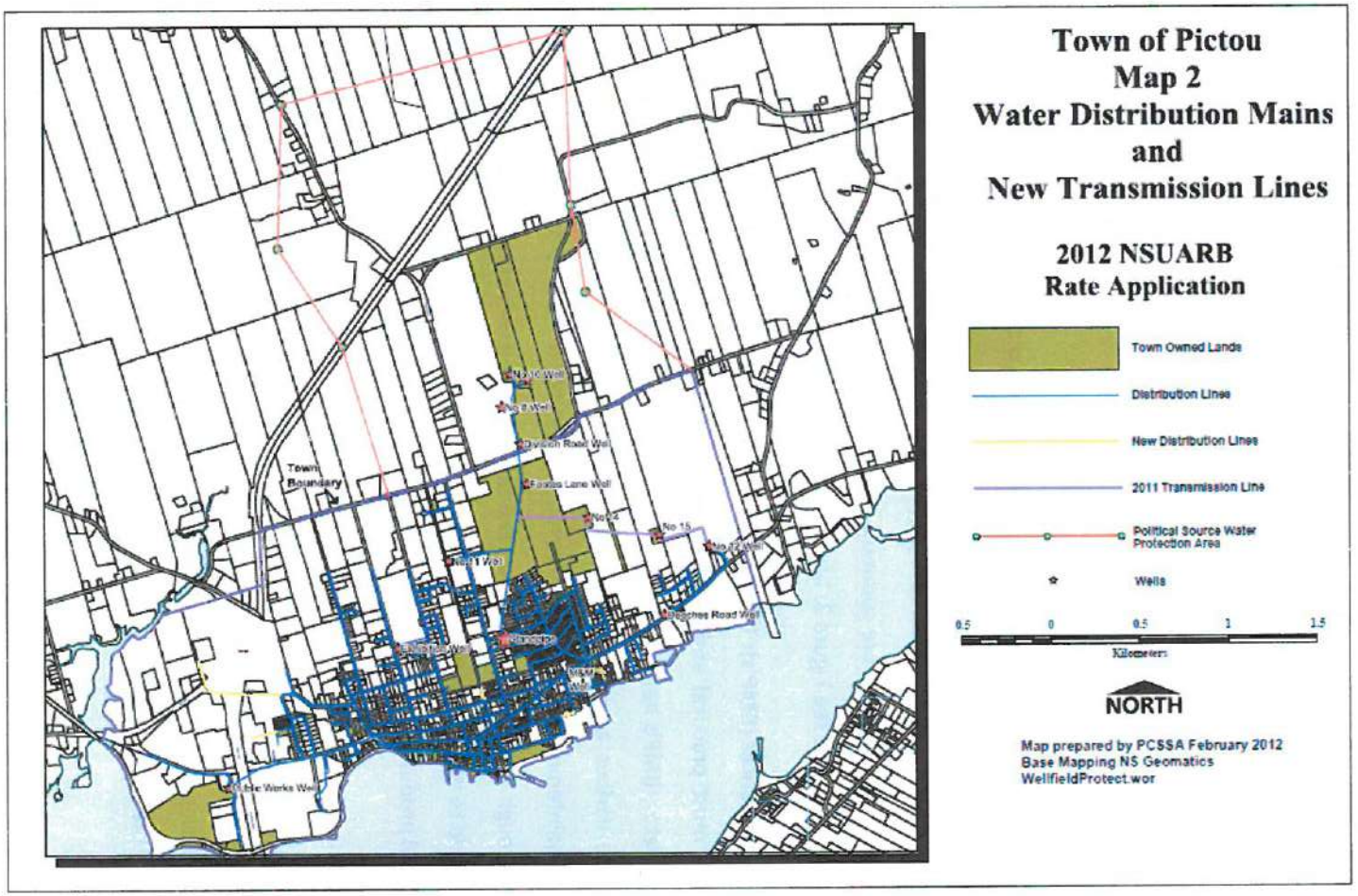

Figure 3: Map of Town owned Land (brown)

Contingency Planning: Contingency planning provides protocols to use in case of a contamination emergency in the source water area. The goal of the plan is to protect residents against contamination and ensure the immediate and long-term viability of the source area for water supply. The Town currently has an emergency response plan in place that includes boil water directives, mapping, resource lists, work plans and communications protocols to deal with emergency situations. These plans are reviewed and updated annually.

Designation as Source Water Protection Area: Designation is not being considered as a management option.

Education and Stewardship Initiatives: The development and promotion of an education and stewardship program can be an effective management option for protecting source water quality.

Education of stakeholders can reduce the uncertainty of the objectives of the Town and can help introduce a change in behavior if necessary. Education also creates a sense of ownership and responsibility among residents in a water supply area, which can significantly increase the success of other con-current management practices adopted. Specific opportunities for education and stewardship initiatives have been identified in the residential development, recreation, and forestry sectors.

The following sections describe the management options selected to address and reduce the risks identified in STEP 3: Source Water . The Watershed Advisory Committee selected these management options based on the type of water supply, the physical nature of the watershed and the specific activities that take place within the watershed. Refer to Table 3: Activities to Manage Identified Risks in Pictou/Caribou Wellfields in Implementation Plan for all the activities identified below.

4.1 AGRICULTURE

Agriculture activities are limited within the Central Caribou Watershed. The following management options are proposed to manage risks associated with, bacterial contamination of source water due to manure spreading and storage, and the use of chemical fertilizers.

- Make available the Recommended Agriculture Practices within Municipal Watersheds that has been developed by NSE, and Nova Scotia Department of Agriculture (Appendix III: A Guide to Recommended Agricultural Practices within Municipal Drinking Water Supply Areas in Nova Scotia) and general information on the Source Water Protection initiative.

4.2 Industrial/Commercial Activities

Industrial and commercial development is found throughout the watershed area, especially in the Town. It is important to emphasize contaminants that runoff from these activities can enter the groundwater system either directly through infiltration or through leaking storm sewers. It is important to educate proprietors that prevention and due diligence is the key to preventing accidental release of substances into the environment that can adversely affect water quality. The following recommendation was developed to address industrial and commercial contamination/pollution concerns.

- Develop an information/education package targeted at commercial and industrial users in the watershed area that introduces the Source Water Area Planning initiative and discusses potential contaminants associated with industrial/commercial activities such as petroleum storage, fuel spills, chemical storage, the use of pesticides, etc. The package should highlight the various best management practices for fuel storage, spill clean up, chemical storage, etc. Proper disposal of substances that could potentially affect groundwater quality should be explained. The information package should also include existing publications that discuss issues such as spraying. (See Appendix IV: Industrial/Commercial Best Management Practice References and Appendix V: Emergency Response Planning)

4.3 Recreation

Recreation is generally considered a desirable aspect associated with living in a rural setting. Passive recreation needs to be promoted. Passive recreation fosters an appreciation for the environment and aids in the informal policing of sensitive areas. Recommended management options include:

- Establish signage at trail heads in the Caribou Wellfield and at Town boundaries educating users on the sensitive nature of the area (i.e. as a source water protection zone) and to keep it clean by not littering and being diligent with respect to forest fires etc.
- Develop bylaws regarding pet waste pickup near streams, and other sensitive areas.

Activities or concerns associated with "active recreation" include golfing, ice making and maintenance at the arena, the swimming pool and activities at the marinas. As illustrated in STEP 3: Source Water , the main concerns are associated with transfer of petroleum products, various chemicals used in cleaning and disinfecting and the use of pesticides. The recommended management options to address concerns associated with these activities include:

- Develop an information package for managers of the various recreational venues in the source water area. This package should include BMP's for golf courses, BMP's for the handling/disposal of chemicals or liquids, petroleum products and other substances that may impact water quality and general information on the Source Water Protection Planning initiative.
- Signage discussed in the above section is also an important management option that can be used.

4.4 Residential Activities

The main risk activities associated with existing residential development in the watershed were identified as on-site septic systems, sewage lines, exterior oil tanks and household hazardous waste management. The management options selected to manage risks in the residential sector are as follows:

- Develop a Homeowner Education Program to help residents understand the importance of maintaining septic systems and oil tanks and the potential impacts to water quality from malfunctioning systems. The education program will include BMP's that have been developed by NSE with respect to septic systems, oil tanks, the use/storage and disposal of various household hazardous wastes and general information on other practices that contributes to watershed protection and the Source Water Protection initiative. (See Appendix VI: Residential Best Management Practice References).
- Develop a general SWP Newsletter to educate the public about impact on water quality, because of specific activities. For example, stress the importance of eliminating or restricting the use of pesticides, and when necessary use only those that degrade quickly and are recommended for use in such areas. Pesticide application must be done in accordance to the Non-Essential Pesticides Control Act, List of Allowable Pesticides Regulations, and Exceptions to Prohibitions on Non-Essential Pesticides Regulations from NSE.
- Encourage landowner responsibility for clean-up of derelict vehicles, old tanks, drums, tires, etc. for proper disposal through the SWP Newsletter.

4.5 Transportation

In Transportation / Road Maintenance, the main risks identified with the transportation sector were associated with road construction/maintenance and accidental spills of petroleum products or other contaminants and the management of road salt contamination. The critical areas were identified as the intersections between roads and watercourses, roadside ditches and proximity to wellheads. The recommended options to manage these risks are as follows:

- Establish high profile signage along public access routes indicating the presence of the Water Supply Area and to use caution.
- Develop an awareness program (BMP's i.e. reduced speeds) for transport companies focusing on watershed protection. Include contact numbers for Emergency Response.

- Employ Contingency/Emergency Response Plan for spill response and containment (Appendix V: Emergency Response Planning).
- Continue to monitor salt levels and evaluate alternatives (i.e. sanding, de-icing chemicals) if required.

4.6 Forestry Operations

Forests are the dominate vegetation in the watershed. Healthy and properly managed forests support quality water protection, generate economic activity for public and private owners, and support wildlife, recreation, and other forest-based values. Potential risks to water quality identified in STEP 3: Source Water include biological, chemical and petroleum contamination and potential impacts to water quantity/availability. The following management options have been identified to manage risks associated with harvesting, pest and weed control, and fuel use, transfer and storage.

- Stress the benefit of maintaining forest cover in watershed areas. Landowners should be encouraged to minimize forestry harvesting, and to follow best management practices regarding harvest/extraction, silviculture, and fuel use and storage, developed by the Departments of Natural Resources and Environment (Appendix III: A Guide to Recommended Agricultural Practices within Municipal Drinking Water Supply Areas in Nova Scotia). In addition, any forestry activities on Town owned lands must follow the Forestry Management Plan (Appendix VII: Forest Management Plan).
- Discourage the use of pesticides for silviculture and forest protection through education (newsletter, etc.).

4.7 Environmental

Drought is the immediate concern for conservation of water. Steps have already been conducted to ensure early indication of adverse effects. The Town has several monitoring sites as well as real time water level monitoring in all well houses. The Town currently has all wells alarm to notify operators when the water level in wells drop below 100 feet above the sensor. This value was chosen as it provides the operator early noticed of well drawdown and time to respond. In the event of alarms, operators will adjust the pumping rate down to help reduce the impact on drawdown. It is noticed that an immediate pumping rate change creates instantaneous relief in circumstances observed to date.

If decreases in pumping rates do not create the desired affects, a policy should be created for water conservation. This policy will be triggered by a series of events such as XX number of days without rain, XX consecutive attempts at decreasing pumping rates or some other consideration. Several communities currently

have similar policies in place which limits grass watering or car washes on certain days of the week or just provides a request to the public to conserve water.

The Source Water Protection Committee should with Pictou's Water Utility to develop a communications plan before these events occur or happen on a regular basis. For example, water conservation plans will need to be developed and proper communication channels considered. These could include alternating days of the week for watering lawns/gardens or public awareness campaigns.

4.8 Other

The Watershed Advisory Committee identified three additional concerns were through the development of this plan; illegal dumping, the creosote timbers buried in the watershed area and the two cemeteries - one inside Town and one in the Central Caribou Watershed area. The following management strategies are proposed to address these concerns.

- Develop a general education package or newsletter on the value of protecting source water for all residents. Groundwater is a shared resource and all residents play a part in protecting it.
- Develop a school education program focusing on the groundwater resources in the area. Education programs of this nature are generally successful in helping to educate an entire family with respect to the various challenges in protecting water quality and the important roles the various stakeholders play.
- Continue to monitor groundwater quality in monitoring wells and residential wells adjacent to the buried creosote timbers.
- Continue to monitor water quality in wells adjacent to the cemeteries.

4.9 Risk Ranking

Each risk has a varying level of probability and potential impact on the source water. To assess each risk, a rating system must be developed to rank the risk based on threat to the water system. A rating system should be based on possibility of occurrence and the severity of the impact on the water system.

As a single contamination of the water source, which makes the water unsafe could have a greater impact than several minor inconveniences. It is proposed to weigh impact as 8/10 and the probability of occurrence at 2/10. These two factors will provide a risk rating out of 10 for each activity. The table below ranks each activity based on risk:

TABLE 2: RISK ASSESSMENT

Section	Activity	Frequency (2)	Severity (8)	Total Score (10)
5.1	Agriculture			
5.2	Industrial/Commercial			
5.3	Recreation			
5.4	Residential			
5.5	Transportation			
5.6	Forestry			
5.7	Other (creasote piles, illegal dumping, two cemeteries)			

4.10 Implementation Plan

Following the adoption of the SWPP the management options or strategies that have been identified to manage the risks in the Town and Central Caribou Watersheds. Several general management strategies could be implemented immediately after the SWP Plan has been approved and these are outlined below:

- Develop a broad education and stewardship program outlining the purpose and status of the management plan and opportunities for participation. This could be done internally (with help from NSE) and take the form of a watershed newsletter and include information on sewer lines, septic systems, oil tanks, passive recreation and other general stewardship initiatives. Encourage feedback and questions from homeowners and other interested parties.
- Establish signage at access roads indicating the nature of the area as a source water protection zone and provide contact information in case of an emergency.
- Contingency Plans (CP) and Emergency Procedures (EP) are annually updated within the Town of Pictou's operating manual in Chapter 5. Any suggestions for new plans or procedures can be suggested through email or directly to the Utility. These procedures identify the plan of action in the event of emergencies and a contact list depending on the type of issue (news, high-risk customers, emergency services, etc.). The Utility's EP and CP focus on well site-specific contamination or failures and how to mitigate them.
- The Regional Emergency Measures Organization (REMO) has a countywide response plan on dealing with emergencies or disasters. All major emergencies should involve this committee. The Chief Administrative Officer (CAO), Scott Conrod, of the Town of Pictou is the local contact, while John Davison is the regional contact. To contact Scott, call the Town Office at 902-485-4372 and to reach John call 902- 759-1797.

The remaining strategies identified in Step 4: Risk Management Recommendations are listed in the Table 3: Activities to Manage Identified Risks in Pictou/Caribou Wellfields to illustrate when the strategy may be implemented.

Table 3: Activities to Manage Identified Risks in Pictou/Caribou Wellfields

Management Activity	Target Area	Status	Date of Completion	Comments
Education and Stewardship Initiatives				
Develop and distribute SWPP Newsletter	All	Ongoing		Distributed in 2007, 2008, and 2011.
Establish Signage at Access Roads	Transportation / Recreation	Complete	September 2007	
Assemble and Distribute Homeowner Information Package (Appendix VI: Residential Best Management Practice References)	Residents	Complete	September 2007	Available on the Town's website.
Develop & Distribute Forestry Education Package (Appendix VII: Forest Management Plan)	Forestry Operations	Complete	September 2007	Available on the Town's website.
Develop an information package: Managers of recreational venues	Recreation	Complete	September 2007	
Develop an information package: Industrial / Commercial sector (Appendix IV: Industrial/Commercial Best Management Practice References)	Industrial / Commercial	Complete	December 2008	Available on the Town's website.
Develop and deliver a school education program	Residents	Incomplete	TBD	
Develop conservation plans	Residents	Incomplete	TBD	
Best Management Practices				
Distribute Agricultural BMP's (Appendix III: A Guide to Recommended Agricultural Practices within Municipal Drinking Water Supply Areas in Nova Scotia)	Agricultural	Complete	September 2007	Contact NS Department of Agriculture annually to determine if any changes have been made. Available on NS Department of Agriculture website.
Develop & Distribute Transportation BMP's	Transportation	Complete	December 2007	Contact NS Department of TIR annually to determine

Management Activity	Target Area	Status	Date of Completion	Comments
				if any changes have been made.
Develop Forestry Management Plan	Forestry Operations	Complete	December 2008	Contact NSDNR annually to determine if any changes have been made.
Wellhead Upgrade Project	Utility	Complete	November 2014	Phase 1: November 2013 Phase 2: November 2014
Water Meter Installation	All	Complete	Spring 2014	Conservation
Wellfield Management Policy (Appendix II: Wellfield Management Policy)[1]	Utility	Complete	August 2011	
Eliminate Chemical Use at multiple sites and reduce traffic near water sources	Utility	In Progress	April 2019	When the Town builds a Water Treatment Plant it will centralize chemical and monitor requirements
Emergency and Contingency Planning				
Review Existing Contingency / EMO Plans	All	Complete	March 2008	
Develop Contingency Plan for Accidental Spills (residential) (Appendix V: Emergency Response Planning)	Residents	Complete	September 2007	Available on the Town's website.
Develop Contingency Plan for Accidental Spills / Accidents	All	Complete	September 2007	
Monitoring				
Monitor salt levels		Ongoing		Sampled annually
Monitor wells adjacent to buried creosote timbers		Ongoing		Sampled quarterly
Monitor water quality in wells adjacent to the cemeteries		Ongoing		Sampling frequency to be determined.
Review and Evaluation				
Review and update SWPP		Ongoing		Latest Update January 2017

[1]Activity added since previous version of SWPP.

