BOMONT
WATERSHED AREA

SOURCE WATER
PROTECTION PLAN

May, 2017

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List of Abbreviations

BMP	Best Management Practice
C&D	Construction and Demolition
CBCL	CBCL Limited – Consulting Engineers
CCME	Canadian Council of the Ministers of Environment
CMHC	Canada Mortgage and Housing Corporation
CN	Canadian National Railway Company
CWQG	Water Quality Guidelines for the Protection of Aquatic Life
CZ	Control Zone
ERP	Emergency Response Plan for Halifax Water
GCDWQ	Guidelines for Canadian Drinking Water Quality
GFULM	Generalized Future Land Use Map
HIA	Halifax International Airport
HIAA	Halifax International Airport Authority
HRWC	Halifax Regional Water Commission
HRM	Halifax Regional Municipality
LUB	Land Use By-law
MAC	Maximum Acceptable Concentrations
MLD	Million Litres per Day
MPS	Municipal Planning Strategy
MSDS	Materials Safety Data Sheet
NGO	Non-government Organization
NSDNR/DNR	Department of Natural Resources
NSE	Nova Scotia Environment
NSPI	Nova Scotia Power Inc.
NSTIR	Nova Scotia Department of Transportation and Infrastructure Renewal
PA	Protected Area
PCBs	Polychlorinated biphenyls
PWA	Protected Watershed Area (provincially designated)
PWS	Protected Water Supply (HRM municipal by-law zone)
RAZ	Risk Area Zones
RCMP	Royal Canadian Mounted Police
RMPS	Regional Municipal Planning Strategy
SWPP	Source Water Protection Plan
SWQMP	Source Water Quality Monitoring Program
ToR	Terms of Reference
WSP	Water Supply Plant
WUI	Wildland Urban Interface
WWTF	Wastewater Treatment Facility

Executive Summary

This Source Water Protection Plan (SWPP) describes the BoMont watershed area and outlines the management of the source water area, the risk assessment, the management plan and the monitoring program. Delineating the BoMont watershed area boundary lays the foundation for source water protection planning for this area.

This SWPP's risk assessment indicates that the BoMont watershed area is capable of providing a long-term water supply to the BoMont water supply system; however not without interruption during high flow conditions due to operable limitations of the current water supply plant. Further, to maintain an uninterrupted source of water quality for drinking water purposes: an effective water treatment process needs to be implemented; the inherent risks that are identified in this SWPP must be effectively managed to reduce the impacts to water quality; and a comprehensive source water quality monitoring program (SWQMP) must be sustained.

Baseline monitoring indicates that water quality from the Nine Mile River watershed area heavily influences the type of water quality entering the BoMont Water Supply Plant (WSP) from the Shubenacadie River. The naturally erosive soil conditions of the Nine Mile River watershed area are exacerbated by the types of anthropogenic activities supported by this area; namely forestry, aggregate extraction, and agriculture operations. Under normal conditions the Shubenacadie River provides adequate water quality to the BoMont WSP; however during high water periods, i.e., spring freshet and heavy rainfall events (>20mm in 24hr period) the treatability of the water supply is limited by the treatment plant process. During these times bulk water is delivered to the WSP in order for Halifax Water to fulfill its commitments to its customers. **It is strongly recommended that Halifax Water continue to monitor source water quality parameters to provide data that will guide watershed protection and/or treatment process decision-making; and assess and evaluate the program to ensure water quality needs are being met.**

Halifax Water has set management objectives for implementing this SWPP including: best management practices; public communication, education and awareness programs; fostering stakeholder collaboration and cooperation; regulation and land-use by-law adherence; public roads and highway maintenance collaboration; emergency measures; and source water quality monitoring and evaluation. Monitoring consists of maintaining a presence by way of patrolling, encouraging public reporting of activities considered a threat to water quality or suspicious activities, conducting raw water sampling, and liaising with various governing agencies and stakeholders to ensure a clean and safe drinking water supply.

1 Introduction

Halifax Water is responsible for monitoring and managing all activities that may impact water quality and quantity on eleven (including BoMont) distinct source water supplies. The BoMont water supply serves 17 customers in the BoMont subdivision, east of Elmsdale.

The primary objective of this Source Water Protection Plan (SWPP) is to comply with Nova Scotia Environment requirements and to meet the needs of Halifax Water's customers. The primary focus of this SWPP is water quality.

This document serves as the SWPP for the BoMont watershed area. The SWPP describes the watershed area and outlines the current management of the source water area, the risk assessment, the management plan and the monitoring program.

2 Description of the BoMont Watershed Area

This chapter describes the history, land form, watershed profile, and how the water supply area is managed through provincial, municipal and stakeholder governance structures.

2.1 History of BoMont Water Supply System

BoMont is one of Halifax Water's six (6) small systems; the treatment plant and intake are located at 317 Old Trunk Road, Elmsdale, near Lantz. Raw water is piped into the BoMont water supply plant (WSP) through an intake pipe lying mid-channel on the bottom of the Shubenacadie River.

The following describes the history of the BoMont water supply system.

2.1.1 Pre Halifax Water Ownership

The BoMont subdivision was developed in the mid-1970s and sourced its water from the Shubenacadie River. That system consisted of basic filtration with chlorination and was serviced and operated by a private water utility company.

Faced with increasing costs due to increased insurance liabilities and recent changes to provincial regulations, which required private water utilities to make significant system upgrades to privately run water systems, the Hillside Utilities Association met with Halifax Regional Water Commission (Halifax Water) staff in January 2002, to discuss having Halifax Water take over the operation of the BoMont water supply system.

In February 2002, Halifax Water and the Hillside Utilities Association met again to discuss the terms of the take-over agreement. It was determined:

- upgrades to the plant had been conducted in 1999 and 2000;
- 17 homes were on the system;
- due to the plant's limitations, no more connections would be permitted; and
- all residents, except for one exempted in exchange for a property easement grant, would pay for their water.

A cost-recovery, fee-for-service water treatment operation agreement between Halifax Water and the Hillside Utilities Association came into effect April 1, 2002.

Residents of the BoMont subdivision also expressed their desire for Halifax Water to eventually transfer the private system to a public utility; Halifax Water stipulated that the takeover could occur once the BoMont WSP is upgraded to meet new provincial regulations.

2.1.2 Halifax Water Acquisition Process

As a first step toward taking over the BoMont system, a formal System Assessment Report on the Hillside Utilities system, completed in 2007, summarized the existing utility's operation and identified the capital upgrade requirements to bring the system to provincial standards. It was also determined that the customers would need to pay for the new system.

Halifax Water initially assumed operation on a cost-recovery, fee-for-service basis. Once the new WSP was built, Halifax Water would take over operations.

The new WSP was built in 2011 followed by Halifax Water gaining possession in 2012.

An Approval to Operate (AO) – Water Treatment System Serviced by a Surface Water Treatment Facility Approval No. 2014-091305 was given to Halifax Water effective May 21, 2015, expiring March 31, 2018.

2.2 Land Form, Landscape Characterization and Water Quality

The land formation of the BoMont watershed area (BoMont) is characterized by the geology, topography, surficial geology, soil, hydrology, climate, flora and fauna, and cultural and social activities that created the various forms and shapes it takes. The natural environment of BoMont is "comprised of geographic, biological and human elements. Geographic elements include the climate, geology, topography and water; biological elements include plants and animals, [described in this section]; and built elements include[ing] streets, buildings, bridges, yards, parks and human waste"[1] described in the next section, *2.3.3: Built Form* beginning on page 45 and illustrated on the maps indicated.

2.2.1 Ecological Land Classifications

The relationships between ecological land formations, as they occur in and on the landscape, are classified by Regions, Districts and Units that closely follow the Theme Regions Classification System described in the *Natural History of Nova Scotia, Volume II: Theme Regions by Davis & Browne ((*1996)[2]. Their classification system is defined according to distinctive land characteristics using the approach which *"closely follows the Biophysical Land Classification System that has been widely applied to terrestrial areas since the mid-1960s*"[3].

Since the Davis & Browne (1996) classification system was catalogued, Stewart and Neily (2008)[4] built on that by incorporating new data and data systems into a slightly different cataloguing system to refine the Ecological Land Classification for Nova Scotia (ELC) defined by Neily et al (2005) through GIS. The ELC is a holistic approach to identifying and mapping similar areas of ecology, developed in reference to the Davis and Browne (1996), among others'[5]

1 Municipality of East Hants. September 2014. *Plan East Hants Community Inventory Report*. Document Number: 2. Planning and Development Department. p. 77.

2 Davis, Derek S. and Sue Browne, Editors. 1996. *Natural History of Nova Scotia, Revised Edition, Volume II: Theme Regions.* The Nova Scotia Museum, the Department of Education and Culture, Province of Nova Scotia.

3 Ibid., quoting Lacate, D.S. (compiler) (1969) *Guidelines for Biophysical Land Classification*. Publication 1264. Department of Fisheries and Forestry, Canadian Forestry Service, Ottawa.

4 Stewart, Bruce and Peter Neily. 2008. Revised Edition. *A Procedural Guide for Ecological Landscape Analysis: An Ecosystem Based Approach to landscape Level Planning in Nova Scotia*. Report for 2008-2. Approved Guide for the Nova Scotia Department of Natural Resources Integrated Resource Management (IRM) Planning Process.

5 From Neily et al. 2005. "There have been several other classifications for Nova Scotia which have prepared maps and documentation describing various components of the province's natural ecology. These classifications include:

- Natural History of Nova Scotia Theme Regions, Volume 2 (Davis and Browne, 1996)

- Natural Landscapes of Nova Scotia (NSDNR, 1997) narrative classifications. The purpose of defining the ELC was to provide a common language tool upon which to base planning and discussions concerning biodiversity, forest ecosystems and resource management.

When the Davis & Browne (1996) classification systems are compared with Neily's et al (2005), they overlap easily such that the former's "Theme Regions" are referred to as the latter's "Ecoregions", their "Districts" as "Ecodistricts" and their "Units as "Ecosections". Within this SWPP, where GIS data is used, Stewart and Neily (2008) references are used; while the narrative descriptions use Davis & Browne's (1996) classification system definitions, as indicated

Ecoregions

According to the map associated with the Davis & Browne (1996) Theme Regions delineations, there are two Theme Regions specific to the BoMont watershed area. The Eastern Ecoregion area defined by Neily et al (2005) and the GIS data sets developed by Stewart and Neily (2008) also delineate two Ecoregions within the BoMont watershed area. Further, the 400 Ecoregion exactly matches Davis & Browne's (1996) Atlantic Interior Theme Region 400 within BoMont.

The ecoregions that are prevalent in BoMont are described under the subheadings below and illustrated on *Map A: Ecoregions, Ecodistricts and Ecosections* on page 39.

400 – Eastern / Atlantic Interior Ecoregion

The total area of the 400 – Eastern / Atlantic Interior Ecoregion is 6427km^2 or 11.6% of the province, extending from Bedford Basin to Guysborough and sloping toward the Atlantic Ocean. It is bordered by the Atlantic Coastal / Atlantic Coast Ecoregion to the south, and by St. Mary's Fault to the north. Approximately ~70% or ~502km^2 (50,237ha) of the BoMont watershed area is categorized under this ecoregion.

This ecoregion (400) has been further divided into five ecodistricts (described later in this subsection), four of which are represented in the BoMont watershed area. The ecodistrict not represented in the watershed area is Governor Lake where the highest points of elevation in this ecoregion are found. Ecoregion 400 is comprised of disjunct areas, predominated and distinguished by two individual slate ridges separated by the Shubenacadie River and about 20 km. The variety of landforms in this ecoregion includes rolling till plains, drumlin fields, extensive rockland and wetlands. In relation to Shubenacadie Grand Lake, the hub of the BoMont watershed area, this ecoregion extends from the south, southeast and western shores of Grand Lake, extending north through to Upper Rawdon.

The geology of the Atlantic Interior consists of three main rock groups – the Meguma Group consisting of slate and greywacke, the lava and ash of the White Rock Formation and granite (see *2.2.2: Meguma Group* on page 16). The Meguma Group and granite are the most prevalent rock units underlying the BoMont watershed area. The bedrock, planed down by glacial action,

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- Biophysical Land Classification for Nova Scotia (NSDLF, 1986)
- A Forest Classification for the Maritime Provinces (Loucks, 1962)
- National Ecological Framework for Canada (Ecological Stratification Working Group,1996)
- Ecoregions and Ecodistricts of Nova Scotia (Webb and Marshall, 1999)

slopes toward the southeast. Some of Nova Scotia's longest rivers, including the Shubenacadie – the backbone of the BoMont watershed – flow through this ecoregion.

The forests in this ecoregion consist mostly of coniferous, with red and black spruce covering most of the area. Hemlock stands are most prevalent in sheltered, moist areas along narrow streams and river valleys and drumlin slopes. White pine is also found in areas with course, well-drained soils typical of outwash till areas. White pine is also found in fire barrens. Tolerant hardwood forests are dominated by yellow birch and sugar maple, with beech scattered on drumlins and steeper hills. The typical natural disturbances that occur in these areas are hurricanes and fire. Moisture depletion is prevalent in areas of course soils found in the granite ecodistricts which makes these areas vulnerable to fires caused by lightning. Hurricanes travelling along the eastern seaboard frequently destroy large areas of forests, especially in the Eastern and Drumlin ecodistricts.

The climate of this ecoregion is characterized as slightly warmer in summer and cooler in winter than the coastal areas of the province are, due to the influence of the more temperate climate of the Atlantic Ocean.

The remainder of the watershed area, ~30%, extending from the shores of the tip of Grand Lake (also known as Little Grand Lake) and most of the eastern shores of Fish Lake, northward, consists of the 600 – Valley &Central Lowlands / 500 - Carboniferous Lowlands.

600 – Valley & Central Lowlands Ecoregion / 500 – Carboniferous Lowlands

Neily et al (2005) 600 – Valley & Central Lowlands Ecoregion is comparable to Davis & Browne (1996) 500 – Carboniferous Lowlands Theme Region. Despite some differences between these Eco/Theme Regions overall, the commonalities fall within the BoMont watershed area.

The total area of the 600 – Valley & Central Lowlands Ecoregion is 4070km^2 or 5% of the province. Only one of the three 600 Ecoregion ecodistricts, the 630 – Valley & Central Lowland Ecodistrict, is found within BoMont. This portion of the ecoregion underlies 21,640ha (216km^2 or ~30%) of the watershed area.

The 600 – Valley & Central Lowland Ecoregion includes the watersheds of the Annapolis Valley, the Minas Basin (Cobequid Bay) (including the Shubenacadie River portion contained within the BoMont watershed) and the Musquodoboit Valley. Only a few points in this lowland area exceed 50m above sea level, up to 100m above sea level. The distinguishing features of this ecoregion are similar to those in the 400 ecoregion; i.e., these lowlands are sheltered from coastal climatic influences, generating warmer summer temperatures and milder winters than elsewhere in the province. The sheltering is caused by two notable uplands bordering the ecoregion, the Rawdon Hills and Wittenburg Ridge, both of which rise within the BoMont watershed area. Other parts of the ecoregion are sheltered within the river valleys by the gently rolling topography.

The geology of this ecoregion consists of carboniferous shale, sandstone, gypsum and limestone which underlie the lowlands within Hants, Halifax and Colchester Counties. In the areas underlain by gypsum, karst topography with sinkholes and caves can be expected.

This Ecoregion is the most heavily settled area of the Municipality of East Hants (East Hants). It also supports among the best agriculture soil classifications in the province for farming (see *2.2.5: Soils* on page 25) – a very important industry in this area of East Hants.

The predominant soils in this ecoregion are characteristically imperfectly drained and fine-textured, situated on gently undulating to moderately rolling plains of the central to moderately rolling plains of the central river watersheds, including the portion of the Shubenacadie watershed within the BoMont watershed. A distinguishing feature of the majority of river watersheds that make up this ecoregion is the influence on them from the Bay of Fundy tides; the muddy tidal flats extend inland for a considerable distance. Another significant landform feature of this ecoregion is the extensive bogs in Central Hants County, which include much of the area of Stanley. Poorly drained clay loams underlay most of this area.

Due to the imperfectly drained, finer textured soils in this ecoregion, the predominant forest species are red spruce and balsam fir. Where the soil drainage is better, hemlock and white pine combine with red spruce.

Ecodistricts

At the ecodistrict level, there are mapping limitations when using Davis & Browne (1996) ecodistrict area delineation tools (hard copy mapping). Therefore, BoMont ecodistrict descriptions will incorporate the Davis and Browne (1996) explanations, while the maps (including the descriptions) are based on Neily et al (2005) delineations, since GIS data is readily available for these areas.

Each ecodistrict is described under the applicable headings below and outlined on *Map A: Ecoregions, Ecodistricts and Ecosections* on page 39. The following subsections describe how these ecodistricts landscapes apply to the BoMont watershed area and potential influence on its water quality. To help identify the location of these ecodistricts, the communities that they fall within are indicated.

410 – Rawdon/Wittenburg Hills

The Rawdon/Wittenburg Hills (410) Ecodistrict covers ~4010ha (~40km^2 or ~5.6%) of the BoMont watershed area. This ecodistrict is predominantly located in the communities of Upper Rawdon (~1694ha) and Upper Nine Mile River (~1051ha). Other communities that fall within this ecodistrict are East Gore (~637ha), West Indian Road (~269ha), Barr Settlement (~105ha), Rawdon Gold Mines (~116ha), Gore (~121ha) and West Gore (~17ha).

There are two ridges in Central Nova Scotia called Rawdon and Wittenburg that rise above the surrounding valleys of the Stewiacke, Musquodoboit and Shubenacadie rivers and are comprised of folded Meguma Group slate (see *Map B: Bedrock Geology* on page 40). The Wittenburg Ridge is located outside of the BoMont watershed area. The Rawdon Ridge, creating the Rawdon Hills, rises above the Shubenacadie River and comprises the top ridge and north boundary of the BoMont watershed area. It is crosscut by the Herbert and Meander rivers and several major brooks, all of which have valley and interval ecosections. The Nine Mile River also drains the Rawdon Hills. The high elevations of these ridges provide a sharp contrast to the lowlands of the Central Lowlands. Sandy and clay loams are found on the side slopes of these ridges. On top of the ridges, well drained soils of sandy loams and loams derived from shales and slates occur (see section *630 – Central Lowland/Till Plain (510) Ecodistrict* on page 15 and *Map A: Ecoregions, Ecodistricts and Ecosections* on page 39).

In total, freshwater only accounts for only 0.5% or 303 hectares of this ecodistrict. Temperatures are cooler and moister than in the adjacent lowlands.

Red spruce forests are very common on both sides of these slate ridges, occurring predominantly on the hummocky terrain. However, a significant feature of this ecodistrict is the occurrence of mixed wood forests, especially on hilly topography underlain by moist, fine textured soils.

The 410 ecosections that are present within BoMont are illustrated on *Map B: Bedrock Geology* on page 40. The soils in this ecodistrict are almost 90% well drained, medium textured with hilly terrain. Elevation in this ecodistrict is between 180m and 220m above sea level (see *Map E: Watersheds, Hydrology, Elevation and Sampling Points* on page 43.

420 – Eastern Drumlins Ecodistrict

The Eastern Drumlins Ecodistrict covers 5693.63ha (57km^2 or 7.9%) of the BoMont watershed area and is located within the communities of Beaver Bank (3017.05ha), East Uniacke (878.08ha), Lower Sackville (554.2ha), Middle Sackville (889.9ha), South Uniacke (123.57ha), Upper Sackville (482.7ha) and Windsor Junction (2.3ha).

This ecodistrict has three separate areas of drumlins that can be delineated roughly by the watersheds of the three rivers that flow through them; i.e., the Sackville, Tangier and Moser rivers. The eastern drumlin fields are applicable to the BoMont watershed area. Formed by glacial ice movement, the drumlins in this ecodistrict are oriented north-south indicating the route of the glaciers toward the Atlantic Ocean. The drumlins are underlain by Meguma Group greywacke and slate, blanketed by fine-textured tills derived from these underlying rocks.

The well drained drumlins and hummocks provide an opportunity for pure stands of tolerant hardwoods, such as yellow birch, sugar maple and beech, to flourish in the upper reaches of the slopes while on the lower slopes, pure stands of red spruce thrive. Black spruce stands occupy the wetter, imperfectly drained soils between the drumlins while white pine grows on sites with dry, course, shallow soils.

430 – Eastern Granite Uplands Ecodistrict

The Eastern Granite Uplands Ecodistrict covers only 765.47ha (~7.7km^2 or ~1%) of the BoMont watershed area. The communities within this ecodistrict include Fall River (~242.9ha), Goffs (~390.1ha), North Preston (~8.7ha), and Waverley (~78.8ha).

The soil characteristics prevalent in this ecodistrict are predominantly (81.4%) well drained and only 6.4% imperfectly drained. The topography of this ecodistrict in the BoMont watershed area is predominantly (~80.4%) ridged, with 6.4% hummocky and 1% hills. The remaining area of this ecodistrict is 2.9% lake water.

This ecodistricts stretches across a narrow ridge (80km long by 8-10km wide), beginning in the BoMont watershed area, east of Waverley to Sheet Harbour, rising sharply up to 100m above the adjacent coastal area, often with steep cliffs, dissected with narrow river gorges, most notably the

Musquodoboit. Long narrow lakes such as Lake Charlotte and Porters Lake also dissect this ecodistrict.