STEP 5: EVALUATION AND MONITORING

An evaluation and monitoring program has been developed in conjunction with the management plan described above. Monitoring is the basis for Step 5 of the Five Step Guide under the Drinking Water Strategy for Nova Scotia. The purpose of the program will be to carry out on-going monitoring of water quality within the watershed to assess the effectiveness of management controls, warn of potential problem areas and contaminants in the watershed and track the overall health of the supply area.

The evaluation and monitoring program will provide an on-going snapshot of conditions in the watershed and help to provide early warning of potential risks to water quality and target areas where attention is required. Monitoring will also help to determine whether the management plan is working effectively and if any changes to the plan need to be made.

The monitoring program is comprised of two main components – a water quality-monitoring component, to directly measure the quality of source water; and a general component, to monitor land use changes and other activities in the watershed.

The SWPP should be reviewed regularly to assess effectiveness and reflect any major changes in activities or land uses in the watershed or changes in source water quality. Management options should be reviewed individually to assess their effectiveness, usefulness and cost/benefit. It is recommended that the watershed committee meet at least once a year to review the plan and source water quality, or as additional information, concerning the source area, becomes available.

5.1 WATER QUALITY MONITORING

The main component of the monitoring plan is the regular sampling of the source waters within the watershed for quality analysis. Water analyses will provide an indication of the overall source water quality within the watershed and any changes in quality that occur over time because of changing land use practices or other activities in the watershed.

At present, the Utility has in place a comprehensive raw water-monitoring program for each of the wells, as part of its operating permit for drinking water supply. The program includes continual, weekly, quarterly, annual, and five-year sampling. Water quality parameters related to the SWPP are sampled on

a quarterly basis. District 3 residents, under the guidance of the Pictou County Council should develop plans to test private wells adjacent to the creosote timbers, the cemetery, and the salvage yard, at four to six well locations on a semi-annual basis, or as deemed necessary.

5.2 SWPP Evaluation and Review

Monitoring of the activities and issues identified during the risk analysis (Step 3) of the source water protection planning process should be carried out as a general provision of the overall monitoring activities. This can be accomplished by the Watershed Advisory Committee meeting regularly to exchange information regarding changes in land use, water quality or proposed activities throughout the watershed. The Committee may also choose to review and change portions of the SWPP to reflect changes in the watershed.

The following specific monitoring and evaluation activities may be conducted, either formally or informally, and reviewed by the Source Water Protection Committee. The monitoring activities are grouped by major land-use activities:

TABLE 4: STATUS OF EFFECTIVENESS OF MONITORING LAND-USE ACTIVITIES

Monitoring Activities	Status	Next Steps
Agriculture		
Monitor changes in agricultural operations and monitor water quality with respect to changes in water quality from contamination that is associated with agriculture such as nutrient levels or coliform counts.	No major change in activity identified. The Utility monitors for coliform counts weekly at each well operated by the utility. Nutrient levels are monitored annually at each well operated by the utility. Results are found in the Utility's Annual Report submitted to NSE.	Continue monitoring. Evaluate Committee's ability to monitor agricultural operations.
Industrial / Commercial		
Monitor changes in water quality with respect to industrial and commercial operations throughout the watershed	No major changes in industrial or commercial activity in the watershed.	Evaluate Committee's ability to monitor this activity.
Recreation		
Continue monitoring recreation activities with respect to potential fuel spills and littering. Encourage recreational users of the watershed to report any irregularities or problems they encounter.	No significant issues identified with respect to recreational activities.	Evaluate Committee's ability to monitor this activity.
Residential Development		
Monitor the development activities within the watershed, especially new commercial or industrial developments.	No major activities identified.	Continue monitoring.
Monitor any serious issues that arise with septic systems/sewers, such as major malfunctions or changes in policy with respect to waste	No key issues identified with respect to septic	Work closer with NSE to discuss whether septic

Monitoring Activities	Status	Next Steps
disposal.	systems / sewers.	systems malfunctions occur in watershed, and discuss methods for notification.
Develop plans for monitoring private wells adjacent to the creosote timbers, the cemetery, and the salvage yard, at four to six well locations on a semi-annual basis, or as deemed necessary.	No monitoring plan developed.	TBD
Transportation		
Monitor water quality results for any signs of potential contamination of source waters from road salting (i.e. high chloride levels).	Salt levels are continually monitored at each well operated by the Utility. Wells with increasing levels have been identified. These wells do not have surface water influences. Road salt not suspected to be source of increasing levels. Results are found in the Utility's Annual Report.	Continue monitoring.
Monitor transportation patterns in the watershed, to ensure that dangerous goods that are transported through the watershed follow BMP's.	No monitoring of this activity.	Evaluate Committee's ability to monitor this activity. Invite Nova Scotia Department of Transportation and Infrastructural Renewal and / or Transportation Canada to committee meeting to discuss approaches and feasibility.
Forestry Operations		

Monitoring Activities	Status	Next Steps
Monitor changes the forest cover due to the frequency, size, and extent of harvesting or natural disasters such as from wind, fire, insects/diseases, or other agents.	No monitoring of this activity.	Evaluate Committee's ability to monitor this activity. Invite Nova Scotia Department of Natural Resource to committee meeting to discuss approaches and feasibility.
Monitor water quality results for any signs of potential contamination of source waters due to construction, development or other activities (i.e. nutrient levels, coliform counts, TSS).	No major change in activity identified. The Utility monitors for coliform counts weekly at each well operated by the utility. Nutrient levels are monitored annually at each well operated by the utility. Results are found in the Utility's Annual Report submitted to NSE.	Continue monitoring.
Environmental		
The Town will monitor groundwater level and set alarms to provide early notice adverse effects.	These alarms are programmed through the Utilities SCADA system and send automatic alarms to the operators	Continual Monitoring. This should be supplemented by a communication plan during time when conservation protocols are in place.
Other		
Monitor changes in PAH's due to creosote timber burial.	PAHs are sampled quarter annually since 2009 and included in the Utility's	Continue monitoring. Developed policy / procedure for enhanced sampling and

Monitoring Activities	Status	Next Steps
	Annual Report submitted to NSE. Benzo(a)pyrene detected in June 2009. No detection since June 2009.	notification. Develop plan for including private well owners in sampling.
Monitor changes in water chemistry due to contaminants associated with cemeteries.	No sampling frequency established.	Establish sampling frequency. Developed policy / procedure for enhanced sampling and notification. Develop plan for including private well owners in sampling.
Monitor solid waste practices.	No major change in activity identified.	Evaluate Committee's ability to monitor solids waste practices of individuals.
Groundwater Level	Continually through SCADA system	The system is designed to alarm if the water level drops below 100 feet above the sensor's head.
System turbidity, pH, temperature	Continually through SCADA	Alarms will sound if parameters exceed NSE recommended parameters
Centralize Treatment and Disinfection Operations	Build and use a centralized treatment plant	This will eliminate untreated backwash, multiple chemical injection sites and several vehicle trips to the wellfield.

Appendix I: Pictou / Caribou Source Water Protection:

Advisory Committee - Terms of Reference

Advisory Committee - Terms of Reference

The following are the Terms of Reference for the Source Water Protection Advisory Committee for the Town and Central Caribou Wellfields, the source area for Town, Central Caribou & surrounding area, Pictou County, Nova Scotia. The Pictou / Caribou Source Water Advisory Committee will be recognized by the Pictou Town Council (the Town), the Municipality of the County of Pictou, and the Water Utility.

Mandate:

The Pictou /Caribou Source Water Protection Advisory Committee (the Committee) shall:

1. Elect a Chair to provide leadership to the Committee;

2. Review and make recommendations to the Pictou Town Council and Municipality of the County of Pictou Council on all activities that may adversely affect the water quality in the Town and Central Caribou Source Water Area (source area) as requested by the Utility, Council, the Central Caribou Watershed Advisory Committee, landowners or other stakeholders in the source area;

3. Provide a forum for landowner and stakeholder involvement and for reporting to landowners and stakeholders on matters regarding water resources and water quality/quantity protection;

4. Review and make recommendations regarding monitoring of water quality and quantity programs and other studies related to the source area. All water quality/quantity information shall be available to the Committee;

5. The Committee will develop information for educational programs regarding water quality/quantity and source water protection for landowners and other stakeholders in the source area;

6. Develop a SWPP and Implementation Schedule to protect the Town and Central Caribou Wellfields.

Membership of the Committee:

To develop and implement a comprehensive SWPP, the following will be included as members of the Committee:

- members of the Pictou County Council;
- members of Town Council;
- members of Municipality of the County of Pictou Council;
- the water utility operator;
- landowners from the area;
- other interested stakeholders;

The following may be invited to assist the Committee in an advisory capacity:

- Nova Scotia Department of Environment;
- Other government or technical advisors if necessary.

Operation of the Committee:

1 The Committee will be chaired by a member selected by the Committee;

2 Members will serve for a term that is to be determined by the Committee;

3 Secretarial services will be provided by the Committee;

4 These terms of reference may be amended by the Committee;

5 The Committee will endeavour to conduct business by consensus, but should voting be necessary, all motions require support from a quorum (two-thirds) of the Committee members;

6 Disputes that cannot be resolved through consensus will be addressed at a special session mediated by a third-party;

7 The Committee will meet as necessary, but no less than once in each calendar year.

8 The Committee may from time to time request or admit individuals or groups to make representation to the Committee regarding matters or issues affecting the source area.

9 The Committee will liaise with government agencies not represented on the Committee, particularly Nova Scotia Environment;

10 The Committee will prepare an annual report at the end of each calendar year and circulate it to all members of the committee

APPENDIX II: WELLFIELD MANAGEMENT POLICY

Wellfield Management Policy

Policy Objective

The policy objective is to efficiently and effectively address management of existing Town wells and the activities related to the planning of new well installations.

Policy Presentation

1. Exploration and Installation of New Production Wells

The Town's statement of general policy is to:

1.1 Employ the services of a licensed Hydrogeologist to recommend future Town well sites, assess valid complaints, and to prepare an aquifer testing report (ATR). Such an ATR will include, with the permission of private well owners, the completion of pre-assessment reports as described in provision 1.3 of this policy.

1.2 To reduce impacts on private wells, the Town will first focus its exploration for new wells, when and if new Town wells are required, to sites located within the northeastern portion of the Town as shown on the attached map.

1.3 For privately owned domestic well(s) located within 650 meters of a planned installation of a Town production well, and upon consent of the private well owner(s), the Town shall have a Hydrogeologist conduct a pre-assessment.[a] The purpose of the pre-assessment is to collect baseline information specific to the private well(s), e.g., the collection of pre-pumping data, which can be used for comparison purposes should private well interference effects be suspected in the future. Private well owners who do not wish to participate in a pre-assessment process are not necessarily excluded from opportunity to make future complaint, but are advised that a determination of future impact without a pre-assessment is less probable.

[a] The Guide to Groundwater Withdrawal Approvals issued by the Province of Nova Scotia references 500m for the identification of potential interference effects of new installations on nearby groundwater users, The Town increased this distance to 650m due to the number of homes that are just beyond the 500m distance from Town owned lands.

1.4 To advise the owners of private wells within 650 meters of a new Town production well of the expected date of well testing and the date on which the new Town production well is expected to be operational; and

1.5 To maintain observation (background) wells located outside of Town pumping areas (outside of Town pumping influence) for the purposes of collecting data related to natural fluctuations in the water table.[b]

2. Operation of Existing Production Well

The Town's statement of general policy is to:

2.1 Apply steps 2.2 through 2.4 below for the operation of existing production wells following the commissioning of Well #15, currently underway, and including any other new wells after commissioning.

2.2 Employ the services of a licensed Hydrogeologist to prepare an aquifer testing report (ATR) and act upon written complaints from private land owners. Such an ATR will include an assessment of valid complaints from private land owners within 650 meters of a Town production well in a manner consistent with provisions 3.1 through 3.6 of this policy (excluding 3.2))c

2.3 Maintain a series of observation wells, which are both within the Zone of Influence of existing production wells, and located outside the Zone of Influence between the production wells and adjacent private wells. These wells will be used for the purposes of establishing background aquifer water levels and variations due to pumping of Town wells.

2.4 For the purposes of establishing baseline conditions for existing production wells installed prior to the implementation of this policy, the aquifer data to be considered shall be that available under the present wellfield conditions, and is limited to data collected on or after the installation of a production well.

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[b] The Town maintains two backgrounds wells, each is equipped with a hydrograph. One well is located within an aquifer comprising sand and gravels, while the second is located within an aquifer comprising bedrock.

[c] This aspect will be part of a standardized application to NSE for Groundwater Withdrawal Approval by the Town. Other requisites of the NSE application typically include the drilling and monitoring of an observation well within the adjacent influence area of a proposed production well. The observation well is to be used by the Hydrogeologist to gauge the pumping effects of the production well (drawdown cone) relative to groundwater levels within the related area.

3. Administration of Valid Complaints

Specific to the processing of valid written complaints received from private owner(s) of well(s) wherein the owner(s) of said well(s) alleges unacceptable interference (diminished water levels) caused by Town activities, the Town shall:

3.1 A written complaint received by the Town shall be deemed valid based on records of aquifer water levels in existing production and observation wells in addition to pumping rates from existing wells. Water levels in observation wells must be shown to have varied outside normal seasonal fluctuations and/or production rates must have exceeded normal 3-day maximum withdrawal volumes for a written complaint to be deemed valid. Such an assessment will be made by a licensed Hydrogeologist engaged by the Town.

3.2 Engage a licensed Hydrogeologist to undertake an independent review of the complaint. The independent review shall include:

a) a comparison of the conditions encountered by the private well owner(s) to those benchmarked during the pre-assessment (if completed) as referenced above;

b) a comparison of the conditions encountered by the private well owner(s) to those benchmarked within the observation (background) wells as referenced above; and

c) a determination by the reviewing Hydrogeologist of whether there is a relationship between Town pumping activity and water shortage encountered by the complainant.

3.3 In response to valid written complaint(s) received by the Town from owner(s) of private well(s), where the subject well(s) are located within 500 meters of a Town well currently in production, and upon the owner of such well executing a release of liability to the Town in respect of responsibility for loss of water prior to the completion of the Hydrogeologist independent review, the Town shall furnish the owner of said private domestic well with a temporary supply of water, at Town expense, until such time as the independent review referenced in provision 3.2 of this policy is complete.

3.4 In response to a written complaint(s) received by the Town from the owner(s) of a private well(s), where the subject well(s), is located between 500 and 650 meters of a Town well currently in production, the Town shall engage an independent licensed Hydrogeologist as soon as possible to

undertake an independent review and file a report pursuant to provision 3.2 of this policy. The Town will not provide temporary water supply in this instance.

3.5 If it is determined in the independent review that Town pumping activities create unacceptable interference (diminished water levels) within private wells, the Town shall:

a) Notify the owner of the well and NSE in the form of a copy of the report upon its receipt;

b) Attempt at the earliest reasonable date to negotiate a resolution with the private well owner, wherein the deficiencies being experienced are satisfactorily addressed to an objectively reasonable standard. The negotiation/resolution may require the engagement of professional and independent Hydrogeologists and/or professional design engineers; and

c) To keep NSE apprised of independent review work and negotiations in a timely manner.

3.6 This policy shall not relate to new or replacement domestic wells drilled after the date on which Town production wells are operational.

4. Water Conservation Planning

Over the eighteen (18) months succeeding the adoption of this policy, the Town agrees to develop a water conservation program that may include without limitation:

4.1 Determining the feasibility of installing residential water meters and a central water monitoring system for Town wells (known as ***SCADA) that in part could be used to conserve usage and to quantify and locate unaccounted water production.***

4.2 Have the Nova Scotia Utility and Review Board modify the Town's regulations to include a conservation provision empowering the Town to control (restriction or denial) of water usage by its customers during dry periods.

4.3 Analyze historic data relative to precipitation and well operating parameters (e.g., rates of drawdown and recharge) for benchmarking normal operating parameters and quantifying points under which the Town would invoke conservation regulations described above.

APPENDIX III: A GUIDE TO RECOMMENDED AGRICULTURAL PRACTICES WITHIN MUNICIPAL DRINKING WATER SUPPLY AREAS IN NOVA SCOTIA

Prepared by

Nova Scotia Department of Agriculture and Fisheries

Nova Scotia Department of Environment and Labour

2005

INTRODUCTION

Some types of agricultural practices can impair water quality. If not carefully managed, common pollutants of water originating from farming activities may include: sediment, nutrients (especially nitrogen and phosphorous), bacteria, and pesticides. The challenge to farmers is to balance agricultural production with the protection and conservation of water quality.

This document is designed as a guide to farmers and to operators of municipal drinking water supplies, providing recommended management practices that can be incorporated into daily farming activities to help protect water quality in areas, which drain into public drinking water supply areas. It was developed in conjunction with the Nova Scotia Department of Agriculture and Fisheries and the Nova Scotia Department of Environment and Labour. It is aimed at minimizing the risk of an impact on water supply areas, while recognizing that there is no practical method of ensuring an absolute zero risk approach, particularly regarding surface water supplies (rivers and lakes).

Farmers operating within drainage areas contributing to municipal drinking water supplies are expected to demonstrate due diligence. This means taking every reasonable precaution to prevent or minimize impacts from activities that can impair water quality. The best approach to ensuring due diligence is achieved is by using Beneficial Management Practices, or BMPs. The BMPs outlined in this guidance document have a proven record of success in reducing impacts to water from farming activities. Some of the management practices in this document may be superseded by regulations in some water supply areas. For certainty, contact the water utility operator responsible for the water supply in question, or the Nova Scotia Department of the Environment and Labour.

BENEFICIAL MANAGEMENT PRACTICES

ENVIRONMENTAL FARMS PLANS AND NUTRIENT MANAGEMENT

The Nova Scotia Federation of Agriculture and Department of Agriculture and Fisheries have developed programs to assist farmers in reducing impact to the environment from farming activities.

The **Environmental Farm Plan (EFP)** is a voluntary program that helps farmers identify and assess environmental risks on their property. Farmers work with an EFP coordinator and engineer to develop a confidential environmental farm plan for their operation.

The objective of the EFP Initiative is to help farm families develop a practical plan for operating the farm in an environmentally responsible manner. The Environmental Farm Plan acts as a guide which enables farm families to incorporate sound environmental practices into their operations. The EFP Initiative is industry-led and industry-driven.

The **Nutrient Management Program (NMP)** is a farm-specific tool that determines the amount, timing and application of nutrients from manures and fertilizer. Livestock and poultry producers operating in areas which drain into municipal drinking water supplies are strongly encouraged to develop a nutrient management plan for their farming operations. The major elements of such a plan should include:

1.1 Periodic analysis of the manure produced in the animal operation

1.2 Routine soil testing program

1.3 Realistic yield goals for rate calculation

1.4 Accurate records of fields manured and the application rates used

1.5 Sufficient storage capacity

1.6 Field maps where wetland and other freshwater ecosystems are identified

1.7 Proper timing of manure application

1.8 Calibration of manure spreaders so application rates can be determined

For more information about these programs please contact:

Environmental Farm Plan Coordinator

NSFA office - (902) 839-2293.

Email: info@nsfa-fane.ca

Website: www.nsfa-fane.ca

Programs and Risk Management Division

Farm Investment Fund

Nova Scotia Department of Agriculture and Fisheries

176 College Road, PO Box 550, Truro, NS B2N 5E3

Tel: (902) 893-6510 Toll-free: 1-866-844-4276, Fax: (902) 893-7579

MANAGEMENT OF LIVESTOCK MANURES

The land application of livestock manure is recognized as an acceptable farming practice. When properly managed, the risk of an impact on a water supply area is minimized to a level that can be managed by other components of a water supply protection plan.

Between the time manure is excreted and the time it is incorporated into the soil, the loss of nutrients and the resulting potential for pollution can be quite high depending on how manure is handled. The following methods should be employed when managing manure in drinking water supply areas:

1.1 Ensure that all manure hauling and spreading equipment is suited to the type and consistency of the manure produced on the farm.

1.2 Ensure storage structures have the capacity to hold the total volume of manure, wastewater, and bedding produced between periods of land application.

1.3 Time the loading and field application of manure to reduce the potential for environmental contamination and to provide the greatest benefit for soils and crops.

1.4 Make storage facilities manure tight to contain and protect manure from the weather thereby

providing the greatest conservation of nutrients and the best protection against water contamination.

1.5 Keep manure handling to a minimum, agitating manure, particularly in liquid form, causes the gaseous loss of nitrogen, which causes odours. Manage manure to minimize the number of times that manure is mixed and spread.

1.6 Plan the location of animal production and manure storage facilities so that they are adequately separated from water sources.

1.7 Always apply manure following minimum separation distances for water resources.

1.8 Avoid applying manure on wet soils to minimize compaction, runoff and leaching.

1.9 Unless immediately incorporated into the soil, surface apply manure at reasonable distances from residences and public buildings to reduce odor problems.

1.10 Rotate fields receiving manure to avoid nutrient buildup and maximize nutrient utilization, as dictated in the nutrient management plan.

1.11 Only spread manure on slopes greater than 5% between the months of June and August.

1.12 Supplement commercial fertilizers only when manure nutrients do not meet crop yield goals.

1.13 Apply manures as close as possible to the time crop utilization of the nutrients in the manure. Utilize fall cover crops to minimize soil erosion and runoff and to maximize nutrient utilization from manure application.

1.14 Avoid surface application of manure on steep slopes, frozen soil or near surface waters.

SEPARATION DISTANCES FROM WATERCOURSES AND WELLS

The Department of Agriculture and Fisheries has developed Manure Management Guidelines that recommend minimum setback distances for spreading manure on agricultural land. The following tables summarize minimum setback distances recommended for use within the manure management

guidelines.

TABLE 5: MINIMUM SEPARATION DISTANCES FOR MANURE APPLICATION

Water Source	Separation Distance (meters)	
	clay loam & loam soils	sand & gravel soils
Dug or Drilled Wells	30	60
Primary Watercourse	10	10
Tributaries to Primary	5	5
Ditches	3	3

TABLE 6: RECOMMENDED SEPARATION DISTANCES FOR SPREADING MANURE ON SLOPED LAND

Slope gradient to watercourse (located within 2 km of water treatment plant intake)	Separation Distance (meters)
< 2 %	20
2 - 5 %	50
5 - 10 %	100
> 10 %	Not Recommended

Farmers operating within a water supply area that has been designated as a Protected Water Area (PWA) under the Environment Act, may have to comply to other specified setback distances outlined within the PWA designation regulations.

Farmers should also be familiar with the Department of Agriculture and Fisheries Guidelines for the Siting and Management of Hog Farms in Nova Scotia, as well as any guidelines or regulations associated

with separation distances required for the storage of animal manures.

For more information:

http://www.gov.ns.ca/agri/rs/envman/pub.shtml

Nova Scotia Department of Agriculture and Fisheries, Guidelines for the Management and Use of Animal Manure in Nova Scotia, Publication No. R-91-2000, 1991.

Nova Scotia Department of Agriculture and Fisheries, Environmental Regulations Handbook for Nova Scotia Agriculture, January 1997.

Nova Scotia Department of Agriculture and Fisheries, The Development of an On-Farm Manure Management Program, March 1996.

Nova Scotia Department of Agriculture and Fisheries, Factsheets on Manure Nutrients, Manure Spreader Calibration, Earthen Manure Storages, and Integrated Fly Management for Livestock Farms.

PASTURING LIVESTOCK

As a measure of due diligence, pasture land must be fenced to prohibit the entry of livestock into adjacent watercourses.

The minimum recommended setback for fencing pastured cattle from a well or watercourse is 5 meters. If livestock are pastured on both sides of the water supply, an approved crossing must be constructed so the livestock can cross without entering and disturbing the watercourse.

MANAGEMENT OF CHEMICAL FERTILIZERS

Farmers operating in areas which drain into municipal drinking water supplies that use surface water should use the following setback distances when applying fertilizer to crops:

< 10 meters from the primary watercourse

< 5 meters (minimum) from a natural watercourse other than the primary watercourse

< 3 meters from a ditch

BUFFER STRIPS

Buffers are strips of land in permanent vegetation, designed to intercept pollutants and manage other environmental concerns. Buffers include: filter strips, grassed waterways, shelterbelts, windbreaks, living snow fences, contour grass strips, cross-wind trap strips, shallow water areas for wildlife, field borders, alley cropping, herbaceous wind barriers, and vegetative barriers. Riparian buffers refer to a buffer strip along a stream.

Strategically placed buffer strips in the agricultural landscape can effectively mitigate the movement of sediment, nutrients, and pesticides within farm fields and from farm fields. When combined with appropriate beneficial management practices, buffer strips should allow farmers to achieve a measure of economic and environmental sustainability in their operations. Buffer strips can also enhance wildlife habitat and protect biodiversity. Buffers slow water runoff, trap sediment, and enhance infiltration within the buffer. Buffers also trap fertilizers, pesticides, pathogens, and heavy metals, and they help trap snow and cut down on blowing soil in areas with strong winds. Buffers help stabilize a stream, create shade and reduce its water temperature. Buffer strips also offer a setback distance for agricultural activities from water sources. If properly installed and maintained, they have the capacity to:

1.1 remove up to 50 percent or more of nutrients and pesticides.

1.2 remove up to 60 percent or more of certain pathogens.

1.3 remove up to 75 percent or more of sediment.

1.4 reduce noise and odor.

MANAGEMENT AND USE OF PEST CONTROL PRODUCTS

All users of pest control products within a municipal drinking water supply area shall hold a valid certificate of qualification as defined in the Pesticide Regulations of the Nova Scotia Environment Act (1995). Farms operating within a Designated Protected Water Area must comply with Section 21 of the Pesticide Regulations of the Nova Scotia Environment Act (1995), which states.

"No person shall apply a pesticide within a protected water area designated under Section 106 of the Act unless the person complies with any regulations regarding the use of pesticides within the protected water area."

In other words, farmers are responsible for finding out if they are conducting their agricultural activities within a Protected Water Area, in addition to, complying with any associated regulations which may apply to their farm activities.

SOIL CONSERVATION AND MANAGEMENT

The following recommended practices for soil conservation and management apply only within those Municipal Drinking Water Supply Areas in which the water supply is derived from surface waters (lake, river, stream, etc.). Farmers are encouraged to use erosion control methods if the following circumstances apply to their operation:

1.1 In any year that annual crops (i.e. corn, small grains, vegetables, etc.) are grown on slopes exceeding 3%.

1.2 Tillage operations or harvesting are conducted that will expose bare soil during mid-October through mid-April.

1.3 Perennial crops which are subject to erosion (i.e. small fruits and tree fruits) are grown.

1.1 Reduce soil compaction by tilling or harvesting when soil is not wet. Studies have shown fields with soil compacted by farm equipment results in greater runoff of nutrients and pesticides.

1.2 Avoid exposing large areas of bare soil during the winter period

1.3 In Nova Scotia, it is recommended that fields with bare soil or less than 50% cover, be mulched with hay or straw if it is too late to provide adequate field cover with cover crop

Appendix IV: Industrial/Commercial Best Management Practice References

Industrial/Commercial Best Management Practices; Nova Scotia Environment online references:

Pollution Prevention Guide for Printers in Atlantic Canada

http://www.gov.ns.ca/nse/pollutionprevention/docs/Printer_PollutionPreventionGuide.pdf

Business Environmental Checklist

http://www.gov.ns.ca/nse/pollutionprevention/docs/biz_checklist_factsheet.pdf

Pollution Prevention Workbook for Business

http://www.gov.ns.ca/nse/pollutionprevention/docs/PollutionPreventionBusinessWorkbook.pdf

Appendix V: Emergency Response Planning

Emergency Response Plan

In general, initial response to emergency situations will be provided by the fire departments, police and ambulance services. The provincial emergency system is set up to facilitate quick response from these agencies. The responding group will be able to assess the nature of the situation and call for additional resources, ranging from the town and local contractors with equipment and materials to construct containment areas, regional EMO managers, environment department personnel, to hazardous materials response units, and environmental consulting firms with knowledge of the proper procedures. These first response groups have been informed of the sensitive nature of the area, and have been given contact information to the resources available.

The Town has provided emergency response procedures related to source water protection in the regional emergency response plan. For additional information related to the protection of the source water during the emergency responses refer to the Regional Emergency Response Plan and the Water Utility Operations Manual. The Operations Manual can be found at the Town Office or the Public Works building.

APPENDIX VI: RESIDENTIAL BEST MANAGEMENT PRACTICE REFERENCES

Residential Best Management Practices; NSE online references:

Installation and Environmental Management Guide for Aboveground Domestic Oil Tanks

http://www.gov.ns.ca/nse/petroleum/docs/OilTankInstall.pdf

Homeowners Guide to Heating Oil Tank Systems

http://www.gov.ns.ca/nse/petroleum/docs/OilTankGuide.pdf

Heating Oil Tank System Checkup

http://www.gov.ns.ca/nse/petroleum/docs/DomesticOilTankChecklist.pdf

Non-essential Pesticide Uses

http://www.gov.ns.ca/nse/pests/docs/Non-Essential-Consumer.Brochure.pdf

Taking Care of Your Home Sewage Disposal System

http://www.gov.ns.ca/nse/wastewater/docs/Homeowners.Guide.to.Septic.Systems.pdf

APPENDIX VII: FOREST MANAGEMENT PLAN

FOREST MANAGEMENT PLAN

INTRODUCTION

The committee recommends that landowners follow a management plan which would provide a mature forest cover on lands in the source water area, providing the benefits of such wooded areas to water protection and conservation. While acknowledging the owner's rights to the property it is suggested that a long term sustainable harvesting plan be used to insure the regeneration of new growth while thinning over mature trees and keeping a healthy land cover.

MANAGEMENT PRINCIPLES

1 Forest related activities should encourage the establishment and growth of long-lived species such as red spruce, white pine, eastern hemlock and red oak.

2 Forested areas should maintain a tree cover of not less than 10' in height and not less than 50% stocking.

3 The forest should be maintained in a healthy, actively growing state.

4 Forestry activities should be conducted to minimize disturbance or pollution to the forest floor and the underlying soil.

SHORT-TERM OPERATING PLAN (5 YEARS)

Operating recommendations are as follows:

Shelterwood Harvesting

The primary objective is to establish the natural regeneration of shade-tolerant species under the existing canopy of mature or over mature stands through a series of partial cuttings.

Selection Harvesting

Selection harvesting will include partial cutting in which the salvaging of over-mature components of stands is the primary objective, whereas the establishment of natural regeneration is the secondary objective.

It must be remembered that the forest is a dynamic entity, continually changing as trees grow and die with the overall structure of the forest evolving through several seral stages. Because the forest is dynamic, it must be continually monitored for changes which have occurred because of significant influences, often unpredictable in nature. The operators of the plan must be committed to acting decisively when the need arises, while staying the course on the plan, its long-term principles and goals, and its short-term objectives.

GUIDELINES FOR FORESTRY ACTIVITIES AND OPERATIONS

NOTE: All guidelines as presented are subject to amendment from time to time by the Source Water Protection Committee.