The granite that underlies this ecodistrict occurs throughout this ecoregion (as well as others) as outcrops similar to that of the South Mountain Batholith (see section *2.2.2: Geology*, beginning on page 16). Granite is very resistant to erosion; therefore, soils associated with this granite are coarse textured and shallow. Many ecosections in this ecodistrict have exposed bedrock and are scattered with huge granite boulders deposited by glaciers (erratics). This ecodistrict also has one of the highest concentrations of freshwater lakes.

Forests of this ecodistrict are predominantly softwood, with red spruce stands on the better drained and deeper soils associated with hummocky terrain. Elsewhere, the shallow soils give rise to scrubby forests of black spruce and white pine with scattered red pine indicating fire disturbances in the past. Jack pine is also found on the shallow soils of ridge tops. Tolerant hardwoods are found only on the few scattered drumlins. Hemlock stands occur on the steep sided slopes of hills and hummocks along rivers and streams

440 – Eastern Interior Ecodistrict

This is one of the largest ecodistricts in the province, occupying 3,731km^2 or 58.1% of the ecoregion, from Pockwock Lake to the Community (formerly the Town) of Guysborough. This ecodistrict covers 39,767.99ha (397.67km^2 or 55.33%) of the BoMont watershed area, amounting to approximately 10% of the total area of this ecodistrict.

The ecodistrict is underlain by resistant Meguma Group quartzite and slate. Approximately 343km^2 or 9.3% of the ecodistrict has been scraped by glaciers exposing large areas of bedrock. The bedrock is quite apparent where the glacial till is very thin, exposing the ridge topography. This characteristic has also been exacerbated by repeated fires.

The complexity of the ecodistrict topography is due to the glacial history and movement of materials from northerly ecoregions. The thickness of the till is quite variable across the ecodistricts, ranging from 1-10m but averaging less than 3m. Where the till is thicker, the ridged topography is masked and thick softwood forests occur. The ecodistrict is heavily covered with freshwater lakes.

The predominant characteristics of the soils in the BoMont watershed area of this ecodistrict are sandy loams, often quite stony and well drained (20,532ha) on till derived from quartzites. There are a few drumlins and hills scattered throughout the ecodistrict with fine textured soils derived from slates. On the shallow soils, repeated fires have reduced forest cover to scrub hardwoods such as red maple and white birch, with scattered white pine and black spruce underlain by a dense layer of ericaceous vegetation. However, on the deeper, well drained soils red spruce stands are found. On the crests and upper slopes of hills, drumlins and some hummocks, there are stands of tolerant hardwood. Beech and hemlock also occur on these deeper, well drained soils, but more sparsely. On the imperfectly and poorly drained soils, black spruce will dominate the stand composition.

The communities within this ecodistrict area of BoMont are Beaver Bank (5683.6ha), Bedford (366.0ha), Cole Harbour (14.7ha), Dartmouth (1255.9ha), Devon (364.8ha), Dutch Settlement (1.9ha), East Uniacke (456.4ha), Elmsdale (601.0ha), Enfield (4543.8ha), Fall River (3521.0ha), Fletcher's Lake (632.5ha), Goffs (3864.2ha), Grand Lake (603.0ha), Kinsac (104.4ha), Lake Loon (220.8ha), Lakeview (194.7ha), Lower Sackville (451.8ha), Middle Sackville (3.5ha), Montague Gold Mines (354.7ha), Nine Mile River (3143.3ha), Oakfield (599.9ha), Oldham (889.7ha), Rawdon Gold Mines (0.04ha), Upper Nine Mile River (10.9ha), Upper Rawdon (1828.5ha), Waverley (3811.4ha), Wellington (5495.5ha), Westphal (65.1ha) and Windsor Junction (954.0ha).

630 – Central Lowland/Till Plain (510) Ecodistrict

Davis & Browne (1996)'s Theme Region District specific to BoMont is the Till Plain District (510) which corresponds to Neily et al 630 – Central Lowland Ecodistrict. This ecodistrict is a significant lowland area that covers much of Hants and Colchester Counties. The total area of this ecodistrict is 2,704km^2 (270,400ha) or 66.4% of the ecoregion. The south-central area of this ecodistrict amounting to ~8% of it covers 21,639.8ha (~30%) of the BoMont watershed area (including water areas). The significant feature of this lowland area is the extent to which it is drained by several large rivers, all of which are affected by the tidal movements of the Bay of Fundy (except for the Musquodoboit River system, which does not apply to the BoMont watershed area) one of which is the Nine Mile River.

This ecodistrict is underlain by Carboniferous shale, limestone, sandstone and gypsum. Karst topography, which harbours sink holes, is common on areas underlain by gypsum in the southwest of the ecodistrict. There are also abundant glacial outwash deposits, some of which host aggregate quarries, especially along riversides. However, most of the ecodistrict has fine textured soils comprised of loams, silts and clays, which are reddish-brown in colour and derived from the underlying Carboniferous rock, which is characteristic of over 30% of BoMont soil types in this ecodistrict, which is described in more detailed in section *2.2.5: Soils* on page 25.

The topography of this ecodistrict is mostly comprised of level terrain with some hummocky undulating topography with elevations that rarely exceed 90m above sea level. The climate in this ecodistrict is conducive to farming and extensively used for dairy and beef production and growing of forage and cereal crops including corn, as described in section *2.3.3: Agricultural Landscape on page 49* and illustrated on *Map H: Restricted and Designated Land Use Areas* on page 72.

The forest areas in this ecodistrict are predominantly softwood. Hardwoods are only found on the well-drained hummocky and hilly areas (amounting to about 27% of this ecodistrict area of the BoMont watershed area).

Ecosections

Ecosections are the smallest mapped units of the ELC (Neily et al, 2005); these are the repetitive subdivisions of the ecodistrict and the building blocks for the ELC. They describe the enduring physical features – topographic pattern, soil texture and soil drainage. Davis & Browne (1996) described their units, which correspond to Neily et al's ecosections as: Quartzite Barrens Unit (413), subunit (a) – Halifax; Windsor Lowlands Unit (511), subunit a – Shubenacadie River; and Headwater Lakes Unit (436), subunits (a) – Beaver Bank and (b) – Dollar Lake.

The ecosection characteristics found in BoMont are described in more detail in section *2.2.3: Surficial Geology* beginning on page 21.

2.2.2 Geology

There are three known parent rocks – Mabou, Meguma and Windsor – and two unknown parent rocks uderlying the BoMont watershed area. The Horton Group is derived from one of the two unknown parent rocks, while the other unknown parent rock consists of Middle – Late Devonian muscovite biotite monzogranite granitoid rock. These parent rocks consist of eight different rock units.

The Meguma Group (metamorphic rock) underlies almost all of the southern and western portions (the 400 Ecoregion) amounting to 51,330ha (71%) of the BoMont watershed area, except for two granitoid pluton areas (igneous rock) amounting to 1520ha (2%). A cluster of mixed (sedimentary) rock groups covers the northeast quadrant (the 600 Ecoregion) amounting to 19,437ha (27%) of the watershed area. The latter covers a rectangular-shaped area beginning in the south at Fish Lake and the Halifax International Airport, northward almost to the watershed boundary that is edged by a thin portion of the Horton Group, west to Upper Rawdon and east to the watershed area boundary (see *Map B: Bedrock Geology* on page 40).

The granitoid rock (course grain rock that is similar to granite) units known as plutons are igneous intrusive rock. The largest and most intrusive example of this rock feature in Nova Scotia is the South Mountain Batholith, the largest body of granitoid rocks in the Appalachian system, which extends from the northwest area of Nova Scotia and meets the Meguma strata in the central part of the province. Within BoMont, the two representations of these plutons are in the communities of Fall River and Goffs (*Map B: Bedrock Geology* on page 40).

The geology of the Shubenacadie River watershed (BoMont) also hosts mainly acidic soils such that the water tends to be largely acidic (pH 5.3 to 7.0) but more alkaline conditions with pH above 7.0 are found in the waters flowing off the Windsor Group sedimentary rocks, toward the northern portion of the watershed area.

The parent rock underlying the watershed area also affects the susceptibility of erosion and sedimentation. The Horton, Windsor and Mabou parent rock types that make up the northeast quadrant of the BoMont watershed area, including approximately half of the Nine Mile River subwatershed area, through which the Nine Mile River flows and empties into the Shubenacadie River, are made up of rock types that are more susceptible to erosion and sedimentation. More details on the bedrock parent rock age class and unit description, rock formations, family, category and type underlying the BoMont watershed area are described in more detail under the subheadings below and are outlined in *Table 1: Rock Unit Descriptions* on page 19 and illustrated on *Map B: Bedrock Geology* on page 40.

Meguma Group

The Meguma Group is a parent bedrock group which is divided into two formations, the Halifax and Goldenville.

Halifax Formation

The composition of the Halifax Formation, which underlies 14,968ha (21%) of the BoMont watershed area is described as thinly bedded slates, siltstones and argillites with lesser amounts of interbedded quartzite. Halifax slates range from grey in the Upper Halifax Formation to black with abundant sulphides towards the base of the formation. Pyrite is the most common sulphide and occurs in massive veins, aggregates or disseminated crystals.

Above the transitional area, black slates are found interbedded with pyritiferous, grey, rippled and cross-stratified sandstone beds, approximately 20-50cm thick. It is believed that the majority of the pyrite in this unit occurs in the sandstone rather than the slates since the coarser grained sediments were permeable and provided a better medium for migrating mineral-rich fluids even though the source of the mineralization was likely the slates. The rest of the Halifax Formation above this area is less pyritiferous, and less of a concern regarding acid rock drainage (ARD). These slates are light grey, dark grey and blue-grey and patterned within thinly bedded grey sandstones. However, sulphide mineral content and the potential for acid producing and acid consuming ability are extremely variable throughout the Halifax Formation.

Nevertheless, the geology in the area has the potential to negatively impact water quality aquatic ecosystems. Nova Scotia Environment regulates exposure of pyritic slate under the *Sulphide Bearing Material Disposal Regulations Act* under section 66 of the *Environment Act*.

Where the Halifax and Goldenville Formations meet, the slate content as well as mineralization increases. Increased mineralization makes this area potentially valuable to the mining industry because of its potential for gold, tungsten, antimony and arsenic (see *Map B: Bedrock Geology* on page 40). This area is also where the potential for ARD is most likely.

Goldenville Formation

The Goldenville Formation covers 36,362ha (~50.3%) of the watershed area. Together with the Halifax Formation, these formations alternate from top to bottom, running southwest – northeast, as strips of various widths across the BoMont watershed area as outlined in *Table 1: Rock Unit Descriptions* on page 19 and illustrated on *Map B: Bedrock Geology* on page 40.

Mabou Group

The Mabou Group underlies the smallest area of the BoMont watershed area and consists of the Watering Brook Formation. The rocks contained in this Formation are described as siltstone, minor sandstone, gypsum and anhydrite, >150m.

The Mabou Group underlies two areas of the northeast quadrant of BoMont, amounting to approximately 1884.37ha (~2.6%). The larger area, amounting to 1436.84ha (~2%), underlies the communities of Hardwood Lands, Lower Nine Mile River, Enfield and Belnan. The smaller area, amounting to 447.53ha (0.6%), is north of the larger area lying slightly northwest of the brick quarry operation in the Sipekne'katik (Indian Brook IR 14) and Nine Mile River communities, east of Blois Road and north of Robinson Road.

Windsor Group

Three levels of formations of the Windsor group (Upper, Middle and Lower) underlie 15,842ha (~22%) of the BoMont watershed area, i.e.: the Murphy Road, Pesaquid and Green Oaks Formations (Upper) (6196ha); the Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations (Middle) (4282ha); and the White Quarry, Stewiacke, Carroll's Corner, Macumber and Gays River Formations (Lower) (5365ha). These areas are located in the northeast quadrant of BoMont, as described previously, and are outlined in *Table 1: Rock Unit Descriptions* on page 19 and illustrated on *Map B: Bedrock Geology* on page 40.

The Windsor Group is approximately 1000m thick and is a major source of industrial minerals and base metals mined today in the province. It is the primary source of limestone used in the manufacture of cement for concrete, gypsum for wallboard and salt for the fishery and road de-icing. Nova Scotia is among the leading gypsum producers of the world. The Windsor Group area of BoMont is also where the Shaw Brick company is situated and sources its product.

Unknown

Among the unknown parent rock types within the BoMont watershed area are the Horton Group and units of granitoid rock, as described below.

Horton Group

The Horton Group rock underlies 1711ha (2.4%) of the northern edge of the BoMont watershed area. As illustrated on *Map B: Bedrock Geology* on page 40, a thin slice of this rock group cuts across the communities of Nine Mile River and Harwood Lands.

The Horton Group, ranging in thickness from 1000m to 2000m, consists of the sedimentary rock family type, which is categorized as Clastic and Organic and consists of sandstone, coal, siltstone and conglomerate types. See *Table 1: Rock Unit Descriptions* on page 19 for further details. Common uses are coal, building stone, barite, copper, lead, zinc, iron and shale.

Granitoid Rock

The South Mountain Batholith is the dominant feature in the southwest landscape of Nova Scotia, forming an arc between Yarmouth and Halifax and outcrops over a 10,000 km^2 area.

Within the BoMont watershed area, there are two plutons of this intrusive igneous or granitoid rock; one is a 995ha area pluton situated in Fall River, bracketed by Kinsac and Fletcher Lakes and the other is a 525.82ha area comprising the "nose" of a larger body of granitoid intrusive rock that stretches inland along the eastern shore from Fall River/Goffs to Sheet Harbour. This intrusive rock makes the succession of the parent rock unknown.

These pluton rock units, described as muscovite biotite monzogranite, are considered to have been at one time molten (magma). Granitic-type rock is resistant to erosion due to its hard, impermeable and poorly jointed rocks. Where granitoid rocks are prevalent in Nova Scotia, the landscape is characterized by knolls and boulder-strewn surfaces with thin acidic soils and large areas that have exposed bedrock. The drainage pattern typical in granitic-type rock areas is called "deranged" due to the proportion of water that is retained on the irregular surface and how runoff is channeled through a disorganized series of interconnected bogs, shallow lakes and streams. This pattern is characteristic of the topography where this rock type is found in the BoMont headwaters region, as illustrated on *Map D: Soil and Topography* on page 42. See *Table 1: Rock Unit Descriptions* on page 19 for further details.

Table 1: Rock Unit Descriptions

Unit Name/ Rank	Parent Rock	Age Description	Text Label	Unit Description	Group	Formation	Rock Family	Land Use Rock Category	Various Rock Types	Comm	Shape Area (ha)
Goldenville Formation / formation	Meguma Group	Cambrian - Ordovician	COMg	Sandstone turbidites and slate: continental rise prism (in places metamorphosed to schist and gneiss), >5600 m (U-Pb concordant zircon and detrital titanite ages near base and top of unit of 566+/-8 and 552+/-5 Ma(39) respectively)	Meguma Group	Goldenville Formation	Meta-morphic	Gold-bearing metasediments	greywacke, quartzite, slate	gold, aggregate, tungsten, zinc, lead	36,123
Halifax Formation / formation	Meguma Group	Cambrian - Ordovician	COMh	Slope-outer shelf slate, siltstone, minor sandstone and Fe-Mn nodules (in places metamorphosed to schist), 500->4400 m (Tremadocian graptolites and acritarchs)	Meguma Group	Halifax Formation	Meta-morphic	Sulphide-bearing meta-sediments	slate	Base metals	14,739
Horton Group / group	Un-known	Late Devonian - Early Carboniferous	LD-ECH	Undivided, 0-1650 m	Horton Group	none	Sedi-mentary	Clastic and Organic	sandstone, coal, siltstone, shale, con-glomerate	coal, building stone, barite, copper, lead, zinc, iron, shale	1,823
Middle - Late Devonian muscovite biotite monzogranite / unit	unknown	Middle - Late Devonian	M-LD mbmg	Muscovite biotite monzogranite	none	none	Igneous	Intrusive	granite, granodiorite, diorite, diabase, gabbro	building stone, aggregate, tin, copper, lead, zinc	1,566
Murphy Road, Pesaquid and Green Oaks Formations / compound formation	Windsor Group	Early Carboniferous	ECWu	Siltstone, minor gypsum and shallow marine limestone (Visean (Asbian), C-E subzones fauna and spores)	Windsor Group (Upper)	Murphy Road, Pesaquid and Green Oaks Formations	Sedi-mentary	Clastic and Organic	sandstone, coal, siltstone, shale, conglomerate	coal, building stone, barite, copper, lead, zinc, iron, shale	6,033

Table 1: Rock Unit Descriptions											
Unit Name/ Rank	**Parent Rock**	**Age Description**	**Text Label**	**Unit Description**	**Group**	**Formation**	**Rock Family**	**Land Use Rock Category**	**Various Rock Types**	**Comm**	**Shape Area (ha)**
Watering Brook Formation / formation	Mabou Group	Early - Late Carboniferous	E-LCMw	Siltstone, minor sandstone, gypsum and anhydrite, >150 m (Visean (Brigantian)-Namurian spores)	Mabou Group	Watering Brook Formation	Sedi-mentary	Clastic and Organic	sandstone, coal, siltstone, shale, conglomerat e	coal, building stone, barite, copper, lead, zinc, iron, shale	1,870
Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations / compound formation	Windsor Group	Early Carboniferous	ECWm	Gypsum, minor siltstone, marine limestone and dolostone (Visean (Holkerian), B subzone fauna and spores)	Windsor Group (Middle)	Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations	Sedi-mentary	Evaporites	gypsum, salt, limestone, anhydrite	gypsum, salt, limestone, anhydrite	4,361
White Quarry, Stewiacke, Carrolls Corner, Macumber and Gays River Formations / compound formation	Windsor Group	Early Carboniferous	ECWl	Anhydrite, salt, marine dolostone and limestone (Visean (Arundian), a subzone fauna and spores)Angular unconformity on Cheverie Formation, Devonian granitoids and Meguma Group	Windsor Group (Lower)	White Quarry, Stewiacke, Carrolls Corner, Macumber and Gays River Formation	Sedi-mentary	Evaporites	gypsum, salt, limestone, anhydrite	gypsum, salt, limestone, anhydrite	5,361

2.2.3 Surficial Geology

The surficial geology unit types, derived from glaciation, found in the BoMont watershed area are alluvial deposits, bedrock, glaciolucastrine deposits, glaciofluvial deposits (kame fields and esker systems), organic deposits, silty drumlin, silty till plain, stony till plain and surface water.

The following subsections describe the surficial geology unit types found in BoMont that are illustrated on *Map C: Surficial Geology* on page 41 and outlined in *Table 2: Surficial Geology Areas in Watershed* on page 24. Despite significant anthropogenic activity from residential and highway development within BoMont, the surficial geology areas are mapped as the original material because of the sporadic and shallow nature of the modifications. The information describing the characteristics of the surficial geology in the following sections comes from one source[6] unless otherwise stated.

Alluvial Deposits

There are 1770.55ha of alluvial deposit areas covering 2.45% of BoMont that are situated along the Nine Mile River and southwest of Beaver Bank Lake. These deposits consist of gravel, sand and mud, and are characterized as bedded, coarse at base, finer at top, stream channels with generally gravelly sand, and floodplains sand. These areas are a major source of groundwater, a source of aggregate and utilized for sod farming, and pasture land; limitations for crop use and construction include flooding, a high water table and poor drainage. The thickness of these areas is thin veneer, < 1m, in small streams; and approximately 20m in large floodplains.

There are 8 mapped alluvial deposits areas in BoMont (see *Map C: Surficial Geology* on page 41) (the largest deposit amounting to ~940.70ha) situated north, where Little Nine Mile River begins in the community of Upper Nine Mile River, running southeast through the community of Nine Mile River where it meets the Nine Mile River, continuing southeast through the communities of Hardwood Lands and Belnan, to where the Nine Mile River meets the Shubenacadie River and west along the Shubenacadie River to about ¾ of the way through the community of Enfield. The BoMont WSP and intake are situated within this alluvial deposit area.

Bedrock

The topography of the bedrock is flat to strongly rolling with ridges of hard rock exposed in thin till areas. It is found in forested regions and has little use as cropland. The acid rain buffer-capacity depends on the rock type, which varies between Halifax, Goldenville and granite which is generally poor.

Bedrock in the BoMont watershed area occurs at 8 sites (see *Map C: Surficial Geology* on page 41) exclusively on the HRM portion of the watershed, amounting to 7035.55ha (~9.8%), consisting of various types and ages, with glacially scoured basins and knobs overlain by a thin,

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[6] Surficial Geology Map of the Province of Nova Scotia, 1:500 000, by R. R. Stea, H. Conley and Y. Brown, 1992. Digital Product Compiled by R. R. Stea and B. E. Fisher. DP ME 36, Version 2, 2006. Digital Version of Nova Scotia Department of Natural Resources Map ME 1992-3.

discontinuous veneer of till. The largest of these sites straddles the communities of Enfield and Oldham amounting to 1848.67ha.

Glaciolacustrine Deposits

This type of surficial geology material is described as sand, silt, clay, laminated to massive or crudely stratified diamictons (mixture of gravel, sand, and mud). The topography is described as flats or gently rolling terraces perched above modern or river valleys. The thickness of the material is generally >2m; however, it can reach a thickness of 30-40m along major valley streams. The deposits are found in a ponded body of water either in direct contact with ice or fed by glacial melt water. Generally, the clay is utilized for brickmaking and pottery, while the land is used for pasture. The limitation of this surficial geology includes poor drainage and surface runoff.

Four glaciolacustrine deposit areas, amounting to 299.14ha (0.41%) covers BoMont (see *Map C: Surficial Geology* on page 41). The largest deposition area (~136.45ha) lies a half kilometer southwest of where the Nine Mile River meets the Shubenacadie River.

Glaciofluvial Deposits (Kame Fields and Esker Systems)

The glaciofluvial (kame and esker) deposits are described as gravel, sand and silt, diamicton layers, that are poorly to well bedded and have horizontal to angular beds; faulting and collapse features are common. The topography is steep-sided mounds or hummocks (moulin kames); pitted terraces on valley sides (kame terrace); and sinuous, steep sided ridges (eskers). The thickness is generally 4-6m; specifically kames are 4-20m, kame terraces are 3-30m and eskers are 5m. The surficial material is a source of aggregate of varied quality. Severe limitations to crop use include stoniness, rapid drainage and irregular topography. The land is utilized for blueberries and pastureland.

Three glaciofluvial deposits in the amount of 1562.82ha (2.32%) cover BoMont (see *Map C: Surficial Geology* on page 41). This discontinuous chain system cuts across four communities within BoMont; from east to west: Sipekne'katik (Indian Brook) IR 14, Hardwood Lands, Nine Mile River and Upper Nine Mile River. The largest deposit, being 766.21ha, is predominantly located in Hardwood Lands and is the best defined of the discontinuous chain system. The second largest deposit area (592.23 ha) is situated in Upper Rawdon along the same longitude as the largest deposit. It is within this chain of glaciofluvial deposits that the greatest groundwater potential may exist within the entire Shubenacadie/Stewiacke Watersheds.

Organic Deposits

These deposits consist of sphagnum moss, peat, gyttja (mud formed from partially decayed peat, pooling at the base of a peat column), and clay. The topography forms bogs, fens and swamps; the swamps generally form along river valleys. The soil consists of bogs that have a thickness of 1m at the edge, 5m in the centre and swamps that are less than 2m. This type of surficial geology is a source of fuel, fertilizer, medicinal and industrial products. The wetlands provide nesting and feeding habitats for wildlife and peat serves to extract contaminants from groundwater.

Twenty-five 25 organic deposits areas, amounting to 1046.37ha (1.52%) lie scattered throughout BoMont (see *Map C: Surficial Geology* on page 41). The average size of these deposits is ~44ha.

The largest single organic deposit is 122.25ha, is located in the community of Beaver Bank and overlaps the municipal boundary into HRM by 22ha.

Till

The majority of the BoMont's surficial geology is till-based, covers almost 80% of the watershed area, and is described in more detail in the subsections following, covering. Water quality is considerably influenced by the rates of erosion and sedimentation, particularly in the Nine Mile River subwatershed portion of the watershed area and especially where the land is worked as in farming or where development practices do not practice techniques to mitigate such tendencies in areas susceptible to erosion and sedimentation.

Silty Drumlins

BoMont drumlins consist of siltier till, and a higher percentage of distant source material including red clay. They often consist of multiple tills and have thicknesses between 4 and 30m. Silty drumlins generally provide the best agricultural land in the province, due to its moderate drainage and stoniness and moderate-to-good buffering capacity for acid rain because of transported calcareous bedrock components.

Seventy-four drumlins totaling 1613.51ha (2.24%) of BoMont, most of which (62) are concentrated in a large cluster along the western boundary of the watershed area throughout the communities of East Uniacke to Lakeview (see *Map C: Surficial Geology* on page 41). The largest drumlin is ~80ha, stretching across the communities of Windsor Junction and Lakeview, nestled between Second Lake and Rocky Lake (the one in Lakeview) and marks the bottom end of this large cluster.

Silty Till Plain

Silty till plains within BoMont are described as silty, compact, material derived from both local and distant sources. The topography of the silty till plain areas are flat to rolling, few surface boulders; till is thick enough to mask bedrock undulations, which is typical of the cover in Hants County which has till that is at least 3 - 30m in thickness. Generally provide the best agricultural land in the province, moderate drainage and stoniness; moderate to good buffering capacity for acid rain because of transported calcareous bedrock components.

There are 42,701.02ha of silty till plain, the most prevalent type of surficial geology (~59%) BoMont. The largest contiguous area is 42,701.02ha, covering most of the communities between Lakeview and Upper Nine Mile River as illustrated on *Map C: Surficial Geology* on page 41.

Stony Till Plain

Stony till plain topography within BoMont is flat to rolling, with many surface boulders with a thickness of 2-20m. The soil has moderate limitations to crop use include stoniness, rapid drainage, erodibility; factors affecting use for construction include shallowness, stoniness and high water table; and poor buffering capacity for acid rain.

Stony Till Plain geology is the second most prevalent unit type in BoMont, covering 13,588.52ha (~19%). This type of surficial geology is situated primarily in the HRM portion of the watershed area, along the eastern side of the watershed from the community of Enfield to Cherry Brook and on the western side of the watershed from the community of East Uniacke to Middle Sackville; except for two small areas in East Hants amounting to ~990ha, in the communities of Upper Rawdon and Nine Mile River.

Surface Water

Surface water surficial geology amounts to 2259.01ha (3.13%) of the watershed area (which does not include most of the water bodies in the watershed area) as illustrated on *Map C: Surficial Geology* on page 41. There are six surficial geology units which embody only five (5) of the 711 lakes identified through GIS; i.e., Grand, Miller, Lewis, Beaver Bank and Third lakes. The rest of the lakes are incorporated by the other surficial geology unit types previously described. Section *2.2.4: Hydrology* on page 29 further describes the surface water features in BoMont.

Table 2 below outlines all of the surficial geology unit areas within the BoMont watershed.

Table 2: Surficial Geology Areas in Watershed

Unit Type	Area in BoMont Watershed (ha)	% of Watershed Area
Alluvial Deposits	1770.55	2.46
Bedrock	7035.55	9.8
Glaciolacustrine	299.14	0.42
Glaciofluvial	1562.82	2.20
Organic Deposits	1046.37	1.46
Silty Drumlins	1613.51	2.24
Silty Till Plain	42,701.02	59.41
Stony Till Plain	13,588.52	18.91
Surface Water	2259.01	3.13

2.2.4 Topography

BoMont's three highest elevations are located on the northwest boundary of the watershed area(see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43); two are in East Hants, in the communities of West Gore and Upper Nine Mile River and one in the community of Beaver Bank on HRM side of the boundary.

As described in section *2.2.1: 630 – Central Lowland/Till Plain (510) Ecodistrict* on page 15 and illustrated on *Map A: Ecoregions, Ecodistricts and Ecosections* on page 39, most of the ecodistrict is fairly level with hummocky to undulating topography, with elevations rarely exceeding 90m above sea level. The area has been extensively used for dairy and beef farming as well as the growing of forage crops including corn, all of which is attributable to the favourable climate for farming in this area. The total area of this ecodistrict is 2704km^2 or 66.4% of the ecoregion.

Topography is also influenced by various anthropogenic activities in the watershed area, particularly: farming; extraction activities associated with mining and aggregate materials; and construction activities associated with mixed use development, which have reshaped the land and covered it with impervious surfaces – a prevalent feature in the more developed areas of the watershed – i.e., Elmsdale, Enfield and Fall River.

Topography has a strong influence on natural vegetation patterns and flows of animals, wind, and water. In the case of water quality, topography influences flow rate in streams and rivers and to the width of the floodplain. Topography also determines the size and shapes of the lakes in the area, i.e., large or small, deep or shallow, round or irregular. Topography can also influence acidity of water quality depending on the buffering capacity of the bedrock and soils or the humic materials in which the water travels through.

The surficial geology and soil-types that influence the topography and drainage patterns of the BoMont watershed area are described in the Surficial Geology subsection above and illustrated on *Map D: Soil and Topography* on page 42.

2.2.5 Soils

There is a wide range of soil characteristics within BoMont of which approximately three quarters, particularly in the headwaters region, have a tendency to be acidic in nature. The other quarter of the soils which are mainly located northeast quadrant of BoMont, are more alkline and have a tendency toward sedimentation. The soils in this region are among the best agriculture soils in the province, as described in more detail on section *2.3.3: Agricultural Landscape* on page 49. *Table 3: Definition of Soil Types* on page 26 provides a list of the soil types and descriptions within the BoMont watershed area as illustrated on *Map D: Soil and Topography* on page 42.

Table 3: Definition of Soil Types[7]									
Symbol	**Soil Series**	**Description of Surface and Subsoil**	**Parent Material**	**Landform**	**Soil Drainage Class Surface Stoniness*****	**Texture****	**Soil Reaction Class (Acidity)# 1. 0-25 cms 2. 25 - 50 cms 3. 50 - 100 cms**	**Present Land Use Agricultural Capability Class Limiting factors***	**Area (ha) (%) in BoMont**
APG	Aspotogan	Dark greyish brown sandy loam over dark reddish brown sandy loam; mottled	Dense moderately course textured stony till; moderate permeability; firm and nonplastic	Gently sloping and basin sites on undulating plain with thin till veneer and scattered peat bogs. Slopes 1-5%	Poor to very poorly drained 3-4	Moderately course over course skeletal	1. very strongly acid 2. very strongly acid 3. Strongly acid	Forested, unsuitable for agriculture. ACC 7. Stoniness, poor drainage, shallowness, acidity, infertility	238.11 (0.33)
BWT	Bridgewater	Brown shaly loam over yellowish-brown shaly loam	Olive shaly loam till derived from Precambrian slates	Gently undulating to gently rolling	Good drainage	Medium and moderately course textured.	Strongly acidic		4263.88 (5.93)
CBR	Cumberland	Reddish-Brown fine sandy loam over reddish brown sandy loam and gravelly sandy loam	Alluvial sands and silts along river courses.	Level to very gently undulating.	Moderately rapid drainage, but often subject to flooding.			Chiefly hay or grain crops. Good crop land.	1241.56 (1.73)
CSY	Castley	Sphagnum peat.	Remnants of bog plants, chiefly sphagnum mosses with sedge type plants dominant locally; mostly	Domed bogs, with flat bogs in some valley bottomlands	Very poorly drained	Mesic	1. Extremely acid 2. Extremely acid 3. Extremely acid	Wildland, few trees. Very little cultivation and peat moss exploitation	652.15 0.91)

[7] Data sourced and adapted from Agriculture and Agri-Food Canada; *Soils of Nova Scotia: Map* compiled by J. I. MacDougall and J. L. Nowland, Research Branch. Canada Department of Agriculture. Fredericton, NB. Compiled drawn and published by the Cartography Section, Soil Research Institute, Research Branch, Canada Department of Agriculture, Ottawa 1972. Date modified on website, 2013-06-25. Web-accessed May 3, 2017 at http://sis.agr.gc.ca/cansis/publications/surveys/ns/nss/index.html.

			moderately (mesic) to poorly (fibric) decomposed						
DFN	Dufferin	Dark grayish brown sandy loam over yellowish-brown sandy loam; mottled	Dark-brown sandy loam till derived from quartzite	Gently undulating to gently rolling	Imperfect drainage				672.38 (0.94)
FSH	Fash	Kettles, slump structures and stones may be present.	Glacial ice materials deposition		Poor drainage.				177.33 (0.25)
GIB	Gibralter	Brown sandy loam over strong-brown sandy loam	Pale-brown course sandy loam till derived from granite	Gently undulating to gently rolling	Good to excessive drainage				329.15 (0.46)
HFX	Halifax (associated with Aspotogan soils)	Light/brown/Reddish sandy loam over yellowish sandy loam; fairly stony	Brown/olive sandy loam till derived from hard sandstone slate and quartzite	Rolling to hilly; gently undulating to gently rolling	Good to excessive drainage; numerous poorly drained depressions;	Medium and moderately coarse; Very stony and bouldery		Chiefly forest, very small areas cleared.	15,364.51 (21.38)
HBT	Hebert	Brown sandy loam over strong-brown to brown sandy loam	Dark greyish brown to brown loamy sand to gravelly sandy loam; water deposited material, outwash plains, kames and eskers. Herbert soils are derived from igneous material and Torbrook soils from sedimentary rocks.	Level to knob and kettle.	Good to excessive drainage.		Extremely / strongly acidic pH < 5.6	Only very small areas are used for agriculture. Cornwallis soils are used for truck and orchard crops. Excessive drainage is a limiting factor in land use.	1594.67 (2.22)
HFD	Hansford	Light brown sandy loam over strong brown sandy loam. Contains sandstone stones and cobble.	Reddish brown sandy loam till from brown and grey sandstones.	Undulating to rolling.	Well drained, but contains numerous depressional areas.	Moderately course	Extremely / Strongly acidic; pH < 5.6	Mixed farming, hay and grain crops;	4735.20 (6.59)
QUE	Queens	Light/dark reddish brown sandy clay loam over	Dense moderately fine-textured till and minor lacustrine deposits, weakly	Undulating to moderately rolling till plain, with some till-	Well drained; internal drainage	Moderately fine	1. very strong acid 2. variable 3. slightly acid	Forest, hay, pasture, some grain. ACC 4. Imperfect drainage ,	9550.11 (13.29)

		strong-brown sandy clay loam	calcerous; slow permeability; firm and plastic	mantled upland and glaciolucastrine basins. Slopes 2-15%	moderate to slow.			dense subsoil, acidy, infertility, local slopes	
STW	Stewiacke	Dark brown silt loam over dark-brown to brown silty clay loam. Stone free.	Alluvial sands and silts along river courses.						541.81 (0.75)
WFV	Wolfville	Dark reddish brown loam to sandy clay loam over strong-brown loam to sandy clay loam.	Reddish brown loam to sandy clay loam till derived from shale and sandstone	Gently undulating to gently rolling	Good drainage				25,167.39 (35.01)
ZRL	Rockland		Stony, this course-textured till in hollows, with bedrock (chiefly granite, quartzite, or schist) occupying more than 50% of the surface	Ice-scoured peneplain surface locally boulder strewn, with structural ridge, and hollow microrelief, and peaty depressions	Variable		1. very strong acid 2. – 3. –	Forest and open heath vegetation. ACC 7. Bedrock exposures, shallowness, stoniness, wet areas.	2511.98 (3.49)
ZZZ	Water								4791.3 (6.67)

* For details on Agricultural Classes see section *2.3.3: Agricultural Landscape* on page 49.
** Soil Texture Groupings: Very Course = sand, loamy sand; Moderately course = sandy loam; Medium = loam, silt loam, silt; Moderately fine = sandy clay loam, clay loam, silty clay loam; Fine = sandy clay, clay, silty clay; Coarse-skeletal = coarse, with 35% or more (by volume) gravel and stones.
*** Surface Stoniness is assessed by its effect on cultivation: 0 = stoneless; 1 = slightly or no hindrance; 2 = moderate interference; 3 = serious handicap; 4 = cultivation impossible; 5 = stone pavement.
# Soil Reaction classes refer to weighted average pH (in water) over depths indicated; Extremely acid = less than 4.5; Very strong acid = 4.6 – 5.0; Strongly acid = 5.1 – 5.5; Medium acid = 5.6 – 6.0; Slightly acid = 6.1 – 6.5; Neutral = 6.6 – 7.3.

2.2.6 Water

The following section describes the hydrology, bathymetry, water budget, and water quality characteristics of the BoMont watershed area. *Table 4: BoMont Watershed Lakes > 1 ha* on page 31 outlines the size and location of lakes greater than 1 ha in area. All water features are illustrated on *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43.

Hydrology

Hydrology is heavily influenced by the underlying geology and type and depth of surficial overburden. The potential for erosion, permeability and jointing of the bedrock determine both the amount of water that is retained on the surface and how runoff is channelled. Impermeable, poorly jointed rocks, such as granite, greywacke and slate which are characteristic of the headwaters region of BoMont, as described in the next subsection, retain most water on the surface in a disorganized series of streams, lakes and bogs. This pattern is called deranged drainage, prevalent in the 400 Region (Davis & Browne, 1996) and in the headwaters region; whereas permeable, well-jointed rocks such as limestone, sandstone and gypsum, allow substantial infiltration, have few lakes, and channel surface runoff along joint lines and the bedding trend. This results in trellised drainage. This is well developed in the Carboniferous sandstones and salts of central and northern mainland Nova Scotia - Region 500 (Davis and Browne, 1996) and characteristic of the northern tertiary subwatersheds of the BoMont watershed area which drain directly into the Shubenacadie River.

Watershed Areas

The Shubenacadie watershed is the largest watershed in Nova Scotia stretching across approximately 2,475km^2, from Dartmouth in the south to Cobequid Bay in the north. During the mid-1800s, the Shubenacadie Canal (see section *2.3.3: Shubenacadie Canal System* of page 57) created a connection between the Shubenacadie watershed and Dartmouth lakes at the south end of Lake Charles (Shubie Park), draining into the Atlantic Ocean.

The Shubenacadie watershed consists of two distinct areas, particularly in relation to geology and hydrogeology, i.e., the headwaters and the corridor region. The headwaters region, mostly in HRM portion of the watershed, consists of five lakes into which the surrounding stream waters drain, i.e., lakes Charles, William, Thomas and Fletcher, which empty into Grand Lake, that is the water source for the Shubenacadie River (see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43). The corridor region, where ~60% of the East Hants population lives, is characterized by urban and residential settings, a concentrated business environment, and a growing population and strong community setting.

The BoMont watershed is a subwatershed of the Shubenacadie River watershed amounting to ~71,876.55ha. The headwaters region makes up ~38,143ha (53%) of the BoMont watershed area while the corridor region makes up the remaining 33,733ha, including the Nine Mile River tertiary subwatershed (see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43) which flows into the Shubenacadie River ~1.1km upstream of the BoMont WSP intake.

Natural Water Bodies (Stopped hear May 22, 2017)

Based on GIS data there are 1884 natural water bodies including 711 lakes, 76 river water areas, 1097 swamps, bogs and fens covering ~7800ha (10.8%) of the BoMont watershed area. The headwaters region consists of 478 lakes covering 4506ha (91%) of the BoMont watershed area lake surface coverage); 88 river water areas covering 57.76ha (81.73% of the BoMont river area surface coverage); and 862 swamps, bogs and fens covering 1434.82ha (55% of the BoMont swamp, bog and fen areas) (see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43). These numbers support the hydrology research by Davis and Brown (1996) wherein the headwaters of the BoMont watershed area (where the bedrock is impermeable granite and greywacke) supports most of the lake and river water areas and a little over half of the bogs, fens and swamp areas, while the northern portion of the watershed area (where permeable bedrock types are prevalent) support fewer and smaller lakes, a few river areas and almost half of the bogs, swamps and fens. *Table 4: BoMont Watershed Lakes > 1 ha* on page 31 lists the 110 lakes inside the watershed area that are over 1ha in size.