1. White pine and red oak should only be cut when individual trees are diseased or pose a health threat.
2. Where possible, tolerant tree species such as red spruce, hemlock, white pine and red oak should be selected as crop trees (leave trees) over all other species in harvesting or thinning treatments.
3. Maximum basil area removal should not exceed 50% at any given time.
4. Any equipment proposed for use should be free of leaks.
5. Fuel barrel and jugs, oil containers or other similar containers should not be stored on site other than enough to complete a day's work and then on PVC lined areas.
6. It is recommended that absorbent materials such as peat moss, saw dust, or other material be on hand in case of spillage of fuel, oil, lubricants, antifreeze, or other liquids. All contaminated materials, including contaminated soil, should be immediately removed from the area and properly disposed.
7. Carpet or other absorbent mats will be used at the point of chainsaw refueling to absorb spillage from fuel and oil jugs. The mats should be removed from the site daily and properly disposed of when they become saturated.
8. Adequate fire fighting equipment must be kept on site during fire season. Only fresh water may be used for fire suppression. Flame retardant chemicals may not be used other than as approved commercial fire extinguishers, which must be kept with each piece of equipment

Appendix E

Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia

(Hoffman, Guernsey, Walker, Kim Sherren, Andreou, 2017)

Environ Sci Pollut Res (2017) 24:20685–20698
DOI 10.1007/s11356-017-9719-5

RESEARCH ARTICLE

Pilot study investigating ambient air toxics emissions near a Canadian kraft pulp and paper facility in Pictou County, Nova Scotia

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Received: 15 December 2016 / Accepted: 21 June 2017 / Published online: 15 July 2017

Abstract Air toxics are airborne pollutants known or suspected to cause cancer or other serious health effects, including certain volatile organic compounds (VOCs), prioritized by the US Environmental Protection Agency (EPA). While several EPA-designated air toxics are monitored at a subset of Canadian National Air Pollution Surveillance (NAPS) sites, Canada has no specific "air toxics" control priorities. Although pulp and paper (P&P) mills are major industrial emitters of air pollutants, few studies quantified the spectrum of air quality exposures. Moreover, most NAPS monitoring sites are in urban centers; in contrast, rural NAPS sites are sparse with few exposure risk records. The objective of this pilot study was to investigate prioritized air toxic ambient VOC concentrations using NAPS hourly emissions data from a rural Pictou, Nova Scotia Kraft P&P town to document concentration levels, and to determine whether these concentrations correlated with wind direction at the NAPS site (located southwest of the mill). Publicly accessible Environment and Climate Change Canada data (VOC concentrations [Granton NAPS ID: 31201] and local meteorological conditions [Caribou Point]) were examined using temporal (2006–2013) and spatial analytic methods. Results revealed several VOCs (1,3-butadiene, benzene, and carbon tetrachloride) routinely exceeded EPA air toxics-associated cancer risk thresholds. 1,3-Butadiene and tetrachloroethylene were significantly higher ($p < 0.05$) when prevailing wind direction blew from the northeast and the mill towards the NAPS site. Conversely, when prevailing winds originated from the southwest towards the mill, higher median VOC air toxics concentrations at the NAPS site, except carbon tetrachloride, were not observed. Despite study limitations, this is one of few investigations documenting elevated concentrations of certain VOCs air toxics to be associated with P&P emissions in a community. Findings support the need for more research on the extent to which air toxics emissions exist in P&P towns and contribute to poor health in nearby communities.

Keywords Air toxics · Air quality · Volatile organic compounds (VOCs) · Community health · Pulp and paper · Cancer risk

Responsible editor: Constantini Samara

Electronic supplementary material The online version of this article (doi:10.1007/s11356-017-9719-5) contains supplementary material, which is available to authorized users.

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Introduction

Poor ambient air quality is an increasing global concern with recent revelations that 92% of the world's population is exposed to air pollution levels above the World Health Organization (WHO) air quality guidelines (WHO 2006, 2016; Kelly and Fussell 2015). Ambient air pollution is widely recognized and increasingly associated with a wide range of acute and chronic adverse health effects, including cancer, cardiovascular, respiratory, and mortality outcomes (IOM 2011; Villeneuve et al. 2013; ECCC 2015a). The pathological mechanisms by which these toxic exposures exert their effects are not well understood. WHO highlights the need for research in order to better inform exposure-response relationships (WHO 2016).

Most air pollution surveillance activities are limited to measurement of respirable fine particulate matter ≤2.5 μm ($PM_{2.5}$), without regard to their specific chemical composition and criterion air contaminant (CAC) gases (i.e., nitrogen oxides [NO_x] and ground-level ozone [O_3]). There is growing concern about the toxicity of volatile organic compounds (VOCs) (Cicolella 2008) and the consequences of long-term, low-dose exposure to these agents. VOCs are varied and widespread air pollutants (e.g., hydrocarbons, aromatics, and some chlorinated compounds) that are increasingly recognized as important precursors to $PM_{2.5}$ and ground-level O_3 formation through photochemical reactions (Ryerson et al. 2001). Atmospheric deposition of VOCs may contaminate other environmental media (e.g., soils, sediments, and biota) (ATSDR 2014a; MacAskill et al. 2016). Many VOCs are included in the US Environmental Protection Agency (EPA) "air toxics" list. "Air toxics" are defined as "those pollutants that cause or may cause cancer or other serious health effects [...] or adverse environmental and ecological effects" (EPA 2015a).

According to the Canadian Environmental Protection Act 1999 (CEPA), VOC releases are acknowledged as a health concern, but, due to their highly volatile properties, are challenging to monitor and manage (CCME 2011). Although no specific Canadian legislative or regulatory tools address ambient VOC levels, emissions are indirectly controlled through regulatory mitigation of $PM_{2.5}$ and ground-level O_3 under the Canadian Ambient Air Quality Standards (CAAQS). Under CEPA, it is mandatory for owners or facility operators, who meet reporting requirements, to self-report pollutant releases to air, water, and land to Environment and Climate Change Canada (ECCC)'s National Pollutant Release Inventory (NPRI) (ECCC 2014). While this provides a disincentive to those industries releasing these agents, there is less regulatory control or routine monitoring of these agents in Canada which, in turn, limits scientific understanding of sources, exposures, and the effectiveness of current control measures across the country.

Ambient air monitoring in the US is conducted in accordance with the *Clean Air Act* (CAA) (Clean Air Act 1970). CAA amendments identify 187 air toxics, which form the basis for EPA's approach to regulating emissions (EPA 2015a). Of these, EPA identified 30 air toxics that pose the greatest potential health threat in urban areas (EPA 2015b). Although many CEPA-toxic or equivalent agents are monitored by the National Air Pollution Surveillance (NAPS) network, it includes a selection (not all) of EPA's list of prioritized air toxics, and the main criteria for air toxics monitoring in Canada has been their potential contribution to ambient PM and ground-level O_3 (Galarneau et al. 2016). Consequently, there are gaps in understanding of air toxics concentrations across the NAPS network. Using the risk-based principles outlined in CAA, EPA developed the National Air Toxics Assessment (NATA), a comprehensive evaluation tool that prioritizes efforts to regulate emissions of air toxics (EPA 2015c). Such a rigorous initiative has yet to be implemented in Canada, where no federal guidelines exist for ambient air toxics.

Despite economic benefits of the P&P industry, it generates large quantities of atmospheric and effluent emissions, resulting in environmental degradation (Hewitt et al. 2006; Hoffman et al. 2015; Hoffman et al. 2017). P&P mill emissions vary depending on the pulping method, wood species, and by the age and technology used (Soskolne and Sieswerda 2010). P&P mills are industrial emitters of air toxics, although few investigations (e.g., the Nez Perce National Air Toxics Program, funded by EPA [STI 2009]) have characterized ambient concentrations in nearby communities.

Potential adverse health effects associated with exposure to air pollutants in the vicinity and downwind from P&P facilities include respiratory disease, neurophysical symptoms, and higher risks of contracting lung cancer (Soto et al. 1991; Toren et al. 1996; Mirabelli and Wing 2006). Yet, few investigations reported adverse health effects from chronic community-level ambient exposures to P&P mills emissions in Canada (Mirabelli and Wing 2006; Soskolne and Sieswerda 2010). While there have been a number of occupational epidemiological studies of P&P workers, these investigations have not been extended to examine community exposures, due to research design challenges including ecological fallacy (i.e., inferences made about individuals deduced from the population) in community studies (Soskolne and Sieswerda 2010). Additionally, most of these studies focused on respiratory disease outcomes; there is a dearth of epidemiological studies of cardiovascular effects or cancer effects in these communities.

Decades-long concerns for perceived higher incidence and mortality rates for all-cause cancer, cardiovascular disease, chronic respiratory disease, and diabetes (Reid 1989; PCHA 2008; Statistics Canada 2013) in PC, Nova Scotia, have generated considerable community antipathy among residents towards a local P&P mill (Hoffman et al. 2015). This bleached kraft P&P mill ("the mill") is located approximately 3 km south of the town of Pictou (population 3500) and produces approximately 280,000 t of bleached kraft pulp annually from softwood and hardwood chips (NP 2016b) (Fig. 1) and has been in production since 1967 (Ogden 1972). Public backlash gained momentum during 2014 due to the failure of the recovery boiler electrostatic precipitator (i.e., particulate filtration device).

Environmental reporting by the mill, when compared against provincial and federal regulatory compliance standards, contrasted to local perceptions of impacts. Most environmental monitoring reports indicated some

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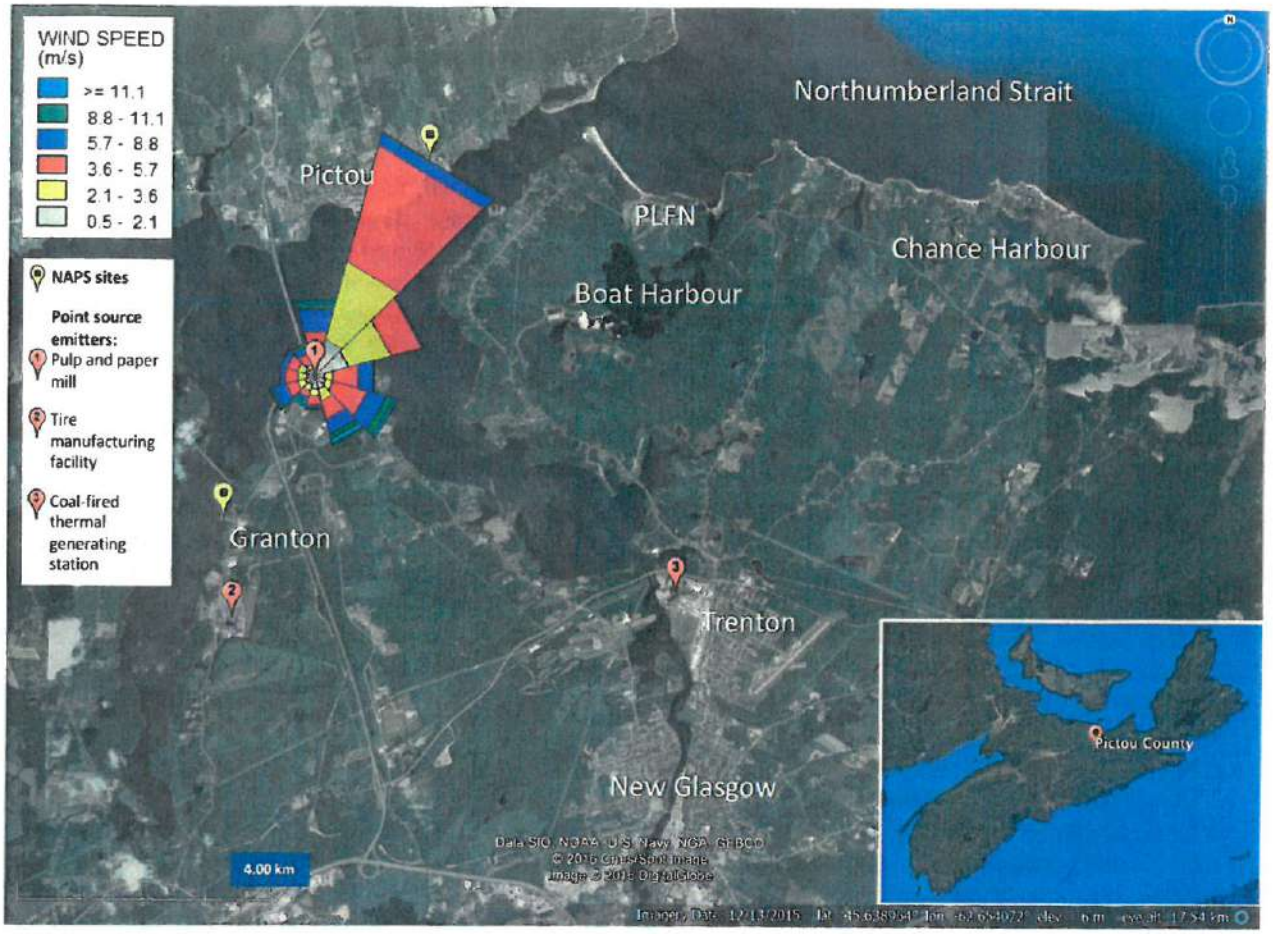

Fig. 1 Summer (2006–2013) wind rose simulation using WRPlot View™ (blowing to direction) with the mill as the focal point (*1*), relative to communities (e.g., Pictou and Pictou Landing First Nation [PLFN]), NAPS discrete receptor sites, and other local point source emitters (e.g., tire manufacturing facility (*2*), coal-fired thermal electrical generating station (*3*)). The length of each radial spoke represents the relative frequency of wind direction (©Google Earth)

level of compliance in atmospheric emissions, but when compliance targets were exceeded, there were inconsistent regulatory enforcement (Hoffman et al. 2015). The mill is required to report emissions to NPRI: conduct third-party stack testing, continuous emission monitoring of total reduced sulfur (TRS), and ambient air monitoring for pollutants found in the Nova Scotia Air Quality Regulations pursuant to the *Environment Act* (NSE 2015). The mill's air emission monitoring data are reviewed by provincial and federal regulators to ensure compliance with applicable environmental permits and air quality objectives (ECCC 2014). Hoffman et al. (2015) provided detailed information on new and existing environmental policies that impose pollution abatement in the P&P industry in Canada, particularly the PC mill (e.g., 2015 Industrial Approval).

These are critical research gaps both in relation to community exposures to VOCs in P&P communities and in regard to adverse health effects resulting from chronic exposure to P&P emissions which are a concern given the potential adverse health outcomes that VOCs and other P&P air emissions pose. This further justifies the need for more research to characterize air quality in this particular subset of industrial communities, which have often been neglected because of their remote locations.

An intensive study of specific ambient air toxic emissions in PC has not been undertaken. The aim of this pilot study was to assess levels of PC community exposures to VOC air toxics emissions from 2006 to 2013, and to evaluate these data in relation to potential risks suggested by EPA air toxic guidelines. The main objective of this study was to determine whether wind direction correlated with prioritized air toxic ambient VOC concentrations at a nearby NAPS site (Granton). As the Granton NAPS site is positioned southwest of the mill, it was hypothesized that prevailing winds (PW) from northerly and northeasterly directions would

positively correlate with an increase in ambient VOC concentrations, as capturing potential VOCs from the mill's plume would be optimized (Fig. 1).

Materials and methods

Spatial and temporal sampling

Historical meteorological and NAPS data from the Granton NAPS site discrete receptor (ID: 31201) were collected from publically assessable ECCC databases (http://climate.weather.gc.ca/climateData/; http://maps-cartes.ec.gc.ca/rnspa-naps/). Hourly surface wind observations (i.e., speed and direction to the nearest 10°) were obtained from the closest EC meteorological station, Caribou Point (45.767° N; 62.683° W), located ~10 km north of the mill (45.652° N; 62.718° W). Temporal data for ambient VOCs monitored at the Granton NAPS station were limited to 2006 to 2013.

Nova Scotia Environment (NSE) operates both NAPS monitoring stations in PC: (i) downtown Pictou (ID: 30901) located 3.5 km northeast of the mill and (ii) Granton (ID: 31201) located 2.5 km southwest of the mill (Fig. 1). The Pictou NAPS site routinely monitors NO, NO_2, NO_x, O_3, $PM_{2.5}$, TRS (not VOCs), and wind characteristics, whereas the Granton site monitors 36 VOC species. Multi-component VOC monitoring at NAPS sites are conducted using canister sampling and gas chromatography/mass spectrometry (GC/MS) (CCME 2011). Sampling of 24 h (midnight to midnight) cumulative ambient air samples ($\mu g/m^3$) are taken on a 1-in-6-day schedule by pumping ambient air into pressurized stainless steel SUMMA® canisters and analyzed by an EC accredited Laboratory (CCME 2011; Galarneau et al. 2016).