Table 4: BoMont Watershed Lakes > 1 ha							
Lake Name	**Lake Area(ha)**	**Location (Lat/Long)**	**Community**	**Lake Name**	**Lake Area(ha)**	**Location (Lat/Long)**	**Community**
Allen's	31.91	45.039 -63.647	Nine Mile River	Square	35.96	44.846 -63.718	Beaver Bank
Ingram	2.0	45.067 -63.604	Upper Nine Mile River	Hamilton	30.41	44.840 -63.706	Beaver Bank
No name (~0.5 km NE of Ingram)	1.54	45.069 -63.599	Upper Nine Mile River	Fenerty	66.38	44.830 -63.718	Beaver Bank
Three Cornered	11.5	45.009 -63.643	Nine Mile River	Horse Shoe	27.16	44.832 -63.709	Beaver Bank
Tooles Pond	2.5	45.011 -63.666	Upper Rawdon	Wilson	10.96	44.813 -63.701	Beaver Bank
Storys	37.34	45.006 -63.675	Enfield/Upper Rawdon	Barrett	9.0	44.185 -63.687	Beaver Bank
McGrath Lake	77.46	45.001 -63.703	Upper Rawdon	Duck 2 (SE of Barrett)	8.05	44.806 -63.683	Beaver Bank
Fahey	6.86	44.995 -63.682	Enfield	Beaver Pond	14.85	44.802 -63.654	Windsor Junction
Carrigan	10.93	45.011 -63.695	Upper Rawdon	Third	84.62	44.793 -63.634	Windsor Junction/ Fall River
No Name (possible flooded gypsum mine)	5.12	45.087 -63.582	MacPhee's Corner	Second	112.77	44.781 -63.649	Windsor Junction/ Lower Sackville
Brazil	2.78	45.106 -63.554	West Indian Road	First	82.09	44.772 -63.663	Lower Sackville
Whelan	6.78	44.980 -63.689	Enfield	Rocky	144.5	44.759 -63.621	Bedford/ Lakeview/ Waverley
Jim Horne	29.43	44.967 -63.669	Enfield	Powder Mill	42.90	44.775 -63.611	Waverley
Rocky	17.63	44.993 -63.650	Nine Mile River	Three Mile	17.36	44.782 -63.625	Windsor Junction/ Fall River
McLennan Mill	25.82	44.988 -63.642	Nine Mile River	No name (Flows into Three Mile)	5.70	44.779 -63.621	Windsor Junction
No name (connected to McLennan Mill via North Brook)	4.04	44.998 -63.630	Nine Mile River	Muddy Pond	4.89	44.789 -63.610	Waverley
Annand	7.24	44.953 -63.637	Enfield	Lake Thomas	113.40	44.801 -63.609	Waverley / Fall River
Fish	51.05	44.907 -63.582	Oakfield	Miller	125.80	44.817 -63.593	Fall River

Table 4: BoMont Watershed Lakes > 1 ha							
Lake Name	**Lake Area(ha)**	**Location (Lat/Long)**	**Community**	**Lake Name**	**Lake Area(ha)**	**Location (Lat/Long)**	**Community**
White's	3.82	44.919 -63.631	Wellington	Fletchers	100.51	44.842 -63.611	Fletchers Lake/ Fall River/ Wellington
Rocky (West of Grand)	3.23	44.922 -63.639	Wellington	Shubenacadie Grand	1882.38	44.914 -63.598	Wellington/ Oakfield/ Enfield/ Grand Lake
No name (NE of Bennery)	1.44	44.901 -63.570	Oakfield	William	301.96	44.768 -63.586	Waverley
Kelly	13.14	44.873 -63.585	Wellington	Soldier	220.79	44.816 -63.571	Fall River / Waverley
Bennery	50.42	44.894 -63.564	Wellington	Perry	6.24	44.796 -63.620	Fall River
Sandy	19.40	44.993 -63.663	Beaver Bank	St. Andrews ("A")	15.36	44.824 -63.634	Fall River
Cranberry	7.60	44.889 -63.680	Beaver Bank	Willis	8.06	44.794 -63.591	Waverley
Golden	7.93	44.870 -63.669	Wellington	Spriggs	5.02	44.786 -63.583	Waverley
Crotched	9.79	44.871 -63.661	Wellington/ Beaver Bank	Little Soldier	2.62	44.794 -63.564	Waverley
Beaver Bank	68.54	44.858 -63.669	Beaver Bank	Granite	13.32	44.812 -63.553	Fall River
Kinsac	168.05	44.825 -63.652	Kinsac/ Wellington/ Beaver Bank/ Fall River/ Windsor Junction	Little Red Trout	4.12	44.814 -63.544	Goffs
Tucker	32.65	44.840 -63.685	Beaver Bank	Unnamed –b/w Soldier and Tillman's Brook	7.22	44.827 -63.582	Fall River
Rasley	13.02	44.856 -63.698	Beaver Bank	Charles	138.61	44.723 -63.551	Dartmouth/ Waverley
Duck 1 (N. of Tucker)	3.67	44.847 -63.683	Beaver Bank	Shubie Canal Greenway (not named)	24.09	44.741 -63.559	Waverley
Hawkin Hall Lake	9.14	44.875 -63.723	Beaver Bank	Un-named W. of Charles	2.30	44.749 -63.590	Waverley
Nicholson	40.12	44.904 -63.761	East Uniacke	Loon	76.20	44.701 -63.504	Lake Loon/ Westphal
Savage	18.07	44.916 -63.770	East Uniacke	Cranberry	11.05	44.689 -63.498	Dartmouth/ Cole Hbr./ Westphal
Lewis	76.10	44.922 -63.779	East Uniacke	Skerry Ponds	4.33	44.784 -63.562	Waverley

Table 4: BoMont Watershed Lakes > 1 ha

Lake Name	Lake Area(ha)	Location (Lat/Long)	Community	Lake Name	Lake Area(ha)	Location (Lat/Long)	Community
Kelly Long lake	10.26	44.871 -63.567	Goffs/ Wellington	Dark	1.82	44.901 -63.560	Goffs
Unnamed (N of Bennery)	1.93	44.903 -63.560	Oakfield	Three Lakes assoc. w. Sand pits	1.86 2.87 3.42	45.069 -63.513	Nine Mile River/ Hardwood Lands (2)
Beaver	12.35	44.937 -63.467	Devon	Rocky	18.21	44.912 -63.476	Oldham
Turf	50.00	44.897 -63.482	Goffs	Unnamed feeder of Black Brook	3.15	44.920 -63.493	Oldham
Rockhead	1.87	44.928 -63.479	Enfield	Unnamed through which Grambley Br. runs	1.15	45.088 -63.535	MacPhees Corner
Unnamed; N of Grand feeding Black Br.	1.09	44.979 -63.580	Enfield	Beaver Pond	1.20	44.846 -63.743	Beaver Bank
Lisle	4.62	44.822 -63.724	Middle Sackville	Springfield	81.20	44.813 -63.738	Middle Sackville
Unnamed more like a river through a bog)	1.06	44.878 -63.712	Beaver Bank	Nelson Pond	4.58	44.830 -63.660	Beaver Bank
Unnamed Feeder pond to Holland Brook	1.06	44.837 -63.562	Goffs	Preeper Pond	2.32	44.850 -63.549	Goffs
King	9.76	44.851 -63.519	Goffs	Juniper	1.62	44.847 -63.532	Goffs
Queen	4.60	44.850 -63.515	Goffs	Preeper Big	13.60	44.836 -63.526	Goffs
Rocky	4.60	44.812 -63.537	Goffs	Unnamed: N. of Second	1.57	44.788 -63.642	Windsor Jct.
Unnamed adjacent N. Three Mile	1.06	44.785 -63.627	Windsor Jct.	Unnamed in Winley Estates Park	3.57	44.785 -63.627	Fall River/ Windsor Jct.
Unnamed (Full of algae – difficult to see)	1.08	44.935 -63.547	Enfield	Unnamed bag-like	1.23	45.015 -63.589	Nine Mile River
Cranberry	1.70	44.889 -63.680	Beaver Bank	Sandy	4.62	44.883 -63.663	Beaver Bank

Table 4: BoMont Watershed Lakes > 1 ha							
Lake Name	**Lake Area(ha)**	**Location (Lat/Long)**	**Community**	**Lake Name**	**Lake Area(ha)**	**Location (Lat/Long)**	**Community**
Receiving Pond from brook from…	1.84	44.749 -63.628	Bedford	Sullivan	2.52	44.882 -63.576	Grand Lake
…holding pond from Rocky Lake Quarry (green)	1.76	44.749 -63.621					
No names (connected to North Brook to the east.	1.27	44.997 -63.607	Nine Mile River	Lizard	1.19	44.835 -63.621	Fall River
	1.12	45.004 -63.606	Nine Mile River	Unnamed (E. of the 102 – W. of L. Fletcher)	1.97	44.849 -63.570	Fletchers Lake

Water Flow Influences

Water flow rates in the BoMont watershed area, particularly with respect to Shubenacadie Grand Lake and Nine Mile River subwatershed areas (see *Map H: Restricted and Designated Land Use Areas* on page 72) may be assessed by reviewing the East Hants Floodplain Mapping Study; Final Report conducted by CBCL for the Municipality of East Hants in 2013. Notwithstanding that report, other key influences on water flow within the BoMont watershed area include the Shubenacadie Canal and the dams and reservoirs, as described below.

Shubenacadie Canal

The Shubenacadie River system flows across a major drainage divide due to the cut from the Shubenacadie Canal system at Lake Charles which causes water to flow both northwards to Cobequid Bay and south into Halifax Harbour. The Canal system was created in the early-mid 1800s and also played a significant role in impacting the hydrology of the BoMont watershed area. More details about the Shubenacadie Canal and its impact are described in section *2.3.3: Shubenacadie Canal System* on page 57.

Dams and Reservoirs

There are four (4) manmade dams in the BoMont watershed area indicated through GIS data (illustrated on *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43), three of which appear to be associated with Nova Scotia Power Inc. (NSPI):

- a dam off Hall's Road in Enfield, purpose/affiliate unknown;
- a dam and spillway associated with the Miller Lake NSPI power generating station reservoir, located in Fall River where the 118 Hwy. splits from the 102 Hwy;
- a dammed brook in North Beaver Bank, (creating a pond) running through the middle of a power line corridor, 1.32km east of where the Beaver Bank Road crosses the power line corridor Nickolson Road, a private and gated road; and
- a dammed-off portion of Beaver Pond Brook, north of a major transmission station on Brushy Hill Road in Beaver Bank and the same power line corridor as above . The latter two are assumed to be associated with NSPI due to their placement on or near power line corridors; and

Bathymetry

The maximum depths and surface area of the BoMont watershed area headwater lakes are 28m and 138.6ha for Lake Charles, 28.4m and 301.88ha for Lake William, 14m and 113.36ha for Lake Thomas, 11m and 100.47ha for Lake Fletcher and 36m and 1821.0ha for Grand Lake (including Little Grand lake) (see bathymetry maps in *Appendix 1: Bathymetry of Headwater Lakes in BoMont Watershed Area* on page 162).

Water Budget

The water budget for the BoMont watershed is currently unknown. As reported in the Nova Scotia Watershed Assessment Project (NSWAP), there is a lack of water budget information. Water budgets are important not only for assessing the risk to available water now and in the future, but also to calculate the flushing rates of lakes. Flushing rates help to determine the rate of eutrophication, which is based on soil types, precipitation, evaporation, lake depth and land area. **It is recommended that the water budget for BoMont be calculated to help evaluate future risks and impacts to the BoMont water supply.**

Water Quality

Factors known to commonly influence water quality in Nova Scotia surface waters are:

- climate related events (e.g. air temperature, precipitation, and seasonal flows);
- watershed characteristics (e.g. forest cover, amount of wetlands, land use, bedrock geology and soil type); and
- pollution sources (point and non-point).

Water quality is discussed further in section *5.4: Source Water Quality Monitoring Program* beginning on page 138.

2.2.7 Climate

The climate research stations most relevant to BoMont are the Stanfield Halifax International Airport; Mount Uniacke and Westphal which provides a range of locations throughout the watershed area, Halifax Stanfield International Airport being the central location, Westphal being the most southerly and closest to the coast, and Mount Uniacke being the highest elevation area in the watershed.

The weather data Normals between 1961 to 2010 indicates: temperature in all three locations has increased over this timeframe, although more so at the airport and Mount Uniacke (0.5 degrees C) than near the coast (0.2 degrees C); total precipitation has decreased (by ~78mm) at the airport, fluctuated in Mount Uniacke (i.e., increased between 1971 and 2000 by ~41mm, then decreased by ~37mm between 1981 and 2010); and increased (by ~56mm) over this timeframe near the coast. Wind speeds at the airport decreased over this timeframe.

The inland portion of the watershed area, which is not as affected by the influences of the Atlantic, experiences slightly warmer summers and cooler winters with much less wind exposure than the coastal area. Variations in temperature and precipitation are influenced in part by proximity to the Atlantic coast and by latitude, as the data suggests.

Additionally, "*downscaled models of extreme precipitation events indicate that 100 year events will become 50 year events by the year 2100*"[8] such that higher amounts of precipitation will fall in a shorter period of time. These types of rainfall events have the potential to greatly impact water quality through erosion and sedimentation, which often accompanies such events, thereby increasing the risk of contamination to drinking water supplies.

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* DeRomilly and deRomilly Limited, Dillon Consulting Limited, Allen Bell Environmental Management Services, Cameron Consulting, Environment Canada, Inter-Cultural Development Innovations. September 2005. *Adapting to a Changing Climate in Nova Scotia: Vulnerability Assessment and Adaptation Options*. p. 35. Website accessed March 9, 2015: https://climatechange.novascotia.ca/sites/default/files/uploads/Adapting_to_a_Changing_Climate_in_NS.pdf .

Precipitation Response

Runoff rates are influenced by precipitation as just described. During high water discharge times, rock formations, such as exposed pyritic slate, can create water quality problems. When pyritic slates are exposed to water and oxygen, sulphuric acid is produced which can lead to fish kills. Peat moss can also create acidic conditions in lakes. Moreover, increased acidity causes aluminum, cadmium, lead and other potentially toxic metals to leach into waterways.

2.2.8 Flora and Fauna

The main influences on regional vegetation are a unique combination of inland and coastal climate conditions; sandy, acid soils; mixed drainage; extensive disturbance by fire and human activities including former logging, agriculture, and mining practices; and current development.

Due to the size and diversity of the BoMont watershed area, there are many species of flora and fauna that exist within the watershed area.

2.2.9 Cultural and Social Environment

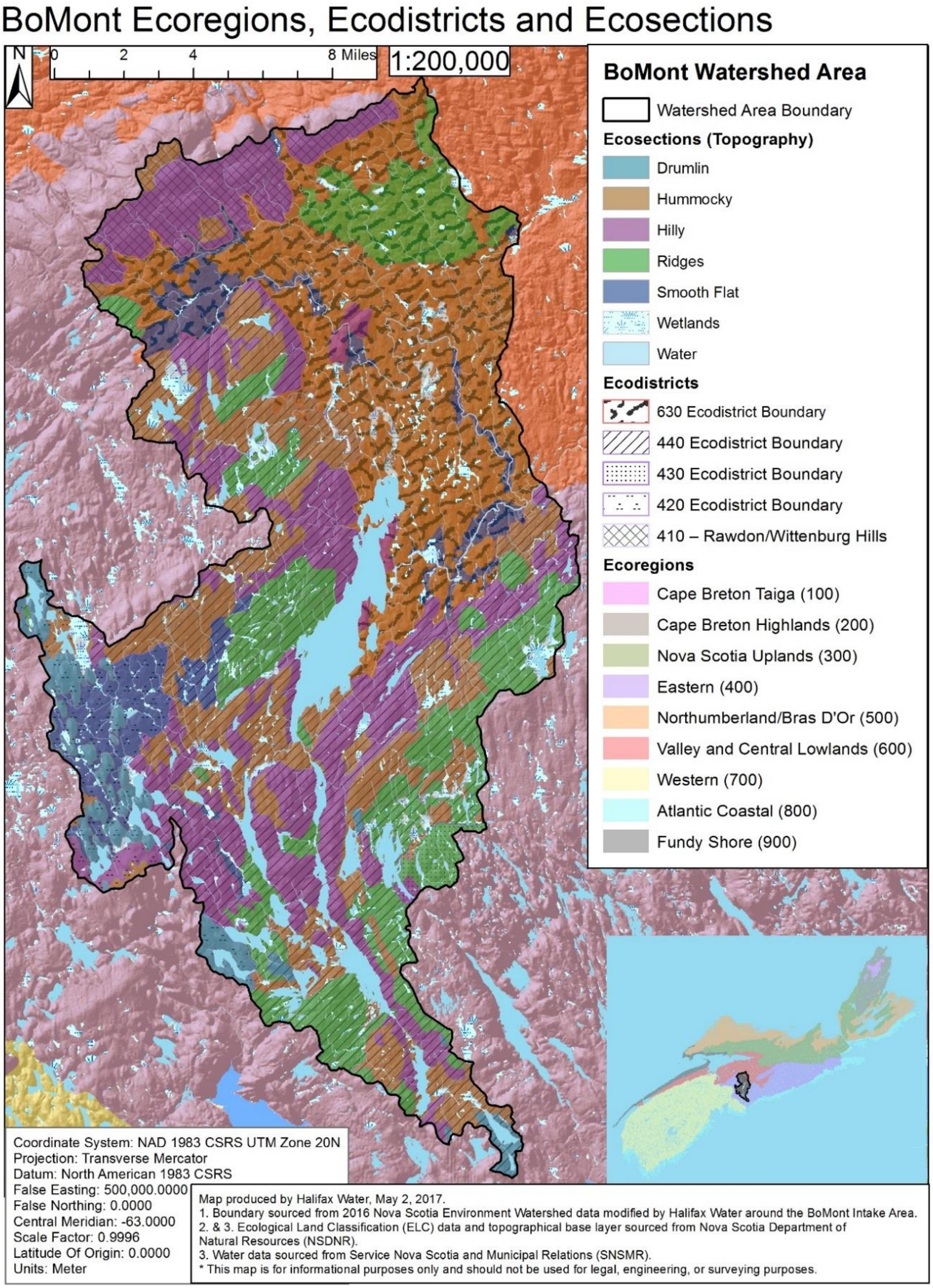
There are 43 whole or partial communities within the BoMont watershed area, including two First Nations communities (Sipekne'katik (Indian Brook IR 14) and Sipekne'katik (Shubenacadie IR 13)), as illustrated on *Map F: Communities* on page 44 and outlined in *Table 5: Communities and Areas within BoMont Watershed (including water areas)* on page 37.

Table 5: Communities and Areas within BoMont Watershed (including water areas)

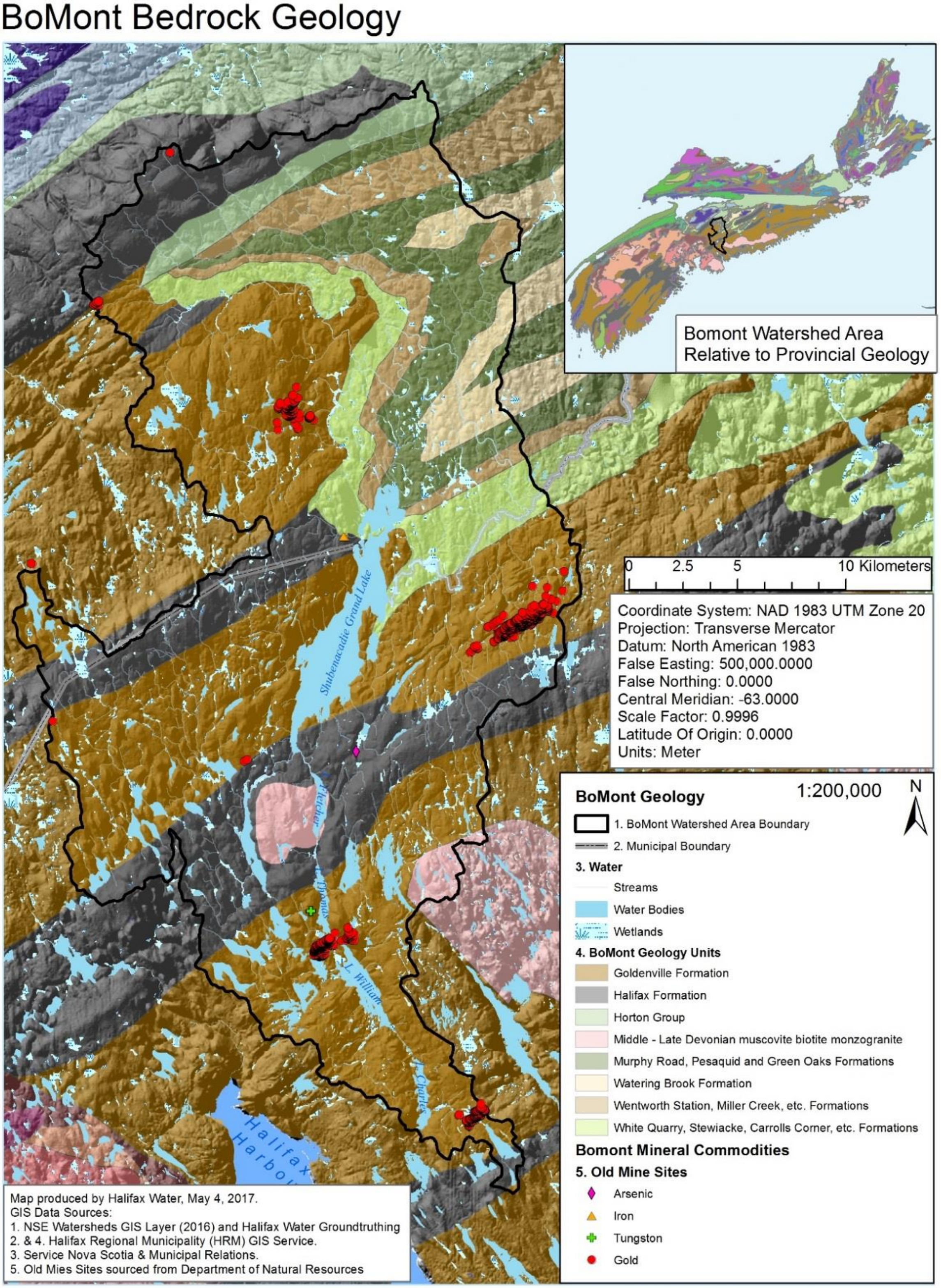
Community	Municipal Unit	Area (ha) of Whole Community*	Area (ha) of Community in BoMont	% of Community in BoMont
Barr Settlement	East Hants	837.21	105.21	12.57
Beaver Bank	Halifax	9023.70	8593.35	95.23
Bedford	Halifax	4690.78	335.30	7.15
Belnan	East Hants	1544.10	1252.40	81.11
Cole Harbour	Halifax	1792.70	15.39	0.86
Dartmouth	Halifax	7579.66	1335.91	17.62
Devon	Halifax	11335.20	383.52	3.38
Dutch Settlement	Halifax	3496.84	0.08	0.00
East Gore	East Hants	2908.38	636.58	21.89
East Uniacke	East Hants	8866.92	1183.51	13.35
Elmsdale	East Hants	789.94	782.58	99.07
	Halifax	849.07	744.08	87.63
Enfield	East Hants	6476.52	5919.12	91.39
	Halifax	2270.66	2270.66	100
Fall River	Halifax	3770.60	3768.09	99.93
Fletchers Lake	Halifax	632.54	632.54	100
Goffs	Halifax	9212.98	4190.1	45.48
Gore	East Hants	2318.54	120.89	5.21
Grand Lake	Halifax	670.29	670.29	100

Table 5: Communities and Areas within BoMont Watershed (including water areas)				
Community	**Municipal Unit**	**Area (ha) of Whole Community***	**Area (ha) of Community in BoMont**	**% of Community in BoMont**
Hardwood Lands	East Hants	4093.64	1770.45	43.25
Sipekne'katik (Indian Brook IR 14)	East Hants	1235.29	182.59	14.78
Kinsac	Halifax	104.34	104.34	100
Lake Loon	Halifax	762.53	219.91	28.84
Lakeview	Halifax	194.70	194.70	100
Lantz	East Hants	878.53	81.86	9.32
	Halifax	198.71	n/a	n/a
Lower Sackville	Halifax	1985.06	923.27	46.51
MacPhee's Corner	East Hants	4418.55	1314.93	29.76
Middle Sackville	Halifax	2603.51	872.89	33.53
Montague Gold Mines	Halifax	985.97	364.54	36.97
Nine Mile River	East Hants	8893.86	8893.86	100
North Preston	Halifax	3928.90	8.54	0.22
Oakfield	Halifax	1229.00	1229.00	100
Oldham	Halifax	1138.01	893.31	78.5
Rawdon Gold Mines	East Hants	3642.98	116.41	3.2
Sipekne'katik (IR 13)*	Halifax	397.00	397.00	100
South Uniacke	East Hants	509.61	123.57	24.25
Upper Nine Mile River	East Hants	3843.78	3733.74	97.14
Upper Rawdon	East Hants	7689.31	5656.06	73.56
Upper Sackville	Halifax	2333.26	388.07	16.63
Waverley	Halifax	6076.80	3907.03	64.29
Wellington	Halifax	5495.48	5495.48	100
West Gore	East Hants	1196.12	16.95	1.42
West Indian Road	East Hants	1848.96	1429.27	77.3
Westphal	Halifax	856.70	54.96	6.42
Windsor Junction	Halifax	956.35	956.35	100
*Sipekne'katik (IR 13) (land area) is included within the communities of Wellington (~389 ha) and Enfield (~8 ha).				