Statistical analyses

Variation of meteorological conditions and VOC concentrations were assessed by conducting a spatiotemporal analysis to characterize ambient air toxics emissions in PC from 2006 to 2013. Various analytical methods can be applied to concentration data to estimate source apportionments of air pollutants to provide additional insights into the source/receptor relationships to guide development of more effective air quality management strategies (Hopke 2016). However, given the limitations of having complete VOC data from only one NAPS monitoring station in the region, a full chemical mass balance analysis to identify and apportion sources of atmospheric contaminants were not conducted in this study.

Wind rose plots were generated with WRPlot View™ (©Lakes Environmental Software) to simulate seasonal and spatial variation of wind direction (°) frequency and wind speed (m/s) with the mill as the focal point. Although simplified, wind rose models have proven utility for estimating spatial gradients for fate and transport of pollutants from emission sources (Gibson et al. 2013). Summer, when local people spend more time outdoors (and more vulnerable to outdoor pollution exposure), was a focus of this study (Figs. 1 and 2).

This pilot study was conducted to determine whether ambient concentrations of VOCs exceeded their EPA-associated cancer and/or noncancer risk thresholds, to help identify potential human health concerns in PC. VOCs selected for analysis were based on EPA's list of 30 urban air toxics (EPA 2015b) and *National Air Toxics Trends Station Work Plan Template* (EPA 2015d). Health Canada and the province of Nova Scotia currently do not have specific guidelines for air toxics exposures. Therefore, EPA thresholds were considered a more acceptable standard for carcinogenic exposures in this study. Cancer risk threshold refers to the probability of contracting cancer if exposed to a substance every day over the course of a lifetime (assumed to be 70 years for the purposes of NATA risk characterization). Lower threshold values correspond with higher toxicity. Noncancer risk threshold is associated with effects other than cancer, based on reference concentrations via the "hazard quotient" ratio (HQ; exposure divided by appropriate chronic or acute value) (EPA 2015c). The HQ should not be interpreted as a probability of adverse effects. Noncancer risk thresholds are typically higher compared to cancer risk thresholds, as lower concentrations can elicit a carcinogenic response, whereas other diseases are not triggered until higher exposure thresholds are reached. US and Canadian method detection limits (MDL) are provided (Health Canada 2010; EPA 2015d) (Table 1).

The mill is located approximately 40° northeast of the Granton NAPS site. The selected PW range expected to result in increased VOC concentrations at the NAPS site (±40° either side of the mill [80° total]). A narrower range may be more accurate; however, due to the sample size of VOC samples, the selected range captured more data. All other wind directions (AOWD) represent ranges outside PW (i.e., >80°, <360°). AOWD represent sampling days when no time PW blew from the selected range (i.e., 0 h). VOC concentrations for AOWD were compared to when PW were present for at least 1 h.

Hourly meteorological data were compiled to correspond with ambient VOC sampling. Hourly wind direction within defined PW range (i.e., 360°–80°) was assigned a value of 1; AOWD were assigned a value of 0. Daily totals represented the proportion of time with PW (i.e., 1–24 h) compared to AOWD. Daily

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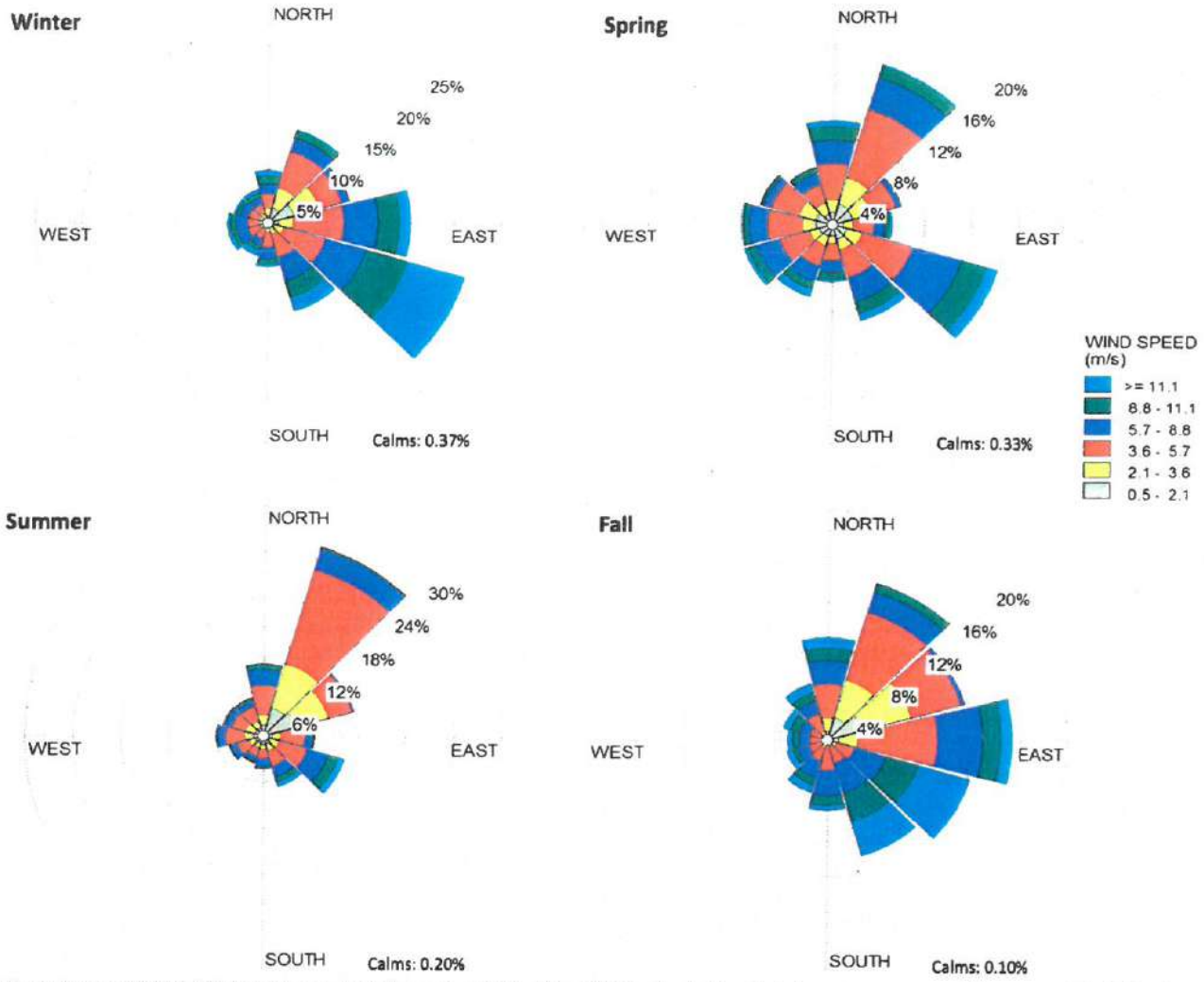

Fig. 2 Seasonal (2006–2013) wind rose simulations using WRPlot View™ (blowing to direction). Percentages represent frequency of wind direction

totals corresponding to VOC sampling were paired. Increasing proportions of PW (AOWD [0 h], ≥1 h, ≥4 h, ≥8 h, ≥12 h) categorized VOC concentrations, which were predicted to correlate with higher VOC concentrations. To test the effect of wind direction and season on ambient VOC concentrations, multivariate analysis of variance (MANOVA) and univariate analysis of variance (ANOVA) were applied in ©R. Due to right-skewed distributions for all VOCs, except for carbon tetrachloride, statistical procedures were performed on both raw and log-transformation of VOC concentrations (Supplementary material Table S1).

Box plots and histograms were used to compare VOC concentrations with PW ≥ 1 h to AOWD on an annual and seasonal basis in relation to their respective cancer and noncancer risk thresholds. See Supplementary material for histograms, and additional box-and-whisker plots illustrating VOC concentrations with increasing time categories with PW (AOWD [0 h], ≥1 h, ≥4 h, ≥8 h, ≥12 h) (Figs. S2 and S4). Box plots display the distribution of data based on a five-number summary: minimum, first quartile, median, third quartile, and maximum. The central rectangle ("box") spans the first to the third quartile (i.e., interquartile range [IQR]). The horizontal line segment within the box represents the median, and "whiskers" above and below the box represent the minimum and maximum. Radar plots consist of a sequence of angular spokes, whose length extending from the center along a separate axis is proportional to the magnitude of the variable relative to the magnitude of the variable across all data points. Lines connect the data values for each spoke. Radar plots were used to display seasonal variation of median VOC concentrations for PW ≥ 1 h and AOWD. One-tailed *t* tests, assuming unequal variance, were performed to determine whether seasonal variation associated with increasing proportions of time

Table 1 List of priority air toxics (i.e., VOCs), associated cancer/noncancer risk thresholds (μg/m^3), and method detection limits (MDL) (μg/m^3) (Health Canada 2010; EPA 2015d)

VOC	Cancer risk[a] (μg/m^3)	Noncancer risk at HQ = 0.1[b] (μg/m^3)	MDL[c] (NATS) (μg/m^3)	MDL (Health Canada) (μg/m^3)
Chloroform	–	9.8	0.50	0.089
1,3-Butadiene	0.0300	0.2	0.10	0.055
Vinyl chloride	0.1100	10.0	0.11	0.046
Benzene	0.1300	3.0	0.13	0.038
Carbon tetrachloride	0.1700	19.0	0.17	0.123
Trichloroethylene	0.2083	0.2	0.20	0.190
Tetrachloroethylene	3.8462	4.0	0.17	0.120

[a] Cancer risk threshold: the probability of contracting cancer over the course of a lifetime (assumed to be 70 years for the purposes of NATA risk characterization). Lower threshold values correspond with higher toxicity (EPA 2015c)

[b] Noncancer risk threshold: the risk associated with effects other than cancer, based on the reference concentration via a ratio known as the "hazard quotient" (HQ; the exposure divided by the appropriate chronic or acute value)

[c] MDL: the lowest concentration that can be detected with confidence. NATA and Health Canada's MDLs are listed for comparison (Health Canada 2010; EPA 2015d)

with PW (i.e., ≥1 h, ≥4 h, ≥8 h, ≥12 h) resulted in a significant increase ($p < 0.05$) in VOC concentrations compared to AOWD (see Supplementary material, Table S3).

Quality control

Standard procedures of the Meteorological Service of Canada have been developed in accordance with internationally recommended procedures established by the World Meteorological Organization (ECCC 2013a). As part of the quality assurance and quality control (QA/QC) program, observational meteorological data are subjected to a computer analysis or review to reveal possible errors. EC and the operating agency are jointly responsible for the NAPS network QA/QC program. Elements of the program include site selection, sampling system requirements, instrument calibration and reference standard requirements, and inter-laboratory testing and performance audits. With few exceptions, analyzers are accorded with EPA designation as either a reference or equivalent method for ambient air monitoring (ECCC 2004). ECCC's air quality laboratories use International Organization for Standardization requirements (i.e., ISO 9001:2008 or ISO/IEC 17025:2005) (ECCC 2013b).

Results and discussion

Meteorological observations

Wind rose simulations illustrate seasonal variability with respect to wind direction, with the mill as the focal point (Fig. 2). During summer, wind blew NNE (25.47%) and ENE (11.80%) directions (aggregate range 15°–75°) towards Pictou and Pictou Landing First Nation (PLFN) (Figs. 1 and 2). Wind blew less frequently towards S-NNW (aggregate range 165°–345°) towards the Graton NAPS site. During winter, wind typically prevailed from the north; the highest frequency (21.99%) blowing ESE, followed by E (15.37%) directions (aggregate range 75°–135°) (Fig. 1). Spring and fall have meteorological characteristics that are similar to summer and winter and were considered transitional periods. Pictou, PLFN, Chance Harbour, Trenton and New Glasgow are communities close to the mill that are downwind of annual PW (range 15°–165°). The Granton NAPS site correlates poorly with seasonal or annual wind directions (Fig. 2).

VOC concentrations

Carbon tetrachloride had the highest median concentration (0.5452 μg/m^3) and vinyl chloride had the lowest (0.0014 μg/m^3) (Fig. 3). Carbon tetrachloride concentrations exceeded its EPA cancer risk threshold (0.1700 μg/m^3) for all samples, with maximum and minimum concentrations of 0.7047 and 0.2892 μg/m^3, respectively. Benzene concentrations exceeded its cancer risk threshold (0.1300 μg/m^3) for most samples, with maximum and minimum concentrations of 1.889 and 0.0266 μg/m^3, respectively. Concentrations of 1,3-butadiene concentrations occasionally exceeded its cancer risk threshold (0.0300 μg/m^3), with maximum and minimum concentrations of 0.1062 and 0 μg/m^3, respectively (Fig. 3). Consequently, 1,3-butadiene, benzene, and carbon tetrachloride were air toxics of primary concern in terms of local

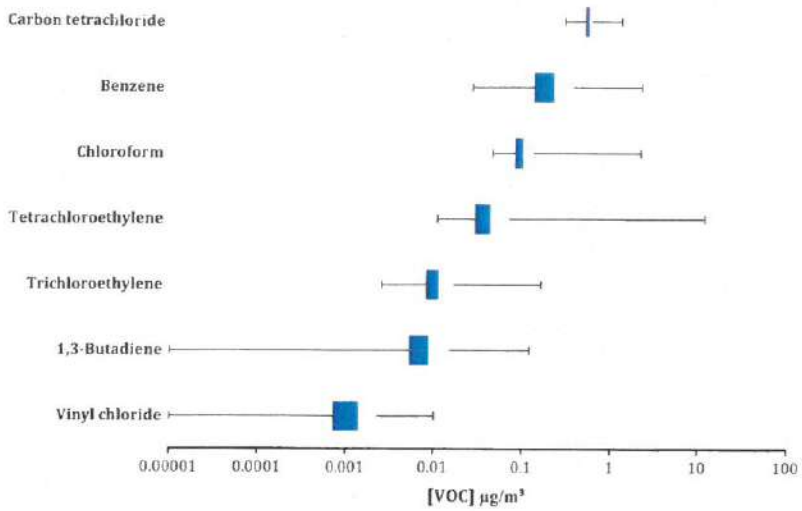

Fig. 3 Relative VOC concentrations (µg/m³) (2006–2013). Should not be interpreted as orders of magnitude of toxicity. Minimum concentration for 1,3-butadiene and vinyl chloride is 0 µg/m³ or undetectable

population risk. Other VOCs are presented in Supplementary material (Fig. S5).

ANOVA and MANOVA results revealed that 1,3-butadiene was significantly higher with the presence of PW ≥ 1 h (p = 0.001and p = 0.01 for raw and log-transformed data, respectively). Tetrachloroethylene was also statistically higher with the presence of PW ≥ 1 h (p < 0.01) for log-transformed data. Benzene approached significance with the presence of PW ≥ 1 h (p = 0.07) for log-transformed data. Although not statistically significant, median concentrations of other VOCs, except carbon tetrachloride, were equal or marginally higher with presence of PW ≥ 1 h compared to AOWD. Season had a consistent significant effect on VOC concentrations, except chloroform and tetrachloroethylene (Supplementary material Fig. S2 and Table S1).

Box plots combined with radar graphs illustrate seasonal variation of VOC concentrations of primary concern (i.e., 1,3-butadiene, benzene, carbon tetrachloride) under PW ≥ 1 h and AOWD conditions (Figs. 4, 5, and 6). Median VOC concentrations associated with PW ≥ 1 h and AOWD display parallel

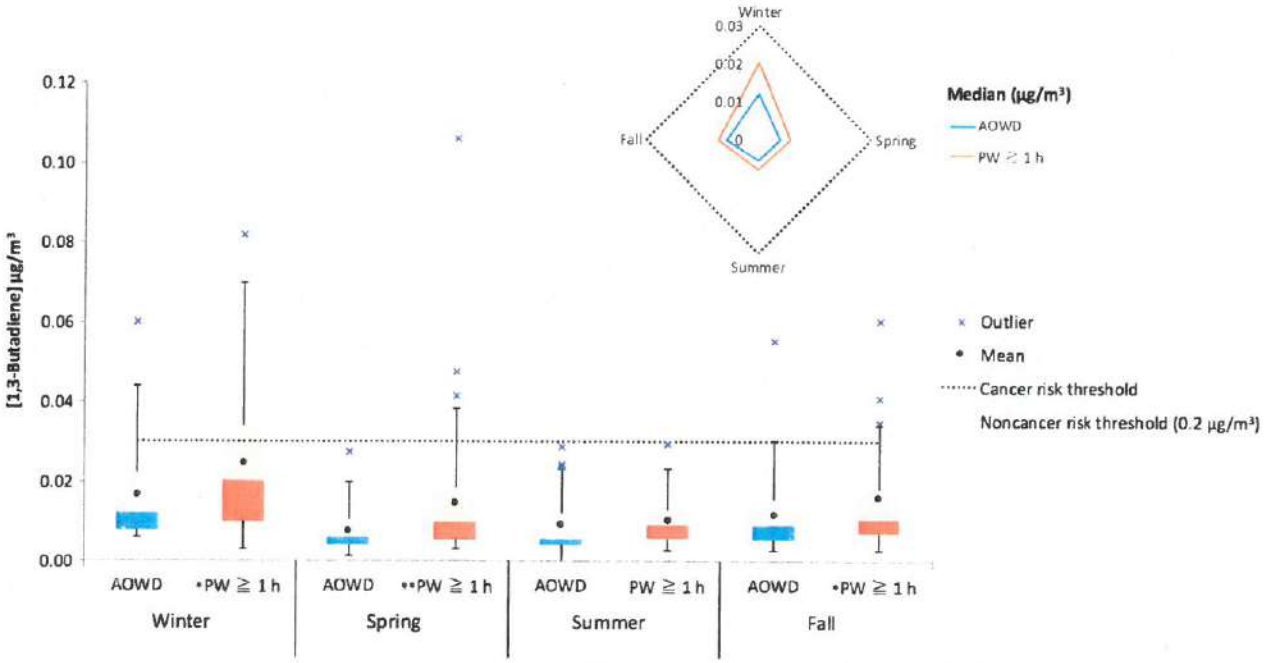

Fig. 4 Seasonal variation (2006–2013) of [1,3-butadiene] (µg/m³) comparing AOWD to PW for at least 1 h on sampling days (i.e., 360° – 80°), relative to associated cancer and noncancer risk thresholds. Minimum concentration is 0 µg/m³ or undetectable. Significant differences indicated as *<0.05; **<0.01

seasonal trends. Concentrations of 1,3-butadiene (Fig. 4) and benzene (Fig. 5) exhibit seasonal variation. Both have evidently higher concentrations during winter, with summer having overall lowest concentrations. In addition to exceeding cancer risk thresholds, *t* test results revealed that 1,3-butadiene and benzene concentrations were significantly higher with the presence of PW ≥ 1 h compared to AOWD during at least two seasons, including spring and fall. Conversely, median carbon tetrachloride concentrations showed little variation (Fig. 6). Regardless of season or wind direction, all carbon tetrachloride samples exceeded its associated cancer risk.

This pilot study presents findings of a secondary analysis of 8 years of air toxic VOC exposure data associated with ambient air quality in a Canadian P&P town. Concentrations of three ambient outdoor air toxics routinely exceeded EPA air toxics-associated cancer risk thresholds and are consequently of primary health concern in relation to population health risk in PC: 1,3-butadiene, benzene, and carbon tetrachloride. Exceedance in cancer risk thresholds for these air toxics is consistent in the literature (e.g., Morello-Frosch et al. 2000). The extent to which threshold exceedances of 1,3-butadiene adversely affect human health is poorly understood, with little toxicity information available to compare with cancer risk estimates (Morello-Frosch et al. 2000). With respect to benzene exposure, most monitoring data are associated with occupational studies (ATSDR 2007a), where long-term exposure can cause leukemia (ATSDR 2007b). High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage (ATSDR 2005). Combinations of air toxics may have additive or synergistic adverse health effects (Morello-Frosch et al. 2000). Therefore, exposure to mixed VOCs might pose health risks to facility employees and neighboring residents (An et al. 2014; He et al. 2015).

Emission sources within the defined PW range, N to ENE of the Granton NAPS site, may be a causal factor for the increase in VOC concentrations, except carbon tetrachloride. The largest point source emitter within this range is likely the mill; however, the origin(s) of VOCs are inconclusive. According to the mill's most recent substance report submitted to NPRI in 2012, 143.18 t of VOCs were atmospherically emitted on-site (ECCC 2012). An estimated 3.195 t of benzene were released to the air from a stack higher than 50 m and 0.022 t were released within 50 m of the ground. Additionally, benzo(a)anthracene and of benzo(a)phenanthrene were emitted to the air (9.7 and 6.7 kg, respectively) and deposited on-site (0.753 and 0.142 kg, respectively) (ECCC 2012). Although trichloroethylene, tetrachloroethylene, and carbon tetrachloride were not reported to have been released, they may become airborne through evaporation from P&P wastewater (Soskolne and Sieswerda 2010). Boat Harbour (the mill's effluent treatment facility) may therefore contribute to ambient concentrations of VOCs. Collectively, these emissions may have contributed to the ambient atmospheric levels of VOCs measured at the Granton NAPS site. While

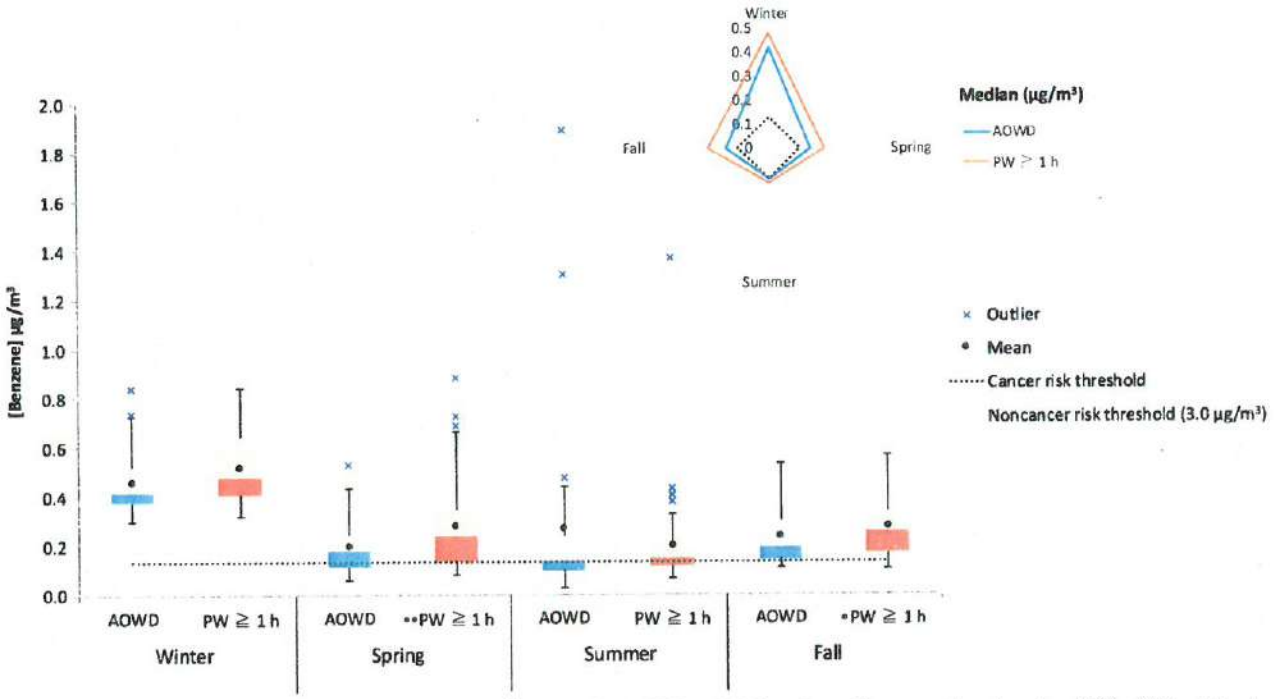

Fig. 5 Seasonal variation (2006–2013) of [benzene] (µg/m³) comparing AOWD to PW for at least 1 h on sampling days (i.e., 360° − 80°), relative to associated cancer and noncancer risk thresholds. Significant differences indicated as *<0.05; **<0.01

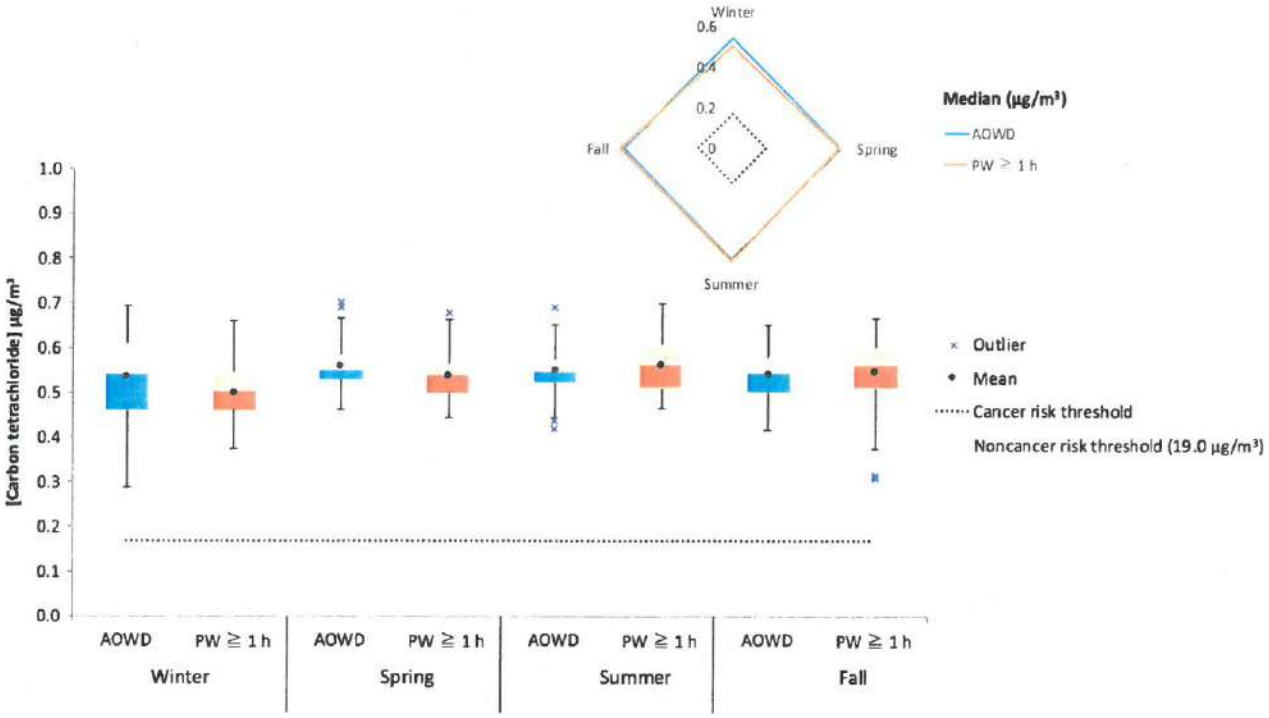

Fig. 6 Seasonal variation (2006–2013) of [carbon tetrachloride] (µg/m^3) comparing AOWD to PW for at least 1 h on sampling days (i.e., 360° – 80°), relative to associated cancer and noncancer risk thresholds

NPRI provides detailed information on pollutant releases, data are self-reported by facilities, with no audits to ensure accuracy. Consequently, data quality may be compromised.

The major chlorinated hydrocarbon emitted into the air from bleached kraft pulp mills of concern is chloroform, which is produced by heating a mixture of chlorine and either chloromethane or methane (EPA 1985). Although chloroform is a recognized by-product of the chlorination process in the P&P industry, it has been suggested that up to 90% of total emission sources may be natural in origin and is widely dispersed in marine environments (McCulloch 2003). As PC is located along the coast of the Northumberland Strait, marine environments may have contributed to the observed ambient chloroform concentrations (see Supplementary material).

Results implicate the mill as a source of air toxics (particularly 1,3-butatdiene and tetrachloroethylene); however, other local sources likely contribute to air toxics emissions. Area and mobile sources have been reported to largely contribute to concentrations of 1,3-butadiene (ATSDR 2014b) and benzene (ATSDR 2007a). Because the Granton NAPS site is located near a highway and access roads, vehicle emissions may have contributed to the observed concentrations of these compounds. A coal-fired thermal generating station and a tire manufacturing facility (located 7 km E and 1.5 km S from the Granton NAPS site, respectively) may be other local point source emitters of VOCs (e.g., 1,3-butadiene is used to make synthetic rubber [ATSDR 2014b]) (Fig. 1). According to the latest NPRI substance reports: the tire manufacturing facility released 220 t of atmospheric VOCs, whereas no VOC releases were reported by the thermal generating station (ECCC 2015b), despite that coal combustion is a significant contributor (Chagger et al. 1999). Direct links between 1,3-butdiene and vinyl chloride with P&P industries were not found in the literature.

Major monitored pollutants at the mill include NO_x, sulfur dioxide (SO_2), and total PM ([TPM] upper size limit of 100 µm diameter) (NP 2016a). A 2013 study concluded that $PM_{2.5}$ concentrations were highest (0.88 µg/m^3) downwind from the mill from using an AERMOD atmospheric dispersion model (Gibson et al. 2013), though this investigation used Halifax wind speed and direction meteorological data (130 km to the south). Hoffman et al. (2015) reported an analysis of 2013 data showing that when Pictou is downwind of the mill, average 1 h ambient $PM_{2.5}$ concentrations result in a twofold increase (12.96 µg/m^3), compared to all other wind directions (5.73 µg/m^3), suggesting the mill is likely the primary contributor of ambient $PM_{2.5}$ in the community. Additionally, TRS, TPM, $PM_{2.5}$, and coarse particulate matter ≤10 µm (PM_{10}) emission exceedances at the mill during 2012 were two to three

orders of magnitude higher than five similar Canadian kraft P&P mills; however, VOC emissions were comparable (Hoffman et al. 2015).

A comparable ambient air toxics monitoring study of a P&P community was conducted in the metropolitan Lewiston, Idaho area and the Nez Perce Reservation (STI 2009). Findings revealed that concentrations of formaldehyde and acetaldehyde were much higher than expected relative to Lewiston's size. Chloroform, tetrachloroethylene, and trichloroethylene were highest at monitoring sites nearest the mill, which presumably contributed at least 50% to pollutant concentrations (STI 2009). However, due to insufficient information on local concentrations of anthropogenic and biogenic VOCs, it was inconclusive whether the mill was a causal factor.

Recent (2009–2013) measurements of ambient CEPA-toxic or equivalent agents monitored at NAPS sites revealed that 11 air toxics, including benzene, chloroform, trichloroethylene, and tetrachloroethylene exceeded ambient air quality guidelines set by respective Canadian jurisdictions (Galarneau et al. 2016). An additional 16 air toxics approached guidelines. Although these guidelines are not necessarily enforceable, CEPA outlines provisions for toxic compounds and are thus subject to risk management actions. Air toxics' contribution to poor health on a regional and national scale has not been thoroughly investigated; therefore, calls into question the effectiveness of current toxic substance management in Canada.

Nova Scotia is known as the "tail pipe of North America," due to being within the trajectory of long-range transport of emissions from transboundary sources along the Eastern Seaboard, plus central and eastern Canada (NSE 2014). Background levels of air pollution that originate from resuspension and natural sources has been found to be major contributors to concentrations of carbon tetrachloride and benzene (Morello-Frosch et al. 2000). Background levels, in combination to carbon tetrachloride's capacity to persist in the atmosphere for a least a year, may explain why observed concentrations are consistently above its associated cancer risk threshold at the Granton NAPS site, regardless of wind direction.

Atmosphere circulation plays a complex role in dispersion, transformation, and removal of pollutants. The dispersion of pollutants from source emitters (e.g., smokestacks) is affected by crosswind mixing in both horizontal and vertical directions. Meteorological variables, including wind speed, wind direction, temperature, humidity, precipitation (process of removal), and atmospheric pressure are the main drivers of variation in pollutant concentrations and dispersion (Bates and Caton 2002). Furthermore, gravitational settling is important for pollutants with larger molecular weights (Oliver 2008); heavier particles settle or deposit closer to emission sources (Walker et al. 2003a, 2003b). Gravitational settling may also explain the high concentrations of carbon tetrachloride.