Map A: Ecoregions, Ecodistricts and Ecosections

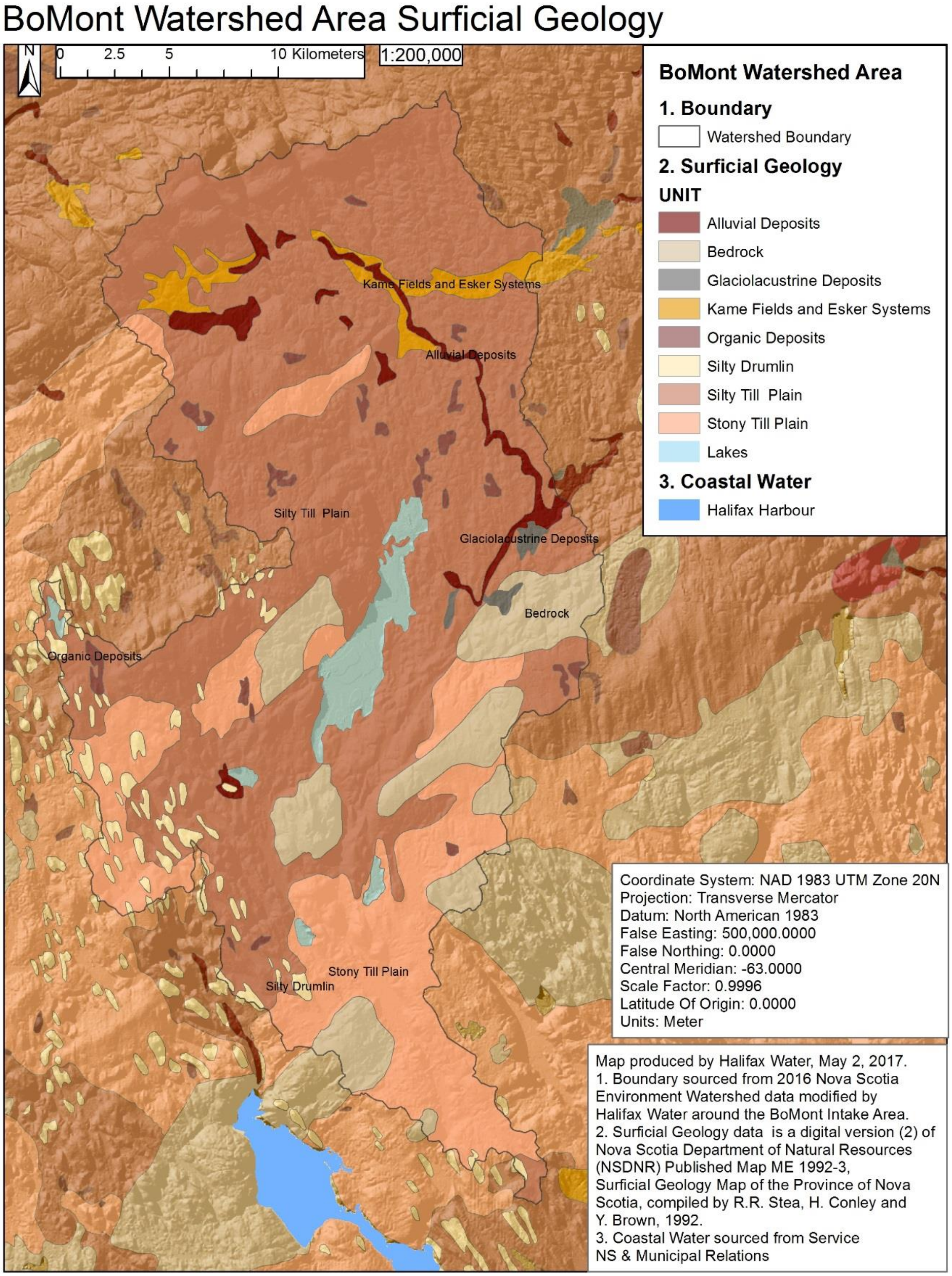


Map B: Bedrock Geology



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

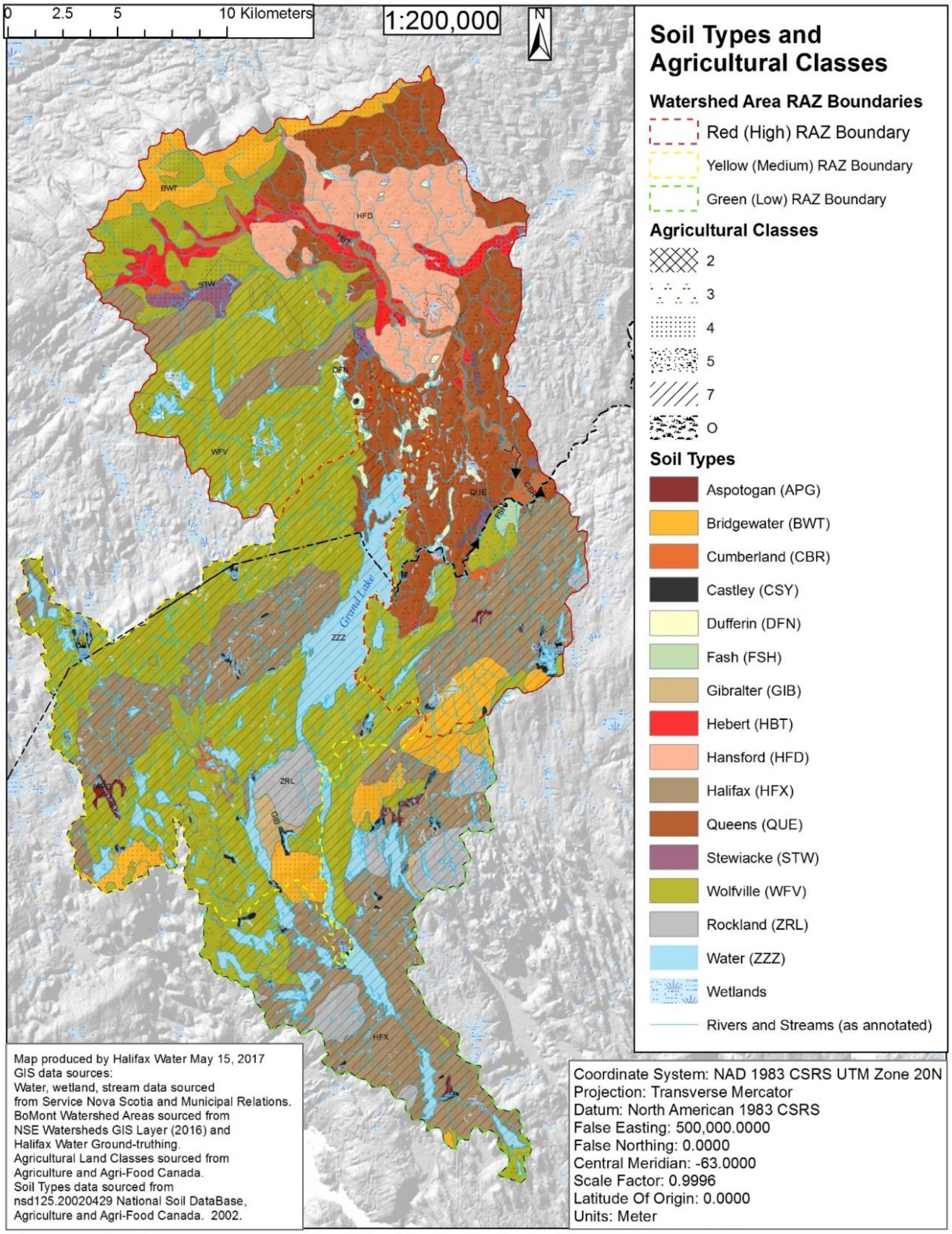
Map C: Surficial Geology



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

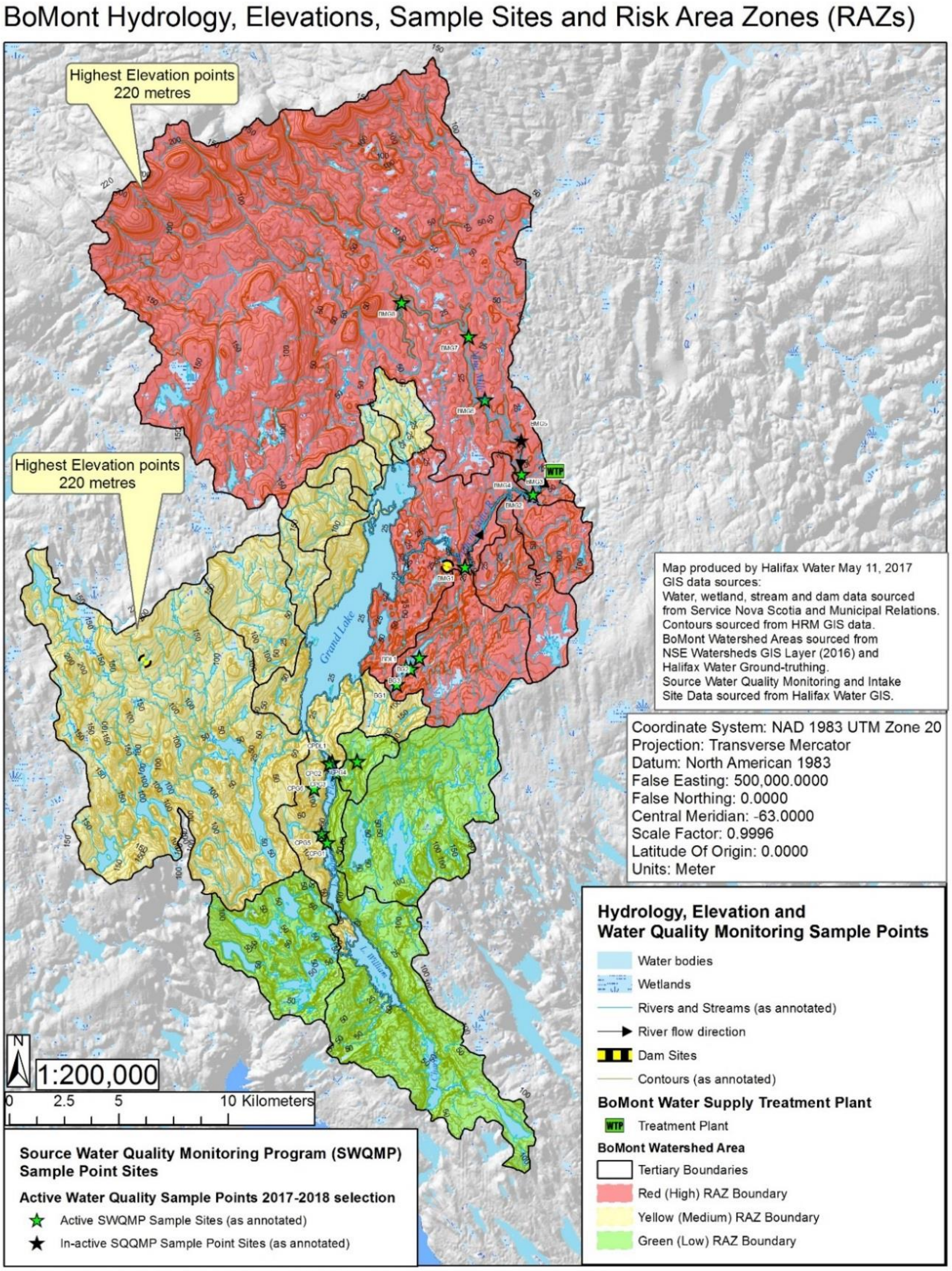
Map D: Soil and Topography

BoMont Watershed Area Soil Types and Agricultural Classes



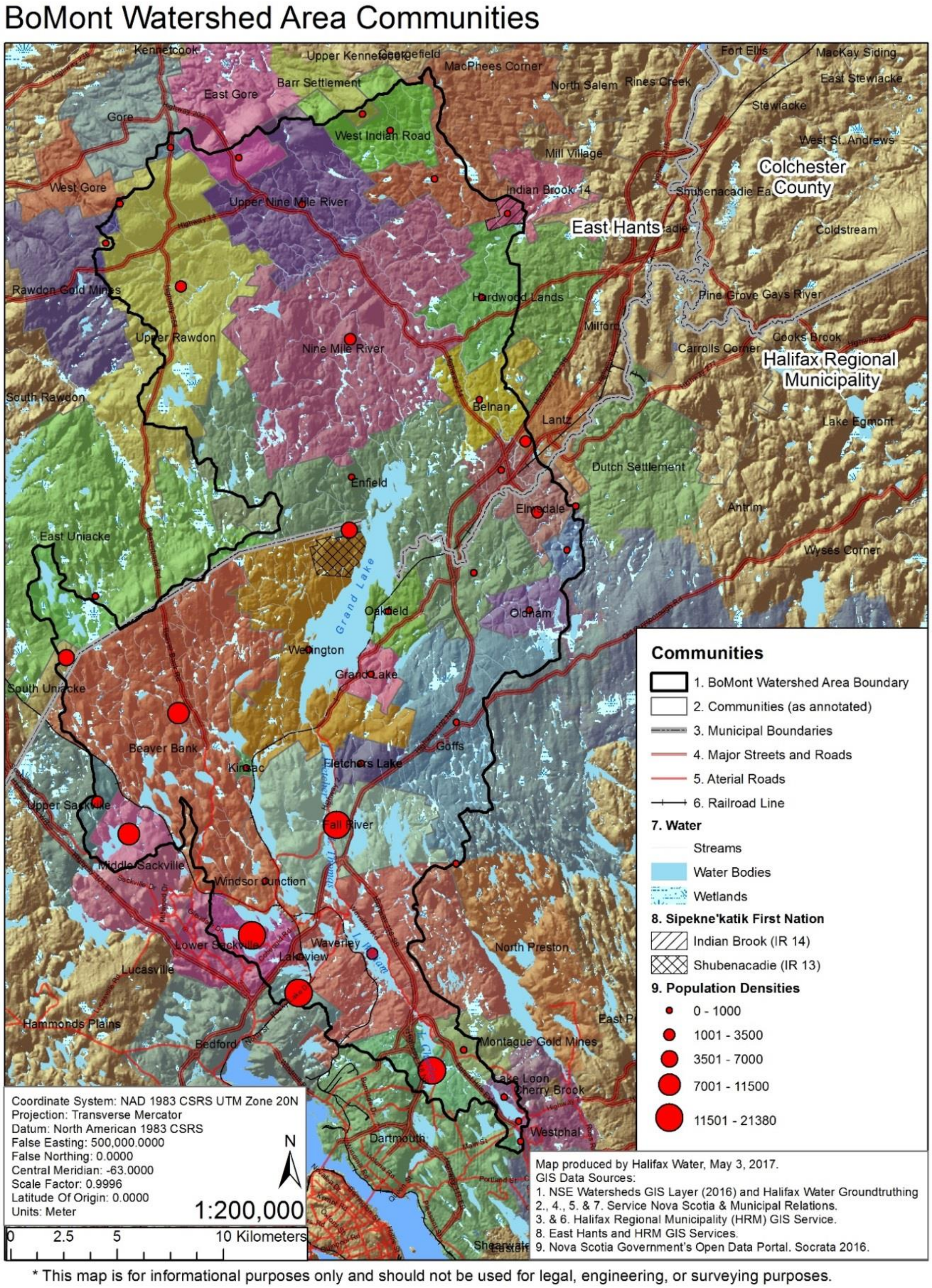
* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

Map E: Watersheds, Hydrology, Elevation and Sampling Points



* This map is for informational purposes only and should not be used for legal, engineering or surveying purposes.

Map F: Communities and Populations



2.3 Watershed Profile

This section of the SWPP describes the location, natural land cover, built form and landownership characteristics of the BoMont watershed area (BoMont).

2.3.1 Location

BoMont extends ~71876.55ha across most of central Mainland Nova Scotia, between the communities of Dartmouth to the south and MacPhee's Corner to the north. BoMont is split almost evenly between two municipal units; i.e., Halifax Regional Municipality (HRM) (38,860.59ha or ~54%) and the Municipality of East Hants (33,428.16ha or 46%)[9],whereas the HRM portion of the watershed captures most of the headwaters region; while the Nine Mile River subwatershed area, makes up most of the East Hants portion and corridor region of the watershed area (see section *2.2.6: Watershed Areas* on page 29).

2.3.2 Land Cover

The land cover of the watershed area is highly varied, from natural forest stands to urban development as illustrated in *Table 6: Land Class and Cover Categories in BoMont Watershed Area* below and *Map G: Land Cover* on page 71.

Table 6: Land Class and Cover Categories in BoMont Watershed Area

Forest and Non Forest Categories	Total Area(ha)	% of Watershed
Forest Cover	49,566.02	68.96
Wetlands & Shrubs	1107.97	1.54
Waterbodies	5472.41	7.61
Barren/ Non-vegetated*	4763.04	6.63
Agriculture**	4104.31	5.71
Developed	6818.83	9.49

*Barren/ Non-vegetated is defined as any land area considered to be in a low to non-productive forest state which includes barrens, rock barrens, pits and quarries, and old mine sites

**Agriculture is defined as any area in hay field, pasture (including the field in Oakfield Park) tilled crops, blueberry fields, orchards that contain no merchantable tree species, golf courses.

2.3.3 Built Form

Based on the percentages outlined in *Table 6: Land Class and Cover Categories in BoMont Watershed Area* above and, the watershed area has undergone moderate-high anthropogenic alterations to at least 9.49% to accommodate, in particular, urban, suburban and exurban[10]

[9] In some instances land areas may not add up exactly due to a number of factors including overlap of community boundary areas and various data sets (e.g., Federal vs. Provincial). For consistency, however, the base watershed area figure used to calculate percentages of watershed land areas throughout this SWPP is 71,876.55 ha.

[10] Exurban development patterns are characterized as being the most land-consumptive residential pattern, creating isolated residential developments without services (therefore relying on on-site septic systems) in rural zoned areas, makes preserving farmland more difficult and generates urban traffic patterns on rural roads. This type of development has expanded particularly in the Nine Mile River and Belnan areas since the 1970s, when this development-type began expanding from approximately 100 acres to 1200 acres in the 2010s. Source: *East Hants Plan Review Background Paper Number 12 – Rural and Exurban Residential Development*; p.p. 3-4. Web-accessed February 3, 2017 at: http://www.easthants.ca/wp-content/uploads/2016/02/12-Exurban-Development.pdf.

settlement patterns. Rural landscapes also feature prominent anthropogenic alterations owing to forestry (68.96%) and agricultural (5.71%) industry practices within the watershed area. The subsections below describe these built forms and the land area or length of corridor they occupy, some of which travel through, over or around the natural land cover areas described in the previous section (*2.3.2: Land Cover* on page 45*)*, to support a population of approximately 110,000 people or over 10 percent of the provincial population.

Urban, Suburban and Exurban Settlement

Urban settlement on both sides of the East Hants/HRM municipal boundary within the BoMont watershed area is concentrated along the existing public highway system, along the two major transportation corridors (Hwy 102 and Hwy 2) that track from Halifax to Truro and Halifax to Windsor (Hwy 101 and Hwy 1) and around the major lakes and waterways (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

Collectively, the communities of Enfield, Elmsdale, Lantz, Milford and Shubenacadie are commonly known as the "Corridor" of East Hants. Only the Lantz, Enfield, and Elmsdale urban areas of East Hants fall within the BoMont watershed area. As these areas grew and municipal services were established, subdivisions were developed to accommodate automotive modes of transportation. Highway 2 is the major collector for the Corridor region, onto which all subdivisions empty; from Highway 2, subdivision commuters connect to Highway 102.

Approximately 60% of the East Hants population lives within the Corridor region which is "characterized by urban and residential settings, a concentrated business environment, and a growing population and strong community setting."[11] A diverse mix of businesses exists along the Corridor – from restaurants to retail and agriculture. It is also home to the Elmsdale and Milford Business Parks.

On the HRM side of the BoMont watershed area, urban settlement is concentrated around the communities of Waverley, along the Waverley Road; around Lower, Middle and Upper Sackville and Beaver Bank; around Lake Fletcher, Wellington, Grand Lake and Oakfield along Highway 2; and in the communities of and between Bedford, Windsor Junction, and Fall River.

In the Waverley, Fall River, Fletchers Lake, Lakeview and Windsor Junction areas, a more urban pattern has become established, particularly since the early 1980s, when new subdivisions created new side streets and small village-style centres became evident at important intersections, which also empty onto Highway 2 and subsequently to the 100 series highways 118 and 102, as in the Corridor region of East Hants.

In the Wellington, Grand Lake, Oldham, and Goffs areas, linear development along existing roads remains the dominant pattern, although new subdivisions have continued to grow in these communities. These areas maintain a mix of land uses whereby commercial and resource-related uses are interspersed with residential development. The use of a residential property for some type of business activity is also common. The HRM communities of Enfield and Oakfield

[11] East Hants: Business – Location – Economic Zones – Highway 102 Corridor. 2017. Website accessed January 3, 2017 at https://www.easthants.ca/business/location/economic-zones/highway-102-corridor/

historically exhibited a linear type of development; however, an increase in subdivision activity and transition to a more suburban community is becoming more evident in these communities.

Demographics and Socio-Economic Trends

BoMont communities along the Highway 102/Highway 2 corridor in both East Hants and HRM are among the few Nova Scotia municipal areas experiencing significant growth trends over the past few decades. This trend is particularly evident in the communities of Enfield, Elmsdale and Lantz in East Hants and Fall River and Middle and Upper Sackville in HRM. Descriptions of population growth trends are found under the population heading below, outlined in *Table 7: Population Density in BoMont Watershed Area* on page 48 and illustrated on *Map F: Communities and Populations* on page 44.

Population

For the purposes of this SWPP, a rough estimate of the watershed area population was determined by multiplying the 2011 census populations (outlined in *Table 7: Population Density in BoMont Watershed Area* on page 48) by the percentage of the urban communities contained within the BoMont watershed area (see *Table 5: Communities and Areas within BoMont Watershed (including water areas*) on page 37). This calculation results in an estimated total population of ~110,000 in the BoMont watershed area. The population centres, populations and their concentrations, and percent change over three decades (to provide a sense of growth trends) are also outlined in *Table 7: Population Density in BoMont Watershed Area* on page 48 and illustrated on (see *Map F: Communities and Populations* on page 44 and *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

Table 7: Population Density[12] in BoMont Watershed Area													
Community	Total Populations					Pop / sq. km / Census year					Percent Change		
	1991	1996	2001	2006	2011	1991	1996	2001	2006	2011	91-01	96-06	01-11
Dartmouth North	21,285	19,784	20,095	19,027	19,238	744.5	692.0	702.9	665.5	672.9	-5.9	-3.8	-4.3
Enfield	3,121	3,317	3,823	4,432	5,016	17.7	18.8	21.6	25.1	28.4	22	33.5	31.5
Nine Mile River	1,331	1,412	1,393	1,403	1,449	7.0	7.4	7.3	7.4	7.6	4.3	0	0
Elmsdale	1,637	2,138	2,632	2,670	3,034	51.7	67.5	83.1	84.3	95.7	60.7	24.9	15.2
Fall River	7,210	8,069	9,112	10,248	11,526	68.1	76.2	86	96.8	108.8	26.3	27	26.5
Lantz	2,591	3,150	3,296	3,308	3,326	35.2	42.8	44.8	45	45.2	27.3	5.1	0.9
Lower Sackville	22,275	23,656	22,417	21,442	21,379	1222.6	1298.4	1230.4	1176.8	1173.4	0.6	-9.4	-4.6
Middle Sackville	6,730	7,830	9,043	10,034	10,712	279.8	325.8	376.0	417.2	445.4	34.4	28.1	18.5
Mount Uniacke	3,182	3,367	3,321	3,361	3,501	12.7	13.5	13.3	13.4	14	4.7	-0.7	5.3
Upper Rawdon	1,710	1,803	1,791	1,810	1,873	5.4	5.7	5.7	5.8	6.0	5.6	1.8	5.3
Upper Sackville	808	830	882	995	1,024	35.9	36.9	39.2	44.2	45.5	9.2	19.8	16.1
Waverley	2,373	2,405	2,336	2,368	2,468	37.7	38.3	37.2	37.7	39.3	-1.3	-1.6	5.6
Beaver Bank	5,933	6,093	6,076	6,038	7,119	67.7	69.5	69.4	68.9	81.3	2.5	-0.9	17.1
Bedford	11,519	13,564	15,971	16,601	18,553	284.7	334.8	394.7	410.3	458.6	38.6	22.6	16.2
Sipekne'katik (Indian Brook IR 14)	784	953	941	1,026	1,099	58	70.5	69.7	75.9	81.3	20	7.7	16.8
Total/Average	94,480	100,367	105,130	106,769	113,328	307.48	318.38	323.89	323.77	332.15	16.6	10.27	11.073

12 Nova Scotia Government's Open Data Portal. Socrata 2016. Website accessed January 4, 2017 at https://data.novascotia.ca/.

Residential

Most East Hants residents (85.4%) live in single detached homes. Elmsdale, Enfield and Lantz have a higher than average number of semi-detached, row house and apartment units than the rest of East Hants. Commuting to work (assuming they are working in the Halifax/Dartmouth region) is longer for East Hants residents than for those of similar communities (i.e., Fall River, Beaver Bank, etc.) and the provincial average. This is due to the number of residents who work in HRM, the large size and mostly rural nature of the municipality and a small commercial sector compared to other municipalities.

Commercial Development Patterns

Within BoMont are five (5) commercial core areas in East Hants, one in Fall River, a small one in Wellington (consisting of a corner store, bakery and pizza shop) and others in Bedford, Beaver Bank, Dartmouth and Upper and Middle Sackville. These areas are regulated mixed use areas where development may be focused and are known as Village Cores or Community Cores. The largest commercial area in East Hants is not located in a village core; it is located around the Highway 102 interchange in Elmsdale. Altogether, East Hants has eight "notable" commercial areas, three of which are located in the BoMont watershed area: Elmsdale – around the 102 interchange; Elmsdale – around Highway 214 and Highway 2 intersection and Enfield. Others in the HRM portion of the watershed area include Dartmouth Crossing, the Bedford Common and the Fall River Village Core.

Particularly in the transportation corridor regions of the watershed area, the commercial areas facilitate automobiles. Commercial development in East Hants in particular "is a priority" for the municipality.

Rural Landscapes

Rural landscapes in the East Hants portion of the BoMont watershed area consist of a mixture of different uses including agriculture, resource extraction and housing (see *Map G: Land Cover* on page 71). Some properties contain both a house and a business such as a farm or a trucking company. Because rural zoning is permissive, many different uses exist side by side. There are many large agricultural buildings in the rural areas, such as barns and silos. Most homes are single family or mobile homes. Most buildings are placed on generous sized lots, away from the highway.

Within the HRM portion of the BoMont watershed area, rural landscapes are sparse; they consist primarily within the communities of Wellington, Grand Lake and Oakfield.

Home-based Businesses

Home-based businesses are dispersed throughout the rural areas in East Hants, especially within the agriculture sector.

Agricultural Landscape

The agriculture landscape is defined by the Canada Land Inventory (CLI) which was produced in the 1960s and 1980s and provides land capability classifications for agriculture among other rural land uses. The CLI Agricultural Capability Classifications presented in this SWPP is outlined in *Table 8: Canada Land Inventory Agriculture Capability Classifications* on page 51 and illustrated on *Map D: Soil and Topography* on page 42.

The CLI categorizes land into seven (7) agricultural land classifications based on soil quality for agriculture; eight (8) including the Organic Soils (e.g., peat) category, as illustrated on *Map D: Soil and Topography* on page 42. Assessment of these land areas provide valuable information with respect to soil structure, erosion and sedimentation characteristics, and other aspects that are important for determining which areas are more susceptible to erosion and sedimentation and have the potential to impact water areas.

Approximately 235,000 ha of provincial land are used for agriculture, including approximately 16,000 ha for wild blueberry production, amounting to 4.3%. Suitable agricultural land is concentrated in the Annapolis Valley, throughout most of Hants County and along the Northumberland Strait. Agriculture is very important to the East Hants economy and culture. Farming supports village and rural economies. East Hants has both a large farm economy and a large amount of land that is suitable for farming.

However, not all land that is suitable is necessarily used for agriculture in the province or in the BoMont watershed area, as illustrated on *Map G: Land Cover* on page 71. According to the 2011 Canadian Census on Agriculture, there are 192 operating farms within the BoMont watershed.

> *"As can be seen by the Canada Land Inventory Soil Capability for Agriculture map some of the best soils for agriculture are located outside of the planned area of East Hants and are not protected by the Agricultural Reserve (AR) Zone. Any type of development could take place on these lands or the lands could be used for topsoil removal. As part of the agricultural policy and regulation review that was completed in 2011, the Municipality established an ongoing Agricultural Advisory Committee that Planning Advisory Committee would consult with for agricultural issues that may arise, or if the Province introduced new municipal requirements regarding agricultural land. As part of the plan review process, the AAC will act as stakeholder for the agricultural community."* [13]

The Agricultural Classifications (see *Table 8* on page 51) overlay the areas where agriculture is actively practiced, as illustrated on *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75, which will help assess risks associated with Agriculture. See section *3.1.1: Agriculture* on page 81 for risks associated with Agriculture activities inside the BoMont watershed area.

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[13] Municipality of East Hants. September 2014. *Plan East Hants Community Inventory Report*. Document Number: 2. Planning and Development Department. p. 107

Table 8: Canada Land Inventory Agriculture Capability Classifications			
Capability Class	Definition	BoMont Land Area / Watershed %	
		Hectares (ha)	Percentage (%)
1	Soils in this class have no significant limitations in use for crops. (Damage from erosion is slight)	0	0
2	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. (have good water-holding capacity and have moderate effects of erosion)	322.45	0.45
3	Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. (**Moderately severe effects of erosion**; very slow permeability; **moderate to strong slopes**; poor drainage; **low water-holding capacity** or slowness in release of water to plants; moderate salinity).	21,415.37 ha	29.8%
4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both. 9Very low water-holding capacity; strong slopes; severe past erosion; slow permeability; more than 1 foot of soil over bedrock or an impermeable layer. Emergency tillage and crops used only for the primary purpose of preventing soil deterioration	4,944.29	6.88
5	Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. Serious soil limitations include low-water-holding capacity, severe past erosion, steep slopes very poor drainage; very frequent overflow; severe salinity; stoniness or shallowness to bedrock that make annual cultivation impractical. Some soils adapted to blueberries.	116.32	0.16
6	Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Have natural sustained grazing capacity for farm animals but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out in Class 5. Very low water-holding capacity; very steep slopes, very severely eroded land with gullies too numerous and too deep for working, very saline; very frequent overflow allowing less than 10 week effective grazing ; water on surface of soil for most of the year; shallowness to bedrock.	0	0
7	Soils in this class have no capability for arable culture or permanent pasture. Bodies of water too small to map are included in this class.	44,473.34	61.88
Organic Soils	Organic Soils	604.78	0.84

Utilities

Nova Scotia Power, Heritage Gas, Halifax Water, and the Municipality of East Hants are the agencies with jurisdiction over the protection and maintenance of the electrical power, natural gas, water, wastewater, stormwater utility functions and the corridors within which they rest within the BoMont watershed area. Details on these systems are described under the heading of the responsible agency's name below and illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Nova Scotia Power Incorporated

Approximately 172km of Nova Scotia Power Incorporated (NSPI) transmission lines run through the BoMont watershed area. The power line system includes three transformer substations. One is located in the communities of Goffs (Aerotech Park, ~150m west of Preeper Pond), a second in Beaver Bank and a third in Elmsdale on the East Hants side, 170m north of the Shubenacadie

River on Elmsdale Road. The power transmission line corridor locations within the watershed area are illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Natural Gas Pipeline

The natural gas distributor for Nova Scotia is currently Heritage Gas Limited (HGL), a Nova Scotia-based company that operates a full regulation class natural gas distribution franchise in Nova Scotia. Heritage Gas Limited is an indirect wholly-owned subsidiary of AltaGas Utility Group Inc., a wholly-owned subsidiary of AltaGas Ltd.

With respect to BoMont, as illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76, the natural gas enters BoMont in the community of Goffs, wherein it travels increasingly closer to the Shubenacadie River system; i.e., approximately 2km from Lake Fletcher, slightly less than 2km from Bennery Lake and approximately 500m from where Highway 102 crosses Lake Thomas. The pipeline continues to travel through BoMont by following along the east side of Highway 118 to Dartmouth and crossing over the Shubenacadie River in the community of Waverley at the outlet of Lake Charles. The pipeline continues in a southwest direction across the watershed area, exiting into Dartmouth's Burnside Business Park west of Juniper Lake (except where it branches off inside the watershed area to service Dartmouth Crossing and the Keystone Village subdivision).

The total amount of gas pipeline within the BoMont watershed area is divided into two types – the gas pipe and the transmission line. The gas pipe is located in areas where gas service is provided, as in the commercial districts and subdivisions; and the transmission line distributes the gas to and between service locales. There is a total of 13.07km of gas pipe in three locations within the BoMont watershed area; Aerotech Park (9.07km), Dartmouth Crossing (3.46km) and Keystone Village (0.54km). Additionally, there is 21.85km of gas transmission line that travels through the watershed area in the communities of Goffs, Fall River, Waverley and Dartmouth.

Water, Wastewater and Stormwater Service and Infrastructure

Within East Hants and HRM are various combinations of private and public water, wastewater and stormwater service operations and supporting infrastructure systems. The operational boundary area for all HRM (Halifax Water) services covers 76,525.5ha. The operational services region within the HRM portion of the BoMont watershed area covers the bottom third of the watershed area, 15,585.7ha, from Wellington to Cole Harbour. In addition to the two small-system water supply areas in this region (described under the Municipal Water heading below), the BoMont operational service areas include the BoMont water-only supply area; the five (5) wastewater sewersheds described in section *2.3.3: Municipal Wastewater Systems: Halifax Water* on page 54; the Aerotech Park and Halifax Stanfield International Airport Authority (HIAA) for both water and sewer; and stormwater areas as described under the *Stormwater, Erosion and Sedimentation* heading on page 56. All are illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Within the East Hants portion of the BoMont watershed area, the serviceable area is delineated by the Growth Management Area (GMA), as defined by the municipality- amounting to 1016.5ha, situated within the communities of Enfield (294.57ha), Elmsdale (605.64ha), Belnan (42.71ha) and Lantz (73.57ha). There are also two portions of the Mount Uniacke GMA amounting to 74.22ha within the watershed area, the majority of which is in the South Uniacke community (73.75ha). The subsections below briefly describe the various systems and where they are situated, as illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Municipal Water Supply Systems

There are six potable water supply systems that are located within the BoMont watershed area; four that Halifax Water is responsible for and two that the Municipality of East Hants is responsible for. Through the utilization of programmable logic controllers and Supervisory Control and Data Acquisition (SCADA) instrumentation, the plant operators monitor and adjust the treatment process to ensure that the output is of the highest possible quality. Water Supply Plant staff are all certified operators in compliance with the Nova Scotia Environment and Labour Certification Program. Each system is described below, under the respective governing agency and system heading.

Halifax Water

HRM (Halifax Water) operational water service areas within the BoMont watershed area amount to 4159.63ha and include four public water supply systems: Bennery Lake Watershed Protected Water Area surface water supply; Miller Lake groundwater supply; and Collin's Park and BoMont small system surface water supplies. These systems are described briefly below and illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Bennery Lake Watershed Protected Water Area

The Bennery Lake water supply plant (WSP) is located between Highways 102 and 2 which services the Halifax Stanfield International Airport and the Aerotech Business Park. For more details on this system please visit http://www.halifax.ca/HalifaxWater/WaterQuality/treatment.php.

Miller Lake Wellhead

The Miller Lake WSP which services the Miller Lake subdivision is located at 138 Miller Lake Road, adjacent to Miller Lake and Highway 102. For more details, please visit http://www.halifax.ca/HalifaxWater/WaterQuality/treatment.php.

Collin's Park Small System Water Supply

The Collin's Park WSP is located at 4123 Highway No. 2, in Wellington. Collin's Park WSP draws its source water from Lake Fletcher, part of the Shubenacadie River system-headwaters region, services a portion of Highway 2, Collin's, Anthony, Carlhealth and Dayhollow drives, Jeffrey Lane and Brook Street. For more details please visit http://www.halifax.ca/HalifaxWater/WaterQuality/treatment.php.

BoMont Water Supply System

The BoMont WSP is located at 317 Old Trunk Road, Elmsdale, in HRM. The BoMont WSP draws its source water from the Shubenacadie River and services the BoMont Subdivision on the HRM side of the Shubenacadie River Elmsdale. For more details please visit http://www.halifax.ca/HalifaxWater/WaterQuality/treatment.php.

Other HRM Water Supply Services

Other central water services within the watershed area are provided through the Pockwock (J.D. Kline) and Lake Major Primary WSP distribution systems. Pockwock delivers piped water to Central Distribution Region communities including Cobequid Road in the community of Lower Sackville, as well as the communities of Windsor Junction and Waverley. Fall River may soon tap into this distribution system to service customers along Fall River Road, as per the Water Service Extension in Fall River Community Council Report Item No. 14.1.6, dated November 8, 2016, regarding the extension of central water services along Fall River Road.

Lake Major delivers water to the Eastern Distribution Region communities including Westphal, Lake Loon, Montague Mines and Waverly along the southern section of Waverly Road and Spider Lake Subdivision (see *Map L: Utility (Power, Water, Gas) Corridors* on page 76 and *Map M: HRM Primary Water Supply Watershed and Distribution Areas* on page 77. For more details please visit http://www.halifax.ca/HalifaxWater/WaterQuality/treatment.php.

East Hants

The municipality of East Hants, through the East Hants Water Utility, operates two water supply systems within the watershed area – Enfield Water Supply Plant (WSP) that services the communities of Enfield, Elmsdale, and Lantz; and a bulk water station, located on the west side of Hwy 102, in community of Enfield, to supplement private water systems through user-pay system (see *Map L: Utility (Power, Water, Gas) Corridors* on page 76).

Dam Infrastructures

No dam infrastructures have been installed for the purposes of managing the BoMont water supply. However, there are dams within the watershed area, which are described in section *2.2.6: Dams and Reservoirs* on page 35.

Municipal Wastewater Systems

With respect to municipal waste water treatment systems, HRM (Halifax Water has five (5) systems within the BoMont watershed area while none of East Hants three (3) systems fall inside the BoMont watershed. Each system is briefly described under their respective headings below and illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Halifax Water

Halifax Water operates 5 municipal wastewater treatment plant systems within the BoMont watershed area with a total service area of 1787.29ha. The five systems and their effluent's receiving waters (in parentheses) are Aerotech (Johnson River), Springfield Lake (Lisle Lake), Fall River (Lake Fletcher), Wellington (Grand Lake) and Frame (Lake William). The details of each system are briefly described below and illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Aerotech

The Aerotech wastewater treatment (WWTF) facility serves the Aerotech Industrial Park and the Halifax Stanfield International Airport and is located at 449 Aerotech Drive in the community of Goffs. The receiving water is the Johnson River System. For more details please visit http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php

Springfield Lake

The Springfield Lake WWTF is located at 29 Lakeview Ave. and serves the Springfield Lake in the community of Middle Sackville. The receiving water is Lisle Lake. For more details please visit http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php

Fall River

The Lockview-MacPherson wastewater treatment facility serves the Lockview-McPherson Road area and is located at 96 Lockview Road in the community of Fall River. The receiving water is Lake Fletcher. For more details please visit http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php

Wellington

The Wellington (Steeves) WWTF serves the Wellington area is located at 12 Wellington Drive in the community of Wellington. The receiving water is Grand Lake. For more details please visit http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php

Frame

The Frame Subdivision WWTF serves the subdivision located at 65 Pembroke Street, in the community of Waverley. The receiving water is Lake William. For more details please visit http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php

Other HRM Wastewater Services

Other central wastewater services within the watershed include the areas around Lower Sackville which are serviced by Mill Cove WWTF located in the Bedford Basin and Westphal-Lake Charles area which is serviced by Eastern Passage and Dartmouth WWTF's respectively (see *Map L: Utility (Power, Water, Gas) Corridors* on page 76). None of these WWTF are located within watershed area. For more details please visit http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php

East Hants

Only the Lantz WWTP services the BoMont watershed area, however the WWTP and outfall are below the BoMont watershed and intake as illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

Other Waste Water Treatment Systems

The locations and maintenance status of private on-site sewage septic systems, which are the typical system used on residential lots; and waste water treatment plants that service commercial facilities are currently not publically available without going through FOIPOP (*Freedom of Information and Protection of Privacy Act*); however, discussion at the 2016 Wastewater Association Annual meeting (which Halifax Water staff attended) indicated that on-site septic system data should become available through Nova Scotia Environment in the future.