Topography and coastal conditions can affect wind characteristics (e.g., direction, speed) and the behavior of pollutant transport. A sea breeze that is trapped under descending warmer air from land can exaggerate conditions at coastal zones, a phenomenon known as coastal inversion (Bates and Caton 2002). In addition, turbulent winds along the coast may influence wind characteristics at the Caribou Point meteorological station, and the fate and transport of pollutants. Such coastal conditions, in combination with transboundary air pollution, may be occurrences that coastal areas experience in Nova Scotia, including PC.

Seasonal variability

Seasonal variability exists for both meteorological conditions and VOC concentrations. Variations in meteorological conditions, the nature and intensity of emissions from nearby sources, and photochemical activity are factors that could have led to the observed seasonal variability of outdoor VOC levels (Al-Khulaifi et al. 2014). Of the three VOCs considered particular concern in this study, 1,3-butdaiene and benzene exhibited the highest concentrations during winter. Photochemical reactions involved with ground-level O_3 formation are catalyzed by ultraviolet radiation and temperature. Therefore, peak ground-level O_3 levels typically occur during warm days with sufficient sunlight exposure; thus, people are more vulnerable to exposure during summer. The opposite is true during winter, when available light is diminished, and temperatures are colder (ATSDR 2014b).

Demographic behavior and technological improvements that aim to mitigate emissions (e.g., smokestack precipitator installation in 2015) also need to be considered when evaluating pollutant concentrations. For instance, households in the Atlantic provinces are heated primarily with oil, electricity, and wood or wood pellets (Statistics Canada 2011); therefore, as residential heating increases during winter, biogenic VOCs (e.g., benzene [ATSDR 2007a], 1,3-butadiene [ATSDR 2014b]) from wood burning may have contributed to higher concentrations of these compounds observed in this study. As the mill operates on a 24/7 schedule (ECCC 2012), atmospheric VOC emissions were assumed consistent throughout the year.

Implications

Location of ambient air quality monitoring stations has a direct impact on the observed concentrations of pollutants

(Craig et al. 2008). Based on the time series and spatial analyses, wind direction appears to play a key role in the Granton NAPS site's ability to monitor ambient VOCs from the mill. PW ≥ 1 h from the selected range (360°–80°) typically resulted in equal or higher VOC concentrations for all compounds, except carbon tetrachloride, compared to AOWD (Figs. 4, 5, and 6; Supplementary material), suggesting that the mill is likely a causal factor. Furthermore, as there is a higher frequency of northerly winds blowing towards the south during winter (Fig. 2), the Granton NAPS site is more likely to capture ambient pollutants from the mill's atmospheric emissions. Southwest PW blowing towards Pictou dominate during the summer months when people are more vulnerable to ambient air pollution exposure. Due to Pictou's geography, air toxics from the Eastern Seaboard in combination with local emission sources, including the mill, converge there; hence, higher concentrations of VOCs are expected in Pictou during summer. Subsequently, southwest PW are expected to result in lower VOC concentrations at the Granton NAPS site, as capturing the mill's atmospheric emissions would not be optimized. Therefore, VOC concentrations at the Granton NAPS site during winter would likely be representative of ambient VOC concentrations in Pictou during summer. Moreover, Pictou's considerably larger population base compared to the rural area of Granton further confirms that the NAPS site is not strategically positioned to accurately represent ambient levels of air toxics where there is higher residential exposure.

Study limitations

This study only evaluated exposure to ambient VOC air pollutants. Human exposure to air pollution is a combination of both outdoor and indoor environments and varies according to daily activity patterns and the conditions of specific settings. Secondary data analysis was used in this study; therefore, the ecological nature of these findings limit the explicit attribution of ambient air toxic exposures to the risk potential for cancer for community residents. Personal exposure monitoring, more detailed spatial analysis of ambient conditions, and source apportionment studies would be required to establish more explicitly the health risk associated with these exposures. The analysis was limited by the inability to examine the interaction of local meteorological conditions. Meteorological data were retrieved from Caribou Point, located approximately 10 km from the mill; consequently, coastal conditions may cause differences in meteorological measurements between sites.

Future research and monitoring

A *field component* consisting of real-time measurements of ambient air toxics would improve the rigor and validly of the present study. Although labor intensive, air toxics samples can be analyzed with a high degree of accuracy (Craig et al. 2008). Because monitoring stations are typically fixed, government-approved *atmospheric dispersion modeling* that considers landscape dynamics and seasonal meteorological variability (e.g., ©CALPUFF, ©AERMOD) would more accurately estimate spatial patterns of air toxics dispersion, and human exposure at the population or individual level (EPA 2013). This would require numerous stations within the community so would likely only be feasible for a specific research investigation. Further, installation of a new precipitator in 2015 has likely changed in ambient conditions. A follow-up assessment would provide a comparison to these findings to determine if VOC levels have improved. Additional research includes applying a *Conditional Probability Function* to calculate the probability that an air pollution source is located within a particular wind direction sector to help determine direction of a source from a NAPS discrete receptor site, and conducting an analysis of the effect of mixing height on measured VOC concentrations to further investigate seasonal patterns.

Investigation of health outcomes might involve longitudinal epidemiological research of human exposures to air toxics emissions in the ambient Pictou environment with appropriate consideration for latency of health outcomes, while controlling for indoor and occupational sources and other contextual factors. Several recent Canadian nationwide cohort studies that may provide a foundation for such investigations have been described (e.g., Crouse et al. 2012).

A *comprehensive risk assessment* investigates uncertainties that have implications for risk estimates in the present study, including those surrounding toxicity information (Morello-Frosch et al. 2000). More research is required to determine what cancer and noncancer risks are from ambient air toxics exposure. Further, it is important to consider synergistic effects of a full suite of ambient pollutants, and physical and chemical processes involved in fate and transport of these compounds. Comprehensive emission inventories are necessary to thoroughly address (i.e., characterize, model, and manage) air quality issues (CEC 2009). Collectively, these research efforts aim to better inform air quality management, composed of federal (e.g., ECCC, Health Canada) and provincial (e.g., NSE, Nova Scotia Department of Health and Wellness) government and public health agencies, how best to proceed to ensure the health of residents in industrial communities is prioritized. Implications of the current findings warrant further investigation.

Given the contribution emissions from local sources have to regional, national, and global airsheds, local mitigation initiatives should be an integral part of air quality strategies. There is no common approach to assess health effects of a mixture of pollutants, as they tend to be site specific; hence, an assortment of effective measures may be required. Case studies that provide evidence of effective of air quality

management interventions and guidance documents for risk managers may help inform air quality management for stakeholders (Craig et al. 2008).

To address potential adverse health effects associated with degraded air quality, Health Canada, the Public Health Agency of Canada (PHAC) and provincial partners might work collaboratively with local stakeholders to mitigate health risks and improve efficient industrial technology, while balancing economic, political, and social factors in development and implementation of air quality management. Mitigating industrial emissions has beneficial outcomes for wellbeing (Clougherty 2010); environmental stewardship and governance fosters a more proactive and cleaner environment, while building trusting relationships between industrial stakeholders (Pascal et al. 2013). "A comprehensive enforcement program with mandatory reporting of emissions, [...] and meaningful penalties for noncompliance ensures that emission standards are being met" (Craig et al. 2008), and facility operators are held accountable. Data collected internally by the mill is not readily available. To improve transparency, siting rationale for air quality monitoring stations and accompanying data should be provided as part of a commitment to corporate responsibility of the mill (Hoffman et al. 2015).

To improve air quality conditions, stakeholders could increase the capacity for surveillance, assessment, and response to air quality. Furthermore, evaluation of a wide-suite of air toxics, including NATA compounds not measured by the NAPS network (particularly prioritized air toxics) would contribute to ensuring that air quality in Canada is adequately studied. Therefore, ECCC and NSE should consider implementation of a long-term monitoring program for priority air toxics that is comparable to the NATA network monitored by EPA to characterize air toxics exposure on local, regional, and national scales. Data will be useful to help mitigate emissions and achieve acceptable air quality standards that do not exceed cancer or noncancer risk thresholds.

ECCC should also consider the feasibility of installing and maintaining additional strategically placed NAPS sites to improve air pollution evaluation in both rural and urban areas, as well as in microenvironments (e.g., near point source emitters, high-traffic areas) (Craig et al. 2008). More effective communication of the results is required to increase transparency among stakeholders, including the public (Hoffman et al. 2015). Based on the population's risk of exposure, it is strongly recommended that ambient air toxics monitoring to be incorporated at the established NAPS station in Pictou to optimize capturing of said air toxics, and to best correlate pertinent results. Additionally, atmospheric dispersion modeling should use local meteorological data; therefore, meteorological data should also be collected concurrently at NAPS sites to help identify source emitters.

Measurement of individual VOC compounds is necessary to provide insight into their contribution to $PM_{2.5}$ and ground-level O_3 formation. Data would be useful to help target large source emitters and aid regulatory enforcement. Establishment of stringent and/or adapted air quality standards that encompass more air toxics (e.g., VOCs) fosters strong public support and political engagement to address air quality issues. Moreover, health impacts associated with background air pollution should be estimated. Air quality management programs are human resource intensive; therefore, they must have clear and feasible short- and long-term objectives. These initiatives gain predictive insights on atmospheric chemistry, and engage and support relevant sectors in the development and implementation of policies to reduce health risks associated with air pollution exposure (Craig et al. 2008).

Conclusions

Findings reveal that 1,3-butadiene, benzene, and carbon tetrachloride exceeded their respective cancer risk thresholds and are of primary health concern in terms of population risk. Results highlight associations with wind direction and the Granton NAPS site's ambient VOC concentrations in relation to location of the pulp mill. Compared to AOWD, PW from the selected range (360°–80°) typically resulted in higher VOC concentrations for all compounds, except carbon tetrachloride, suggesting that the mill is likely a contributor to increased concentrations. In addition, there are clear seasonal variations of meteorological conditions and VOC concentrations. Southwest PW blowing towards Pictou dominate during summer months, when people spend more time outdoors, and consequently are exposed to higher concentrations. Due to Pictou's geography, air toxics from transboundary and local sources may converge in summer, resulting in higher VOC concentrations. Findings suggest the Granton NAPS site is not positioned to accurately represent ambient levels of toxicity in PC. Therefore, ECCC and NSE should consider incorporating ambient air toxics (e.g., VOCs) monitoring at the established Pictou NAPS site where there is higher residential exposure.

Future research will provide air quality management with a comprehensive characterization of air toxics to support informed public health decisions. Moreover, this pilot study may serve as a precursor to gaining awareness, so that government agencies adopt more stringent air quality regulations and monitoring programs to ensure health of citizens is safeguarded and prioritized.

References

Agency for Toxic Substances and Disease Registry (ATSDR) (2005) Toxicological profile for carbon tetrachloride. http://www.atsdr.cdc.gov/. Accessed 15 Nov 2015

Al-Khulaifi NM, Al-Mudhaf HF, Alenezi R, Abu-Shady ASI, Selim MI (2014) Seasonal and temporal variations in volatile organic compounds in indoor and outdoor air in Al-Jahra City, Kuwait. J Environ Prot 5:310–326

An T, Huang Y, Li G, He Z, Chen J, Zhang C (2014) Pollution profiles and health risk assessment of VOCs emitted during e-waste dismantling processes associated with different dismantling methods. Environ Int 73:186–194

ATSDR (2007a) Toxicological profile for benzene. http://www.atsdr.cdc.gov/. Accessed 15 Nov 2015

ATSDR (2007b) Public health statement for benzene. http://www.atsdr.cdc.gov/. Accessed 15 Nov 2015

ATSDR (2014a) Public health statement. http://www.atsdr.cdc.gov/. Accessed 15 Nov 2015

ATSDR (2014b) Draft toxicological profile for 1,3-butadiene. http://www.atsdr.cdc.gov/. Accessed 15 Nov 2015

Bates DV, Caton RB (eds) (2002) A citizen's guide to air pollution. David Suzuki Foundation, Vancouver

Canadian Council of Ministers of the Environment (CCME) (2011) Ambient air monitoring protocol for PM2.5 and ozone: Canada-wide standards for particulate matter and ozone. http://www.ccme.ca/files/Resources/. Accessed 22 Oct 2015

Canadian Environmental Protection Act (1999) SC 1999, c 33. http://www.canlii.ca/. Accessed 5 Oct 2015

Chagger HK, Jones JM, Pourkashanian M, Williams A, Owen A, Fynes G (1999) Emission of volatile organic compounds from coal combustion. Fuel 78:1527–1538

Cicolella A (2008) Volatile organic compounds (VOC): definition, classification and properties. Rev Mal Respir 25:155–163

Clean Air Act (1970) Clean Air Act, SS 1986-87-88, c C-12.1. http://www.canlii.org. Accessed 5 Oct 2015

Clougherty JE (2010) A growing role for gender analysis in air pollution epidemiology. Environ Health Perspect 118:167–176

Commission for Environmental Cooperation (CEC) (2009) Comprehensive Assessment of North American Air Emissions Inventories and Ambient Air Monitoring Networks. http://www3.cec.org/. Accessed 30 Oct 2015

Craig L, Brook JR, Chiotti Q, Croes B, Gower S, Hedley A et al (2008) Air pollution and public health: a guidance document for risk managers. J Toxicol Environ Health A 71:588–698

Crouse DL, Peters PA, van Donkelaar A, Goldberg MS, Villeneuve PJ, Brion O et al (2012) Risk of non-accidental and cardiovascular mortality in relation to long-term exposure to low concentrations of fine particulate matter: a Canadian national-level cohort study. Environ Health Perspect 120:708–714

ECCC (2012) Facility & substance information. http://www.ec.gc.ca/. Accessed 29 March 2015

ECCC (2013a) Manual of surface weather observations. http://www.ec.gc.ca/. Accessed 16 June 2016

ECCC (2013b) Quality management systems http://www.ec.gc.ca/. Accessed 16 June 2016

ECCC (2014) National pollutant release inventory. http://www.ec.gc.ca/. Accessed 22 Feb 16

ECCC (2015a) Air and radiation. http://www3.epa.gov/air/. Accessed 18 Oct 2015

ECCC (2015b) Facility & substance information. http://www.ec.gc.ca/. Accessed 8 Sept 2016

Environment and Climate Change Canada (ECCC) (2004) National Air Pollution Surveillance network quality assurance and quality control guidelines. http://www.ec.gc.ca/. Accessed 16 June 2016

EPA (2013) A synthesis of completed community-scale air toxics ambient monitoring projects. http://www3.epa.gov/. Accessed 11 Nov 2015

EPA (2015a) About air toxics. http://www3.epa.gov/. Accessed 18 Oct 2015

EPA (2015b) Urban air toxic pollutants. http://www3.epa.gov/. Accessed 21 Sept 2015

EPA (2015c) National air toxics assessments. http://www3.epa.gov/. Accessed 21 Sept 2015

EPA (2015d) National air toxics trends station work plan template. http://www3.epa.gov/. Accessed 16 Oct 2015

Galarneau E, Wang D, Dabek-Zlotorzynska E, Siu M, Celo V, Tardif M et al (2016) Air toxics in Canada measured by the National Air Pollution Surveillance (NAPS) program and their relation to ambient air quality guidelines. J Air Waste Manage Assoc 66:184–200

Gibson MD, Kundu S, Satish M (2013) Dispersion model evaluation of $PM_{2.5}$, NO_x and SO_2 from point and major line sources in Nova Scotia, Canada using AERMOD Gaussian plume air dispersion model. Atmos Pollut Res 4:157–167

He Z, Li G, Chen J, Huang Y, An T, Zhang C (2015) Pollution characteristics and health risk assessment of volatile organic compounds emitted from different plastic solid waste recycling workshops. Environ Int 77:85–94

Health Canada (2010) Windsor exposure assessment study (2005–2006): data summary for volatile organic compound sampling. http://publications.gc.ca/. Accessed 10 Nov 2015

Hewitt ML, Parrott JL, McMaster ME (2006) A decade of research on the environmental impacts of pulp and paper mill effluents in Canada: sources and characteristics of bio-active substances. J Toxicol Environ Health B Crit Rev 9:341–356