Stormwater, Erosion and Sedimentation

Within HRM, the stormwater service boundary area covers the HRM core area, encompassing the most densely populated (urban and suburban) areas of HRM; i.e., from Sunnylea Road in Wellington in the north, to Upper Hammonds Plains in the west, from North Preston to Cow Bay in the east and Herring Cove in the south. In East Hants, the stormwater boundary area is delineated by the Growth Management Area; i.e., portions of the Enfield, Elmsdale, Lantz and Milford (and part of Belnan) East Hants Corridor Region (see area illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76).

Within BoMont, the HRM core area and East Hants Growth Management Area are where stormwater runoff needs to be managed, due to the prevalence of impervious surfaces such as concrete, asphalt and roofs, which prevent water from being absorbed into the ground. Within HRM, stormwater management is proposed (February 14, 2017) to be managed through stormwater rate fees. The new cost-for-service regime being proposed by Halifax Water to the Utilities and Review Board (UARB) is to account for the amount of hard surfaces on a given property as the means to calculate the stormwater fee charged to each landowner. This rating scenario theoretically will reduce the disruption to or encourage the increase in vegetation and natural areas, resulting in less impervious surfaces when building and designing urban and suburban infrastructure. Currently, HRM Bylaws allow a percentage of a lot to be covered with impervious surfaces in its design regulations. The percentage of impervious coverage is dependent on the Community Plan.

The municipality of East Hants stormwater management practices are outlined in its floodplain study, conducted by CBCL[14], and reported on in its *Plan Review Background Paper (#3)*[15]. Prior to approval, all subdivision plans within East Hants must prepare a stormwater management plan based on the requirements outlined in the *East Hants Official Community Plan: Subdivision Bylaw*[16].

Transportation and Trade Corridor Infrastructure

Approximately 2154.73km of the BoMont watershed area has been converted to various forms of paved and unpaved transportation infrastructure, including roads, railways and recreational trails. The following subsections outline the corridors with the most impact on the watershed and are outlined in *Table 9: BoMont Transportation Corridor Length and Agency Responsible for*

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14 CBCL Limited. November 4, 2013. *East Hants Floodplain Mapping Study: Final Report*. Web-accessed http://www.easthants.ca/wp-content/uploads/2016/02/2013-cbcl-floodplain-study-final-report.pdf.

15 East Hants Planning and Development Department. January 2015. *Plan Review Background Paper # 3: Floodways*; p. 5. Web-accessed January 20, 2017 at http://www.easthants.ca/wp-content/uploads/2016/02/3-Floodways.pdf.

16 East Hants. Policies and Bylaws: *Subdivision Bylaw; East Hants Official Community Plan Bylaw P-600, Section 12: Stormwater Drainage*. p. 26. July 2016. Web-accessed January 19, 2017 at https://www.easthants.ca/wp-content/uploads/2016/08/2016-Subdivision-Bylaw.pdf

Maintenance on page 58 and illustrated on *Map G: Land Cover in Risk Zone Areas (RAZ)* on page 71.

Shubenacadie Canal System

In the early 1800s, Sir John Wentworth had a vision to build a transportation canal system, using the Shubenacadie River system, between Cobequid Bay, Minas Basin and Halifax Harbour to achieve military and economic goals for the British North American colony – Nova Scotia. The subsequent development of the Shubenacadie Canal, beginning in 1826, and opening in 1861, spans 114kms of waterway, took 35 years to complete, contains 9 locks and helped to entrench western society and culture to the area.

The Nova Scotia railway eventually replaced the draw bridges that crossed the canal with fixed bridges, preventing boats from passing underneath, spelling an end to the canal as a commercial transportation route by 1870. Another factor which brought the canal to an end was the act of the Town of Dartmouth taking control of one of the canal's reservoirs for drinking water purposes.

Railway Corridor

BoMont contains 62.25km of active railroad track, owned by Canadian National Railway (CNR), which includes sections of tracks between Halifax and Truro (52.48km) and two sections (actually part of one railway line) amounting to 9.88km that run between Windsor Junction and Windsor. Part of this system could include commuter rail between Windsor Junction and the City of Halifax, which is currently being considered as a future public transportation option. Policies governing railways are described in section *2.4.1: Railway Policies* on page 62.

Motor Vehicle Corridors

Road surfaces within the watershed area upon which motorized vehicles travel are owned and maintained by, in order of amounts: HRM (437.26km); the province, i.e., Nova Scotia Transportation and Infrastructure Renewal (NSTIR) (341.23km); private interests (506.14km); East Hants (13.50km); the HIAA (7.63km); and the Federal government (2.59km).

Multiple road ownership/jurisdiction causes challenges in terms of which direction road and street network growth should take. Maintenance and ownership of these roadways involves maintenance of road surfaces, curbing and drainage ditches in the right of way. Through a service exchange with NSTIR, maintenance of East Hants roads includes road access approvals and snow clearing. According to East Hants' Snow and Ice Removal Service Standards for Roads and Sidewalks (January 2012), the Municipality only has responsibility for class J subdivision roads and no arterial or trunk roads. Otherwise, the maintenance of winter roads in East Hants is looked after by the NSTIR location in Milford. Road servicing arrangements between HRM and NSTIR are described in the subsections below.

An outline of roadway types, their length and ownership/service jurisdiction are outlined in *Table 9: BoMont Transportation Corridor Length and Agency Responsible for Maintenance* on page 58 and illustrated on *Map G: Land Cover in Risk Zone Areas (RAZ)* in page 71.

Air Traffic

The Halifax region's airspace is used by multiple users including: domestic and international flights arriving to and departing from the Halifax Stanfield International Airport; Canadian Armed Forces who are training at Canadian Forces Base Shearwater; and helicopter, non-scheduled tourism and non-commercial flights.

Under the Control Zone of the Halifax Stanfield International Airport aerodrome are four major runways 05, 14, 23 32 plus the Shearwater airport (CYAW). The runways, the use of which is governed by instrument flight rules, vector over the BoMont watershed area as shown on the Halifax Stanfield International Airport IFR Airport Charts[17].

In addition to runways, there are six airways or "highways" that have specific radar vectors for planes to gravitate or merge into when landing on or taking off from runways, all of which vectors within the class D airspace of the Halifax airport transect over the BoMont watershed area as shown on the VFR Navigation Charts[18].

Recreational Trails

Trails are a popular form of transportation and recreation. Official trailways amount to 783.97km and are located throughout the BoMont watershed area. However, unmapped trails, visible through Google Maps© used by off-highway vehicles, as well as hikers are pervasive in the watershed area.

Table 9: BoMont Transportation Corridor Length and Agency Responsible for Maintenance

Corridor Type and Name (includes ramps, bridges, medians and other associated roadways.)		Length in BoMont (km)	Responsible Agency	Description
Highways (100 Series)	102	57.84	NSTIR	From Lantz to Fall River
		19.32	HRM	From where 102 and 118 split in Fall River.
	107	13.23	HRM	From Burnside through Waverley to Westphal
	118	39.33	HRM	From where 102 and 118 split in Fall River.
		0.81	NSTIR	Around exit 14
Arteries (Secondary Provincial)	2	17.48	NSTIR	Lantz to Wellington; where #2 Hwy. meets Sunnylea Rd.
		9.72	HRM	From Wellington at Sunnylea Rd. to the point where Rocky Lake and Waverley roads fork.
		0.78	HRM	Ramp in Elmsdale where #2 and 214 intersect.
	7	0.78	East Hants	From Forest Hills Parkway at Main St. intersection to just past Montague Rd. intersection in Westphal
	14	25.23	NSTIR	Travelling west to east through the watershed area, from Rawdon Gold Mines to Hardwood Lands.

[17] Nav Canada: Information on proposed changes to arrival routes for Halifax Stanfield International Airport. Web-accessed April 27, 2017 http://www.navcanada.ca/EN/media/Documents/Information%20on%20proposed%20changes%20Halifax%20Airport.pdf.

[18] International Virtual Aviation Organisation; Canadian Division: VFR Navigation Charts. Web-accessed April 27, 2017 https://www.ivao.aero/flightops/divprocedures.php?id=CA.

Table 9: BoMont Transportation Corridor Length and Agency Responsible for Maintenance				
Corridor Type and Name (includes ramps, bridges, medians and other associated roadways.)		**Length in BoMont (km)**	**Responsible Agency**	**Description**
Collector	202	2.86	NSTIR	Entering watershed area at East Gore, travelling south through Upper Nine Mile River meeting Hwy #14 just before Indian Road.
	212	2.52	NSTIR	Also called Old Guysborough Rd., off Pratt and Whitney Dr., travelling northeast along southeast boundary of airport property, parallel to runway.
	214	8.71	NSTIR	Road section between Highway #14 travelling southeast until it meets the Shubenacadie River, where road turns into local Elmsdale Road.
	354	21.59	NSTIR	Cuts western edge of BoMont boundary north to south from Gore through Upper Rawdon.
		7.32	HRM	Also called Beaver Bank Road, beginning at East Uniacke and Beaver Bank community boundary, ending just before Douglas Rd.
Local	Various Roads	2.59	Federal (DND)	Throughout the watershed area.
		7.63	Halifax Stanfield International Airport	
		211.52	NSTIR	
		347.56	HRM	
		12.72	East Hants	
		506.14	Unknown/ Private/ Undetermined	
Railway		62.25	Canadian National Railway	Halifax to Truro line travels from Windsor Junction through Lantz; Windsor to Windsor Junction line travels through watershed boundary at Lower Sackville.
Trailways (and Footbridges) (no motorized vehicles)		783.97	Various	Throughout watershed area, mostly near populated areas close to Dartmouth and Elmsdale.

2.3.4 Landownership

Landownership and how land is used are major factors in determining potential risks in the watershed area. Landownership is outlined in *Table 10: BoMont Watershed Area Landownership* on page 60 and illustrated on *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75. To better manage the size and range of the watershed area, especially with respect to identifying the potential for a variety of risks, landownership is described in a cursory way for the whole watershed area and in more detail in the highest risk area.

To establish where the highest risk areas are, BoMont has been divided into three Risk Area Zones (RAZ) – red (high), yellow (medium) and green (low) – as described in section *3.1: Inherent Risk Factors* on page 78 and illustrated on *Map H: Restricted and* on page 72. The landownership within the areas closest to the BoMont water supply intake - red RAZ - is most closely examined in this SWPP, as illustrated on *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73.

<table>
<tr><th colspan="7">Table 10: BoMont Watershed Area Landownership</th></tr>
<tr><th>Government Level</th><th colspan="3">Agency/Department/Municipality</th><th>Area (hectares)</th><th>Total Area (ha)</th><th>% of Watershed</th></tr>
<tr><td rowspan="9">Federal</td><td rowspan="2">Canadian National Railway</td><td colspan="2">HRM</td><td>152.05</td><td rowspan="2">176.81 (62.36 km)</td><td>0.21</td></tr>
<tr><td colspan="2">East Hants</td><td>24.76</td><td>0.03</td></tr>
<tr><td rowspan="2">Transport Canada</td><td colspan="2">Halifax Stanfield Internat'l Airport (HRM)</td><td>765.20</td><td rowspan="2">770.50</td><td>1.07</td></tr>
<tr><td colspan="2">Miscellaneous buildings/lots (5) in and around airport, including a lot adjacent to Bennery Lake (HRM)</td><td>5.30</td><td>0.01</td></tr>
<tr><td rowspan="2">Indian Affairs (Sipekne'katik)</td><td colspan="2">Shubenacadie (IR 13) (HRM)</td><td>412.81</td><td rowspan="2">495.40</td><td>0.57</td></tr>
<tr><td colspan="2">Indian Brook (IR 14) (East Hants)</td><td>82.59</td><td>0.11</td></tr>
<tr><td rowspan="2">Miscellaneous: CMHC, Canada Post, Grant Land (Mun.)</td><td colspan="2">HRM</td><td>0.92</td><td rowspan="2">1.45</td><td rowspan="2">0.00</td></tr>
<tr><td colspan="2">East Hants</td><td>0.53</td></tr>
<tr><td rowspan="15">Provincial</td><td rowspan="2">NS Environment (Protected Areas)</td><td colspan="2">Wilderness Area</td><td>859.33</td><td rowspan="2">1342.33</td><td rowspan="2">1.87</td></tr>
<tr><td colspan="2">Nature Reserve</td><td>483.00</td></tr>
<tr><td rowspan="2">DNR (Crown)</td><td colspan="2">HRM</td><td>6652.73</td><td rowspan="2">7984.87</td><td rowspan="2">11.11</td></tr>
<tr><td colspan="2">East Hants</td><td>1332.14</td></tr>
<tr><td rowspan="4">NSTIR (Transportation & Infrastructure Renewal)</td><td rowspan="2">HRM</td><td>Land Parcels</td><td>227.68</td><td rowspan="2">1305.12</td><td>0.32</td></tr>
<tr><td>Roadbeds</td><td>1077.44</td><td>1.50</td></tr>
<tr><td rowspan="2">East Hants</td><td>Land Parcels</td><td>4.46</td><td>4.46</td><td>0.01</td></tr>
<tr><td>Roadbeds</td><td>"Road Parcel Owners Un-determined"</td><td>N/A</td><td>0.00</td></tr>
<tr><td rowspan="2">Housing</td><td colspan="2">HRM</td><td>5.70</td><td rowspan="2">6.26</td><td>0.01</td></tr>
<tr><td colspan="2">East Hants</td><td>0.56</td><td>0.00</td></tr>
<tr><td rowspan="2">Community Services</td><td colspan="2">HRM</td><td>46.26</td><td rowspan="2">47.05</td><td>0.06</td></tr>
<tr><td colspan="2">East Hants</td><td>0.79</td><td>0.00</td></tr>
<tr><td rowspan="2">Schools</td><td colspan="2">HRM</td><td>29.07</td><td rowspan="2">42.09</td><td>0.04</td></tr>
<tr><td colspan="2">East Hants</td><td>13.02</td><td>0.02</td></tr>
<tr><td>Justice</td><td colspan="2">HRM</td><td>0.55</td><td>0.55</td><td>0.00</td></tr>
<tr><td rowspan="5">Municipal</td><td rowspan="4">HRM</td><td colspan="2">Roads and Rights of Way</td><td>525.76</td><td rowspan="4">1820.64</td><td>0.73</td></tr>
<tr><td rowspan="2">Property</td><td>Condos</td><td>1.69</td><td>0.00</td></tr>
<tr><td>Land Parcels (green space – potentially developable)</td><td>824.98</td><td>1.15</td></tr>
<tr><td>IC&I</td><td>Industrial &Commercial (Aerotech)</td><td>468.21</td><td>0.65</td></tr>
<tr><td>East Hants</td><td colspan="2">Roads and Rights of Way
(Note: Almost all landownership of road parcels in East Hants is identified in Property Online as un-determined.)</td><td>0.66</td><td>156.02</td><td>0.00</td></tr>
</table>

Table 10: BoMont Watershed Area Landownership						
Government Level	**Agency/Department/Municipality**			**Area (hectares)**	**Total Area (ha)**	**% of Watershed**
		Property	Land Parcels (green space – potentially developable)	155.36		0.22
Utilities	Halifax Water	HRM		383.97	608.62	0.53
	Natural Gas Pipeline	Multiple landowners, including NSTIR. Scotian Materials Inc. and HRM (already included in the calculations).		54.33		0.08
	Nova Scotia Power	HRM		163.77		0.23
		East Hants		2.61		0.00
	Communications (Bell and Westower)	HRM		3.94		0.01
		East Hants		0		0.00
Private	Private Individual	HRM		10,373.98	25,729.66	14.43
		East Hants		15,355.68		21.36
	Mobile Home Park	HRM		24.72	24.72	0.03
		East Hants		0		0.00
	Owner Unknown	HRM		10.96	13.40	0.02
		East Hants		2.44		0.00
	Developers and Land Holdings	HRM		5221.77	6704.39	7.26
		East Hants		1482.62		2.06
	Retail	HRM		66.46	100.11	0.09
		East Hants		33.65		0.05
	Services	HRM		130.23	211.92	0.18
		East Hants		81.69		0.11
NGO/ Community Groups	Faith, Fire, Recreation	HRM		184.65	286.23	0.26
		East Hants		5.49		0.01
	Shubenacadie Canal Commission	East Hants		3.02		0.00
						0.00
	Community Housing	HRM		93.07		0.13
		East Hants		0		0.00
Industry	Automotive and Hardware	HRM (Scotia Speedworld)		17.34	17.34	0.02
		East Hants		158.36	158.36	0.22
	Aggregate	HRM		1154.70	1154.70	1.61
	Construction	HRM		92.3	92.3	0.13
	Sand and Gravel	East Hants		1087.25	1087.25	1.51
	Golf	HRM		511.87	511.87	0.71
	Energy	HRM		23.83	23.83	0.03
	Forestry	HRM		3874.74	3874.74	5.39
		East Hants		9306.10	9306.10	12.95
	NS Farm Loan Board	East Hants		99.91	99.91	0.14
	Crops	East Hants		651.58	651.58	0.91

Table 10: BoMont Watershed Area Landownership					
Government Level	Agency/Department/Municipality		Area (hectares)	Total Area (ha)	% of Watershed
	Dairy	East Hants	820.62	820.62	1.14
	Sod, Soil and Landscaping	HRM	238.37	238.37	0.33
		East Hants	752.93	752.93	1.05
Total Area				**66,622.50**	**92.67**

2.4 Governance

The governance measures to protect the BoMont water supply include provincial policies and regulations, and municipal land use planning policies and by-laws which are described in the subsections below. Presently there is no management committee for this water supply area, albeit it is the largest watershed area and serves the second fewest customers.

2.4.1 Water Supply Area Delineation

The BoMont watershed area was defined using provincial GIS database information which included tertiary watershed info, contours, and wet areas mapping, which were followed up with site visits, to ground-truth discrepancy areas (see *Map E: Watersheds, Hydrology, Elevation and Sampling Points* on page 43). The watershed area is not provincially designated and therefore has no specific regulations that govern the protection of the BoMont water supply area, other than what is *generally* covered under provincial and federal legislation. *Table 11: Restricted and Designated Land Use Areas in BoMont Watershed Area* on page 66 below lists restricted land use areas and their applicable legislation within the watershed area; however the following sections outline general legislation and by-laws that apply to the watershed area.

2.4.2 Federal Policies and Regulations

Within the BoMont watershed area, Federal policies that apply with respect to railways and fisheries are described below.

Railway Policies

The framework of environment-related legislation governing the railway industry is shared among federal authorities—mainly Transport Canada and Environment Canada—and with provincial ministries. Within this framework, numerous pieces of environmental legislation focus on protecting air, water, soil, wildlife, and the public interest.

Transport Canada is developing regulations under the *Railway Safety Act* that align with U.S. EPA regulations, applicable in the Canadian context. While Canadian and U.S. approaches to regulation will differ slightly due to differences in legislation (the U.S. regulates manufacturers of engines while Canada regulates rail operators), the environmental outcome will be similar.

Under the *Canadian Environmental Protection Act*, Environment Canada sets regulations for dealing with spills on federally regulated railway rights-of-way.

Provinces have jurisdiction for provincially regulated railways. Provinces are also responsible for their municipalities through various regulatory instruments that govern planning and development, emergency services, and environmental protection. Provinces have jurisdiction over spills and environmental incidents on provincial lands, including environmental response, clean-up and remediation. The Province of Nova Scotia's *Railways Act* is to ensure the safe operation of railways in the Province.

Fisheries Act

The *Fisheries Act* contains two key provisions on conservation and protection of fish habitat essential to sustaining freshwater and marine fish species. The Department of Fisheries and Oceans administers section 35, the key habitat protection provision, prohibiting any work or undertaking that would cause the harmful alteration, disruption or destruction of fish habitat. Environment and Climate Change Canada administers section 36, the key pollution prevention provision, prohibiting the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the *Fisheries Act* or other federal legislation. A deleterious substance can be any substance that, if added to any water, would degrade or alter its quality such that it could be harmful to fish, fish habitat or the use of fish by people.

2.4.3 Provincial Policies and Regulations

The BoMont watershed area does not have its own designation under provincial legislation; however Provincial land use designations provide regulatory protection with respect to land-use practices within the entire watershed (see *Table 11: Restricted and Designated Land Use Areas in BoMont Watershed Area* on page 66). Furthermore the *Municipal Government Act* below and the *Halifax Regional Municipality Charter* on page 64 regulate activities that are likely to occur inside the watershed area under provincial policy frameworks as described below.