Hoffman E, Bernier M, Blotnicky B, Golden PG, Janes J, Kader A et al (2015) Assessment of public perception and environmental compliance at a pulp and paper facility: a Canadian case study. Environ Monit Assess 187:766

Hoffman E, Lyons J, Boxall J, Robertson C, Lake CB, Walker TR (2017) Spatiotemporal assessment (quarter century) of pulp mill metal(loid) contaminated sediment to inform remediation decisions. Environ Monit Assess 189:257. doi:10.1007/s10661-017-5952-0

Hopke PK (2016) Review of receptor modeling methods for source apportionment. J Air Waste Manag Assoc 66:237–259

Institute of Medicine (IOM) (2011) Long-term health consequences of exposure to burn pits in Iraq and Afghanistan. http://iom.nationalacademies.org/. Accessed 1 March 2016

Kelly FJ, Fussell JC (2015) Air pollution and public health: emerging hazards and improved understanding of risk. Environ Geochem Health 37:631–649

MacAskill ND, Walker TR, Oakes K, Walsh M (2016) Forensic assessment of polycyclic aromatic hydrocarbons at the former Sydney Tar Ponds and surrounding environment using fingerprint techniques. Environ Pollut 212:166–177

McCulloch A (2003) Chloroform in the environment: occurrence, sources, sinks and effects. Chemosphere 50:1291–1308

Mirabelli MC, Wing S (2006) Proximity to pulp and paper mills and wheezing symptoms among adolescents in North Carolina. Environ Res 102:96–100

Morello-Frosch RA, Woodruff TJ, Axelrad DA, Caldwell JC (2000) Air toxics and health risks in California: the public health implications of outdoor concentrations. Risk Anal 20:273–292

Northern Pulp Nova Scotia Corporation (NP) (2016a) Environment. http://www.northernpulp.ca/. Accessed 3 April 2016

Nova Scotia Department of Environment (NSE) (2014) Air Quality Health Index (AQHI). http://novascotia.ca/nse/. Accessed 27 Nov 27 2015

NP (2016b) Our company http://www.northernpulp.ca/. Accessed 3 April 2016

NSE (2015) 2015 industrial approval for NP Nova Scotia. Province of Nova Scotia Environment Act, S.N.S. 1994–95, c.1

Ogden JG III (1972) Oxygen demand of effluent from a bleached kraft pulp mill. Water Air Soil Pollut 1:365–374

Oliver JE (ed) (2008) Encyclopedia of world climatology. Springer, Dordrecht

Pascal M, Pascal L, Bidondo ML, Cochet A, Sarter H, Stempfelet M, Wagner V (2013) A review of the epidemiological methods used to investigate the health impacts of air pollution around major industrial areas. J Environ Public Health 2013:1–17

Pictou County Health Authority (PCHA) (2008) Health status profile. http://www.pcha.nshealth.ca/. Accessed 15 Nov 2015

Reid DS (1989) Pictonians, pulp mill and pulmonary diseases. Nova Scotia Med J 68:146–148

Ryerson TB, Trainer M, Holloway JS, Parrish DD, Huey LG, Sueper DT et al (2001) Observations of ozone formation in power plant plumes and implications for ozone control strategies. Science 292:719–723

Sonoma Technology, Inc (STI) (2009) Lewiston area air toxics data analysis. http://wwwnezperceorg/ Accessed 1 Nov 2105

Soskolne CL, Sieswerda LE (2010) Cancer risk associated with pulp and paper mills: a review of occupational and community epidemiology. Chronic Dis Can 29:86–100

Soto AM, Justicia H, Wray JW, Sonnenschein C (1991) p-Nonyl-phenol: an estrogenic xenobiotic released from "modified" polystyrene. Environ Health Perspect 92:167–173

Statistics Canada (2011) Households and the environment: energy use. http://www.statcan.gc.ca/. Accessed 8 Sept 2016

Statistics Canada (2013) Health profile 2013. http://www.statcan.gc.ca/. Accessed 12 Nov 2015

Toren K, Persson B, Wingren G (1996) Health effects of working in pulp and paper mills: malignant diseases. Am J Ind Med 29:123–130

U.S. Environmental Protection Agency (EPA) (1985) Survey of chloroform emission sources. http://www3.epa.gov/. Accessed 15 Oct 2015

Villeneuve PJ, Jerrett M, Su J, Burnett RT, Chen H, Brook J et al (2013) A cohort study of intra-urban variations in volatile organic compounds and mortality, Toronto, Canada. Environ Pollut 183:30–39

Walker TR, Crittenden PD, Young SD (2003a) Regional variation in the chemical composition of winter snow pack and terricolous lichens in relation to sources of acid emissions in the USA river basin, north-east European Russia. Environ Pollut 125:401–412

Walker TR, Young SD, Crittenden PD, Zhang H (2003b) Anthropogenic metal enrichment of snow and soil in north-eastern European Russia. Environ Pollut 121:11–21

WHO (2016) Ambient air pollution: a global assessment of exposure and burden of disease. http://www.who.int/. Accessed 29 Sept 2016

World Health Organization (WHO) (2006) WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: global update 2005. http://www.who.int/. Accessed 1 March 2016

Appendix F

Correspondence on the Matter of the Effluent Treatment Facility Proposal(s).

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December 20, 2017

The Honourable Iain Rankin
Nova Scotia Environment
PO Box 442
Halifax, NS B3J 2P8

Via Email: minister.environment@novascotia.ca

Dear Minister Rankin;

I am writing on behalf of the Town of Pictou to inform you of a motion passed by Council at its Regular meeting on December 18, 2017.

The motion was passed following presentations made to Council by the **Northumberland Fisherman's Association** and **Friends of the Northumberland** expressing their concerns regarding the plan for effluent treatment at the Northern Pulp, Paper Excellence Facility located at Abercrombie Point in Nova Scotia. More specifically, both groups are against the dispersion of the effluent via pipe, into the Northumberland Strait.

We believe that the motion as passed speaks to the expectations of Pictou Town Council that all aspects of the effluent treatment plan are thoroughly examined by both provincial and federal departments prior to making a decision regarding its construction.

Motion: **It is moved that a letter be written to the Nova Scotia Environment Minister, and the Federal Ministers of the Environment and Climate Change and Fisheries and Oceans, requesting a review of the environmental assessment process being employed to assess the Northern Pulp proposal for effluent treatment. This request supports the completion of an Environmental Assessment Report and the possibility of a Class 2 environmental assessment to insure that the best possible solution for effluent treatment, disposal and monitoring is used and the fishing industry on the Northumberland Strait is not placed at risk.**

town of pictou
Birthplace of New Scotland

Thank you for your attention to this important issue.

Sincerely,

James J. Ryan
Mayor

Cc: Hon. Dominic LeBlanc, Federal Minister of Fisheries and Oceans
Hon. Catherine McKenna, Federal Minister of the Environment and Climate Change
Karla MacFarlane, MLA, Pictou West
Pat Dunn, MLA, Pictou Centre
Tim Houston, MLA, Pictou East

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December 20, 2017

COPY

The Honourable Catherine McKenna, P.C., M.P.
Minister of Environment and Climate Change Canada
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3

Via Email: ec.ministre-minister.ec@canada.ca

Dear Minister McKenna;

I am writing on behalf of the Town of Pictou to inform you of a motion passed by Council at its Regular meeting on December 18, 2017.

The motion was passed following presentations made to Council by the **Northumberland Fisherman's Association** and **Friends of the Northumberland** expressing their concerns regarding the plan for effluent treatment at the Northern Pulp, Paper Excellence Facility located at Abercrombie Point in Nova Scotia. More specifically, both groups are against the dispersion of the effluent via pipe, into the Northumberland Strait.

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Thank you for your attention to this important issue.

Yours sincerely,

James J. Ryan

Cc: *Hon. Dominic LeBlanc, Federal Minister of Fisheries and Oceans*
Hon. Iain Rankin, NS Minister of the Environment
Karla MacFarlane, MLA, Pictou West
Pat Dunn, MLA, Pictou Centre
Tim Houston, MLA, Pictou East

Canadian Environmental Assessment Agency
Agence canadienne d'évaluation environnementale

1801 Hollis Street, Suite 200
Halifax, Nova Scotia
B3J 3N4

1801, rue Hollis, bureau 200
Halifax (Nouvelle-Écosse)
B3J 3N4

March 27, 2018

COPY

James J. Ryan
40 Water Street
PO Box 640
Pictou, NS
B0K1H0
Jim.ryan@townofpictou.ca

Dear Mr. Ryan,

Thank you for your email dated December 18, 2017, expressing concern regarding the Northern Pulp Effluent Treatment Facility Replacement Project proposed by Northern Pulp Nova Scotia Corporation.

The Canadian Environmental Assessment Agency recently received a request for the Minister of Environment and Climate Change Canada to designate the Project for a federal environmental assessment under section 14 of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). The Agency is currently assessing the applicability of CEAA 2012 to this Project and is seeking input from other government departments and Indigenous groups on whether the Project should be designated under CEAA 2012. The Agency will reflect the input received in its advice to the Minister.

Further questions regarding the Project and this analysis can be directed to Ms. Melanie Smith, Team Leader, at (902) 426-6623 or by email at Melanie.Smith@ceaa-acee.gc.ca.

Yours Sincerely,

M. J. A.

Mike Atkinson
Regional Director
Atlantic Region

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October 24, 2018.

Mr. Bruce Chapman
General Manager
Northern Pulp Nova Scotia Corporation
260 Granton Abercrombie Branch Road
Abercrombie, NS B2H 5C6

Mr. Chapman;

I have become aware, through media reports, that the draft of a revised proposal by Northern Pulp for the disposal of treated effluent involves the installation of a pipe along TCH 106 to the Caribou Harbour. I am very disappointed that the Town was not consulted, or at least, informed of this potential proposal prior to its release to the media.

Assuming the media reports to be factual, the proposed route for the pipe will not only pass through the Town of Pictou, but will pass directly over the Caribou wellfield which is a major source of domestic drinking water for residents of the Town of Pictou and many residents of Central Caribou.

In light of recent events, I believe the proposed pipeline route will, and should, cause a great deal of concern for all residents of the Town and surrounding area.

As the owners of the Water Utility, the Town of Pictou holds water withdrawal approvals issued by the Nova Scotia Department of Environment for both the Caribou and Pictou wellfields along with the approval to operate a water treatment and distribution system.

In 2002, NSE introduced its Drinking Water Strategy to ensure safe, clean drinking water to its customers. As part of this strategy and the approval process, the town has fulfilled its responsibility to:

1) Form a Source Water Protection Advisory Committee
2) Delineate a Source Water Protection Area Boundary
3) Identify Potential Contaminants and Assess Risk
4) Develop a Source Water Protection Management Plan; and
5) Develop a Monitoring Program to Evaluate the Effectiveness of a Plan.

town of PICTOU
Birthplace of New Scotland

The Caribou/Pictou Source Water Protection Advisory Committee includes representation from both the Town of Pictou and the Municipality of Pictou County. It takes the responsibility to protect our source water for current and future generations very seriously and will continue to do so.

In conclusion, I am requesting that any future consideration of proposals that could have implications for the Town and its residents be communicated directly as part of your due diligence.

Sincerely,

James Ryan

c.c. *Hon. Margaret Miller, NS Minister of Environment*
Karla MacFarlane, MLA, Pictou West
Robert Parker, Warden, Municipality of Pictou County

NORTHERN PULP
NOVA SCOTIA CORPORATION
A PAPER EXCELLENCE COMPANY

October 26, 2018

His Worship James Ryan
Town of Pictou
40 Water Street
Pictou, NB B0K 1H0

Dear Mayor Ryan:

Thank you for your letter of October 24th and for the opportunity to speak with you that same day regarding the additional proposed route for an effluent pipeline.

Northern Pulp's effluent treatment facility (ETF) replacement project is a major undertaking. With work being carried out simultaneously on many files, timely communication with all stakeholders can be challenging. Unfortunately, due to unexpected circumstances, the past few days did not unfold as planned. Once again, please accept my apologies for not contacting you earlier.

Work on the Environmental Assessment (EA) submission documents for the ETF replacement project is still in progress. An important part of finalizing those documents is a feasibility study of the additional proposed pipeline route. Please understand that discovery on this additional proposed route is in its very early stages – there is much work yet to be done.

Northern Pulp acknowledges the Town of Pictou's responsibilities and interests in this matter. As part of our due diligence we will continue to engage and consult with all stakeholders, and look forward to those discussions, as we prepare to register for an EA.

I would welcome your call at any time throughout this process.

Sincerely,

Bruce Chapman
General Manager

Copy to: The Honourable Margaret Miller, Nova Scotia Minister of Environment
Karla MacFarlane, MLA, Pictou West
Robert Parker, Warden, Municipality of Pictou County

Northern Pulp Nova Scotia Corporation, a Paper Excellence Company
P.O. Box 549, Station Main, New Glasgow, NS B2H 5E8
260 Granton Abercrombie Branch Road, Abercrombie, NS B2H 5C6
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November 2, 2018.

Mr. Bruce Chapman
General Manager
Northern Pulp Nova Scotia Corporation
260 Granton Abercrombie Branch Road
Abercrombie, NS B2H 5C6

Via Email: Bruce.Chapman@northernpulp.com

Mr. Chapman;

Thank you for your prompt response to my letter of October 24th.

I appreciate that you are in the 'very early stages' of a feasibility study of proposed route(s) for an effluent pipe as part of the effluent treatment process.

Following consultation with Town Councillors, I believe it is a good time to inform you that any plans to install the pipe across the Town of Pictou watershed would be unacceptable.

As a stakeholder in the recently proposed plan, we look forward to future communications.

Sincerely,

James Ryan

c.c. *Hon. Margaret Miller, NS Minister of Environment*
Karla MacFarlane, MLA, Pictou West
Robert Parker, Warden, Municipality of Pictou County

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Ms. Melanie Smith, Team Leader
Canadian Environmental Assessment Agency
1801 Hollis St., Suite 200
Halifax, NS B3J 3N4

February 24, 2019.

Re: Northern Pulp Effluent Treatment Facility
Environmental Assessment

In November 2017, the Town of Pictou passed a resolution calling for letters to be written to the Nova Scotia Minister of Environment, the Federal Minister of Environment and Climate Change and the Minister of Fisheries and Oceans supporting 'the completion of an Environmental Assessment Report and the possibility of a Class 2 Environmental Assessment' and that the 'fishing industry on the Northumberland Strait is not placed at risk'. It is my understanding, from the correspondence I received from Mr. Mike Atkinson dated March 27, 2018, that the information (letter) to the Hon. Catherine McKenna was forwarded to CEAA for consideration. This is greatly appreciated.

Since that letter was written in 2017, a great deal has transpired with respect to the proposed Northern Pulp Treatment Facility including a modified plan for effluent disposal and consideration of a possible review of the project by CEAA.

At this time, I feel it to be prudent, as Mayor of the Town of Pictou, to elaborate on our original position and comment on additional concerns regarding the modified plan.

We, the Town, remain firm in our position that Federal oversight of this project would provide the most comprehensive assessment of 'risk' to the Northumberland Strait fishery. Due to the financial and regulatory relationship between the mill and the Province, and the potential effects of the project on a lucrative and sensitive marine environment shared by multiple provinces, trust can only be restored with a full Environmental Assessment.

In addition to our originally stated concerns, the modified proposed route for the pipe carrying treated effluent will pass directly over the Caribou/Pictou Watershed. As you can imagine, in light of recent breaks in the current system feeding the Boat Harbour Effluent Treatment Facility (ETF), this causes concern for residents of our Town. Recognizing that water is a Provincially regulated resource the contents of the treated effluent and the security of the transmission system must be adequately addressed within the scientific studies to ensure safety of our water supply.

town of PICTOU
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The Town also has concerns about any potential for increased odour produced by the re-location of the AST (Activated Sludge Treatment) process and risks associated with the emissions from the power boiler when the sludge is burned. We do not have in-house expertise to adequately assess potential effects and how they might affect air quality (safety), but believe the EA Proposal submitted by Northern Pulp may not fully address these concerns.

Thank you for your consideration of this matter.

Sincerely,

James Ryan, Mayor

c.c. *Hon. Catherine Miller, Min. of Environment, Province of Nova Scotia*
Dan Troke, CAO, Town of Pictou

Attachments: *Letter to Hon. Catherine McKenna -December 20, 2017*
Letter from Mike Atkinson, CEAA – March 27, 2018