Municipal Government Act

The *Municipal Government Act 1998, c 18, sec. 1* (as amended to 2016) (2017) provides regulatory protection of a water supply area, including the East Hants portion of the BoMont watershed area through the following policy:

Protected Water Supply Area

180 (1) The council may, by by-law, designate lands owned by a municipality as protected water supply areas.

(2) No person shall

(a) place, or permit to escape, any matter or thing of an offensive nature, deleterious nature or likely to impair the quality of water for use for domestic purposes, upon land in a protected water supply area;

(b) fish or bathe in a lake, or other body of water, in a protected water supply area;

(c) camp on land in a protected water supply area;

(d) cut wood or erect, construct or place a building or structure in a protected water supply area without the permission of the council.

(3) The *Angling Act* does not apply to a lake, river or stream forming part of a water supply area of a municipality or village or to the land surrounding or adjacent to them. 1998, c. 18, s. 180.

Statement of Provincial Interest Regarding Drinking Water

The Statement of Provincial Interest states in section 3. "Existing land use and the location, size and soil conditions of a municipal water supply watershed will determine the land-use controls that should be applied."

Halifax Regional Municipality Charter

The *Halifax Regional Municipality Charter 2008, c. 39, s. 1* (as amended to December 6, 2013) may provide regulatory protection of a water supply area, including the HRM portion of the BoMont watershed area through the following policies:

Protected Water Supply Area

198 (1) The Council may, by by-law, designate lands owned by the Municipality as protected water supply areas.

(2) No person shall

(a) place, or permit to escape, any matter or thing of an offensive nature, deleterious nature or likely to impair the quality of water for use for domestic purposes, upon land in a protected water supply area;

(b) fish or bathe in a lake, or other body of water, in a protected water supply area;

(c) camp on land in a protected water supply area; or

(d) cut wood or erect, construct or place a building or structure in a protected water supply area without the permission of the Council.

(3) The *Angling Act* does not apply to a lake, river or stream forming part of a water supply area of the Municipality or to the land surrounding or adjacent to them.

Content of Land Use By-law

235 (1) A land-use by-law must include maps that divide the planning area into zones.

(2) A land-use by-law must

(a) list permitted or prohibited uses for each zone; and

(b) include provisions that are authorized pursuant to this Act and that are needed to implement the municipal planning strategy.

(3) A land-use by-law may regulate or prohibit development, but development may not be totally prohibited, unless prohibition is permitted pursuant to this Part.

(4) A land-use by-law may …

(n) prohibit development or certain classes of development where, in the opinion of the Council, the

(i) cost of providing municipal wastewater facilities, stormwater systems or water systems would be prohibitive,

(ii) provision of municipal wastewater facilities, stormwater systems or water systems would be premature, or

(iii) cost of maintaining municipal streets would be prohibitive;

(o) regulate or prohibit development within a specified distance of a watercourse or a municipal water-supply wellhead;

(p) prohibit development on land that

(i) is subject to flooding or subsidence,

(ii) has steep slopes,

(iii) is low-lying, marshy, or unstable,

(iv) is otherwise hazardous for development because of its soil conditions, geological conditions, undermining or topography,

(v) is known to be contaminated within the meaning of the *Environment Act*, or

(vi) is located in an area where development is prohibited by a statement of provincial interest or by an enactment of the Province; …"

On-site Septic System Regulations and Best Management Practices

In May 2016, NSE established new *On-site Sewage Disposal System Technical Guidelines as part of the changes to the On-site Sewage Disposal Systems Regulations*. These regulations and best practices provide a tool for municipal units to strengthen policies and take action toward better protection of watercourses in all water supply areas.

Environment Act

The *Environment Act 1994-95, c 1, s. 1.*, provides the framework that everyone must follow in order to help manage and protect Nova Scotia's environment. In addition to the Act, there are also a number of regulations to protect specific "things" in our environment, such as our water supplies.

Mineral Resources Act

Mining is regulated through the *Environment Act*'s *Activities Designation Regulations*. All mining subjected to these regulations require an Industrial Approval and an Environmental Assessment. The *Mineral Resources Act* focuses on the minerals, how they are recovered, and how the land is reclaimed; the *Environment Act* through the Environmental Assessment process and associated regulations (e.g., water approvals and erosion and sedimentation control) detail how to carry out activities with respect to the environment and communities. In the event of a conflict between the *Environment Act* and any other enactment, the *Environment Act* prevails (Sec. 6(1)).

When exploration is being considered on municipal water supply area lands, in the interest of good relations, companies and prospectors are encouraged to consult with the water utility. Specifically, section 73 of the *Mineral Resources Regulations* pertains to water utility lands.

Halifax Water actively monitors potential mining activities or expansions through the Department of Natural Resource Geology Maps and database, NovaROC, a Mineral Rights Online Registry System as a means of monitoring potential mineral exploration activity. In watershed areas, exploration companies and prospectors must consult with DNR and NSE before conducting any exploration activity in addition to any requirements established by the landowner or tenant or under a surface rights permit. Mineral exploration and mining companies are expected to take precautions with respect to the environment and affected landowners.

Table 11: Restricted and Designated Land Use Areas in BoMont Watershed Area

Land Use Theme	Name	Legislation/ Bylaws	Landownership	BoMont WS Land Area (ha)	% of Watershed Area
Special Places (under the Act)	Fletcher Lake Lock of the Shubenacadie Canal	Special Places Protection Act	NSDNR	0.23	negligible
			Private	0.0029	negligible
Designated Provincial Parks and Park Reserves	Laurie Provincial Park	Provincial Parks Act	NSDNR	27.62	0.04
	Oakfield Provincial Park			55.62	0.08
Designated Water Supply Areas	Bennery Lake	Environment Act	Multiple Owners	668.90	1.0
	Lake Major (Boundary Overlap)			181.48	0.25
Indian Reserve Lands	Indian Brook (IR 14)	Federal Indian Act	Department of Indian Affairs and Northern Development	182.25	0.25
	Shubenacadie (IR 13)			397.90	0.55
Natural Watershed Municipal Surface Water Supply Areas	Bennery Lake	Non-specific	Multiple Owners	641.59	0.88
	East Hants			34,818.31	47.78
	Lake Major (Boundary overlap)			11.57	0.02
	Lake Lemont (boundary overlap)			20.57	0.03
	Collin's Park			1024.67	1.41
Operational Non-Designated Parks and Reserves	Fall River	Non-specific	NSDNR	0.58	negligible
	Horne Settlement			1.64	negligible
	Portobello			1.64	negligible
	Second Lake			292.95	0.4
	Shubenacadie Canal			2.28	negligible
	Wellington (Lock 5)			6.36	negligible
Provincial Game Sanctuaries	Waverley Game Sanctuary	Wildlife Act	Multiple Owners	2088.58	2.87
Wilderness Area	Waverley Salmon River Long lake	Wilderness Areas Protection Act	Her Majesty the Queen (NSE)	697.86	1.0
	Devils Jaw	Wilderness Areas Protection Act	Her Majesty the Queen (NSE)	161.47	0.22

Table 11: Restricted and Designated Land Use Areas in BoMont Watershed Area					
Land Use Theme	**Name**	**Legislation/ Bylaws**	**Landownership**	**BoMont WS Land Area (ha)**	**% of Watershed Area**
Nature Reserve	Bennery Lake	Special Places Protection Act	Her Majesty the Queen (NSE)	279	0.39
	Rawdon River			116	0.16
	Little Soldier Lake			88	0.12
Total Area*				**41,767.07**	**57.45**
*Note: Some designated areas overlap, e.g.; the Waverley Game Sanctuary and the Waverley Salmon River Long Lake Wilderness Area as shown on *Map H: Restricted and Designated Land Use Areas* on page 72.					

2.4.4 Municipal Planning Policies and By-laws

BoMont is governed by nine (9) Municipal Planning Strategies (MPS) of which HRM governs eight (8) through the Regional Municipal Planning Strategy (2014); and the Municipality of East Hants governs the ninth through a single Municipal Community Plan. Municipal policies and by-laws governing are complicated for the reason that each municipal unit has its own set of by-laws governing what land use activity is permitted within it (see *Table 12: Land Use By-law Zones (Excluding water areas)* page 68).

Community Plan Areas

The plan areas were intersected with the BoMont watershed boundary and further divided by the Green (low), Yellow (medium) and Red (high) Risk Area Zones (RAZ) to help determine where the highest risk areas are in relation to the land use practices that are permitted by the Land Use By-laws (LUBs) zones. These areas are illustrated on *Table 12: Land Use By-law Zones* on page 68 and illustrated on *Map J: East Hants Bylaw Zones* on page 74 and *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75. The RAZ is further described in section *3.1: Inherent Risk Factors* on page 78.

Land Use Bylaw and Zoning

Land use zones are applied to a particular area of land within a land use by-law (LUB) area. The zone value corresponds with the associated land use by-law, which lists permitted or prohibited uses for each zone. Land use zones differ between LUB areas, so each zone must be interpreted within the context of the LUB area in which it is applied. The by-law zones that pertain to the BoMont watershed area and their respective RAZ are outlined in *Table 12* on page 68 and illustrated on *Map J: East Hants Bylaw Zones* on page 74 and *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75.

Table 12: Land Use By-law Zones (Excluding water areas)							
Municipal Unit	Community Plan District (Plan ID)	Plan Area* (ha)	Land Use By-law Zone	LUB Zone Area**(ha)	RAZ Area (ha)***		
					Red	Yellow	Green
HRM	Bedford (1)	133.56	Heavy Industrial (IHI)	91.55	0	0	91.55
			Light Industrial (ILI)	38.25	0	0	38.25
			Institutional (SI)	3.76	0	0	3.76
	Cole Harbour/Westphal (3)	380.98	Highway Commercial (C-4)	20.16	0	0	20.16
			Open Space (P-1)	46.18	0	0	46.18
			Community Facility (P-2)	8.86	0	0	8.86
			Conservation (P-4)	1.35	0	0	1.35
			Public Water Supply (PWS)	24.78	0	0	24.78
			Single Unit Dwelling (R-1)	130.3.6	0	0	130.3.6
			Single Unit Dwelling (R-1A)	5.62	0	0	5.62
			Two Unit Dwelling (R-2)	2.23	0	0	2.23
			Mobile Dwelling Zone (R-3)	0.05	0	0	0.05
			Multiple unit Dwelling (R-4)	2.86	0	0	2.86
			Row House Dwelling (R-5)	0.49	0	0	0.49
			Rural Estate (R-7)	138.04	0	0	138.04
	Dartmouth (4)	1058.11	Burnside Comprehensive Development District (BCDD)	29.03	0	0	29.03
			Conservation (C)	19.40	0	0	19.40
			Local Business (C-1)	0.1	0	0	0.1
			Hold (H)	151.54	0	0	151.54
			General industrial (I-2)	413.25	0	0	413.25
			Park (P)	3.74	0	0	3.74
			Single Family Residential (R-1)	225.52	0	0	225.52
			Two Family Residential (R-2)	8.03	0	0	8.03
			Multiple Family Residential (R-3)	6.69	0	0	6.69
			Regional park (RPK)	35.08	0	0	35.08
			Urban Settlement (US)	165.68	0	0	165.68
	Beaver Bank/Hammonds Plains/Upper Sackville (11)	10,644.18	General Business (C-2)	0.37	0	0.37	0
			Highway Commercial (C-4)	2.30	0	2.30	0
			Comprehensive Development District (CDD)	180.16	0	180.16	0
			Mixed Industrial (I-1)	117.69	0	102.08	15.55
			Mixed Resource (MR-1)	5187.11	0	5187.11	0
			Mixed Use 1 (MU-1)	2681.91	0	2680.95	0.96
			Mixed Use 2 (MU-2)	232.93	0	232.93	0
			Community Facility (P-2)	12.48	0	12.48	0
			Single Unit Dwelling (R-1)	670.93	0	670.93	0
			Auxillary Dwelling with Home Business (R-1b)	205.44	0	199.92	5.52
			Two Unit Dwelling (R-2)	4.12	0	4.12	0
			Mobile Home Park (R-3a)	24.57	0	24.57	0

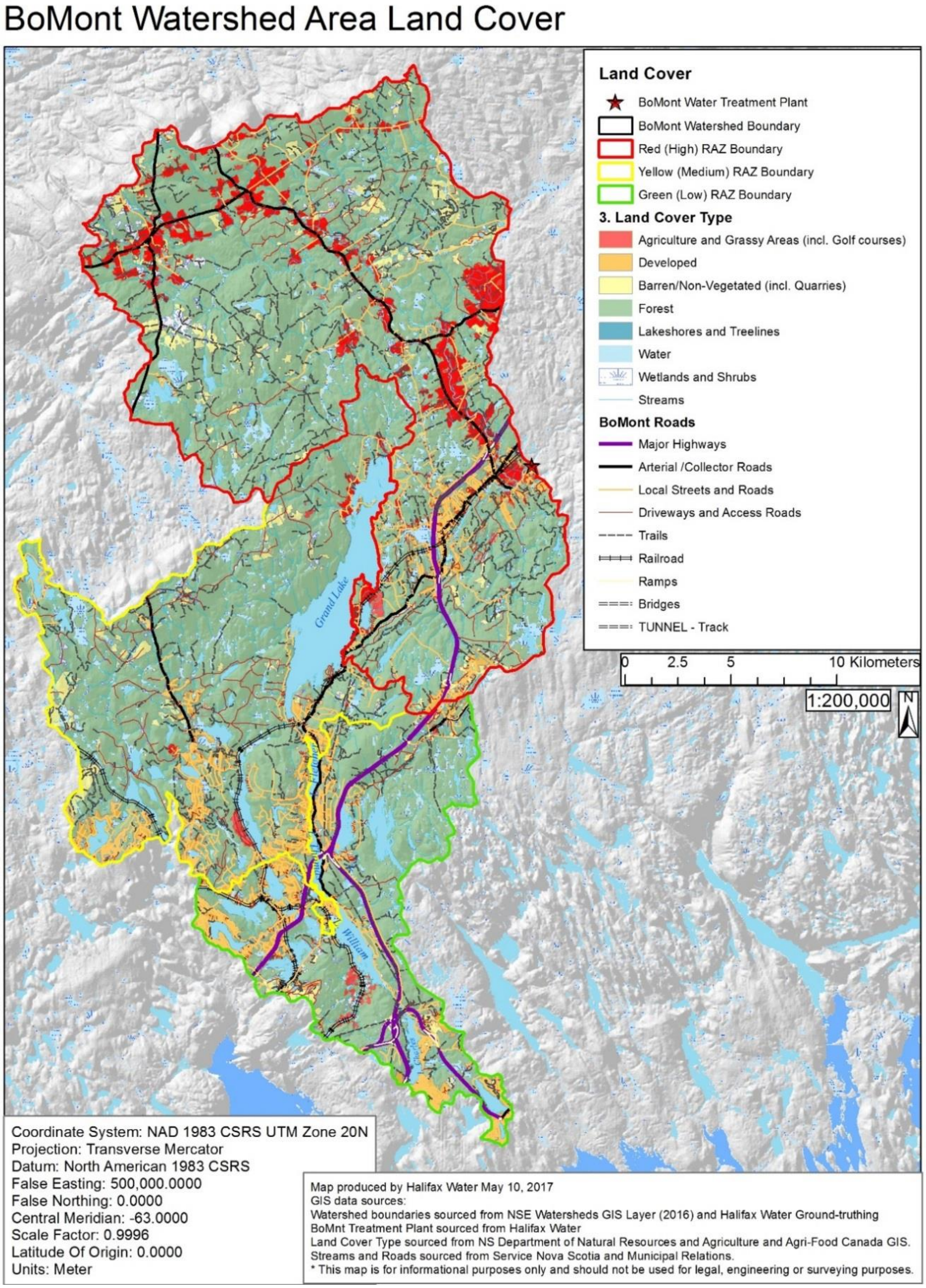
Table 12: Land Use By-law Zones (Excluding water areas)							
Municipal Unit	Community Plan District (Plan ID)	Plan Area* (ha)	Land Use By-law Zone	LUB Zone Area**(ha)	RAZ Area (ha)***		
					Red	Yellow	Green
			Rural Residential (R-6)	281.6	0	281.60	0
			Special Area (R-8)	29.54	0	29.54	0
			Transportation Reserve (TR)	9.20	0	9.20	0
	Musquodoboit valley/Dutch Settlement (14)	1797.37	Mixed Use (MU)	1797.37	1797.37	0	0
	North Preston, Lake Major, Lake Loon, Cherry Brook and East Preston (15)	17.68	Residential (RA)	17.68	0	0	17.68
	Sackville (17)	810.73	Business Park (BP)	7.06	0	0	7.06
			Business Park -1 (BP-1)	8.77	0	0	8.77
			Local Business (C-1)	0.03	0	0	0.03
			Community Commercial (C-2)	10.02	0	1.25	8.77
			Open Space (P-1)	36.90	0	0	36.90
			Community Facility (P-2)	29.52	0	0	29.52
			Single Unit Dwelling (R-1)	143.19	0	0	143.19
			Two Unit Dwelling (R-2)	21.54	0	0	21.54
			Multiple Unit Dwelling (R-4)	1.57	0	0	1.57
			Rural Residential (R-6)	275.2	0	140.55	134.65
			Regional Park (RPK)	272.31	0	0	272.31
			Transportation Reserve (TR)	4.62	0	4.62	0
	Planning districts 14 & 17 (19)	23,070.14	Aerotech Core (AE-1)	291.20	0	0	291.20
			General Airport (AE-2)	857.05	705.07	0	151.97
			Aerotech Business (AE-4)	605.98	213.23	35.62	357.13
			Holding (AE-H)	360.95	0	0	360.95
			Local Business (C-1)	1.38	0	0.50	0.88
			Community Commercial (C-2)	53.47	0.79	20.54	32.14
			Highway Commercial (C-4)	8.35	8.35	0	0
			Canal Court (CC)	4.25	0	2.71	1.54
			Fall River Business (FRB)	63.41	0	0	63.41
			Hazard (H-1)	134.94	0	0.12	134.82
			Light Industrial (I-3)	468.65	11.27	7.59	449.79
			Mixed Resource (MR)	48.64	0	0	48.64
			Community Facility (P-2)	93.97	2.66	53.84	37.47
			Park (P-3)	673.75	0	4.37	669.38
			Protected Area (PA)	683.09	0	0	683.09
			Protected Water Supply (PWS)	616.73	565.85	21.04	29.84
			Single Unit Dwelling (R-1a)	749.57	222.2	267.43	259.94

Table 12: Land Use By-law Zones (Excluding water areas)							
Municipal Unit	**Community Plan District (Plan ID)**	**Plan Area* (ha)**	**Land Use By-law Zone**	**LUB Zone Area**(ha)**	**RAZ Area (ha)*****		
					Red	**Yellow**	**Green**
			Suburban Residential (R-1b)	4291.19	717.31	1317.31	2256.57
			Waterfront Residential (R-1c)	2.34	0	0	2.34
			Residential Auxillary Dwelling (R-1d)	0.35	0	0.35	0
			Residential Estate (R-1e)	497.98	481.0	16.98	0
			Rural Residential (R-6)	2331.8	975.28	962.48	394.04
			Rural Estate (R-7)	5826.08	1008.86	3142.41	1674.81
			Residential Comprehensive Development District (RCDD)	12.17	0	0	12.17
			Regional Park (RPK)	164.56	55.71	28.44	80.41
			Urban Reserve (UR)	7.16	0	0	7.16
			Village Core Comprehensive development (VC-CDD)	5.72	0	0	5.72
			Village Gateway (VG)	13.83	0	0	13.83
			Village Main Street (VMS)	50.58	0	22.29	28.29
East Hants	District of East Hants	31,837.76	Agriculture Reserve (AR)	1404.69	1383.31	21.38	0
			Business Park (BP)	160.14	160.14	0	0
			Country Residential (CR)	656.42	620.41	36.01	0
			General Commercial (GC)	0.54	0.54	0	0
			Highway Commercial (HC)	15.58	15.58	0	0
			High Risk Floodplain (HF)	280.27	280.27	0	0
			Industrial Commercial (IC)	28.22	28.22	0	0
			Sipenkne'katik – 14 (IR-14)	182.28	182.28	0	0
			Institutional Use (IU)	25.50	25.50	0	0
			Lakeshore Residential (LR)	327.01	45.94	281.07	0
			Mixed Use Centre (MC)	13.76	13.76	0	00
			Open Space (OS)	416.18	278.75	137.43	0
			Established Residential (R1)	609.01	366.85	242.16	0
			Two Dwelling Unit Residential (R2)	440.18	437.62	2.56	0
			Townhouse (R2-T)	5.07	5.07	0	0
			Multiple Unit Dwelling (R3)	13.24	13.24	0	0
			Regional Commercial (RC)	144.78	144.78	0	0
			Rural Comprehensive Development District (RCDD)	11.60	0	11.60	0
			Rural Use (RU)	20,962.26	18,135.36	2826.9	0
			Village Core (VC)	54.35	54.35	0	0
			Walkable Comprehensive development District (WCDD)	70.70	70.70	0	0
			Wind Energy Zone (WE)	5831.32	5831.32	0	0
			Watercourse Greenbelt (WG)	184.66	184.66	0	0
		69,750.51		64,465	35,043	19,227	10,193

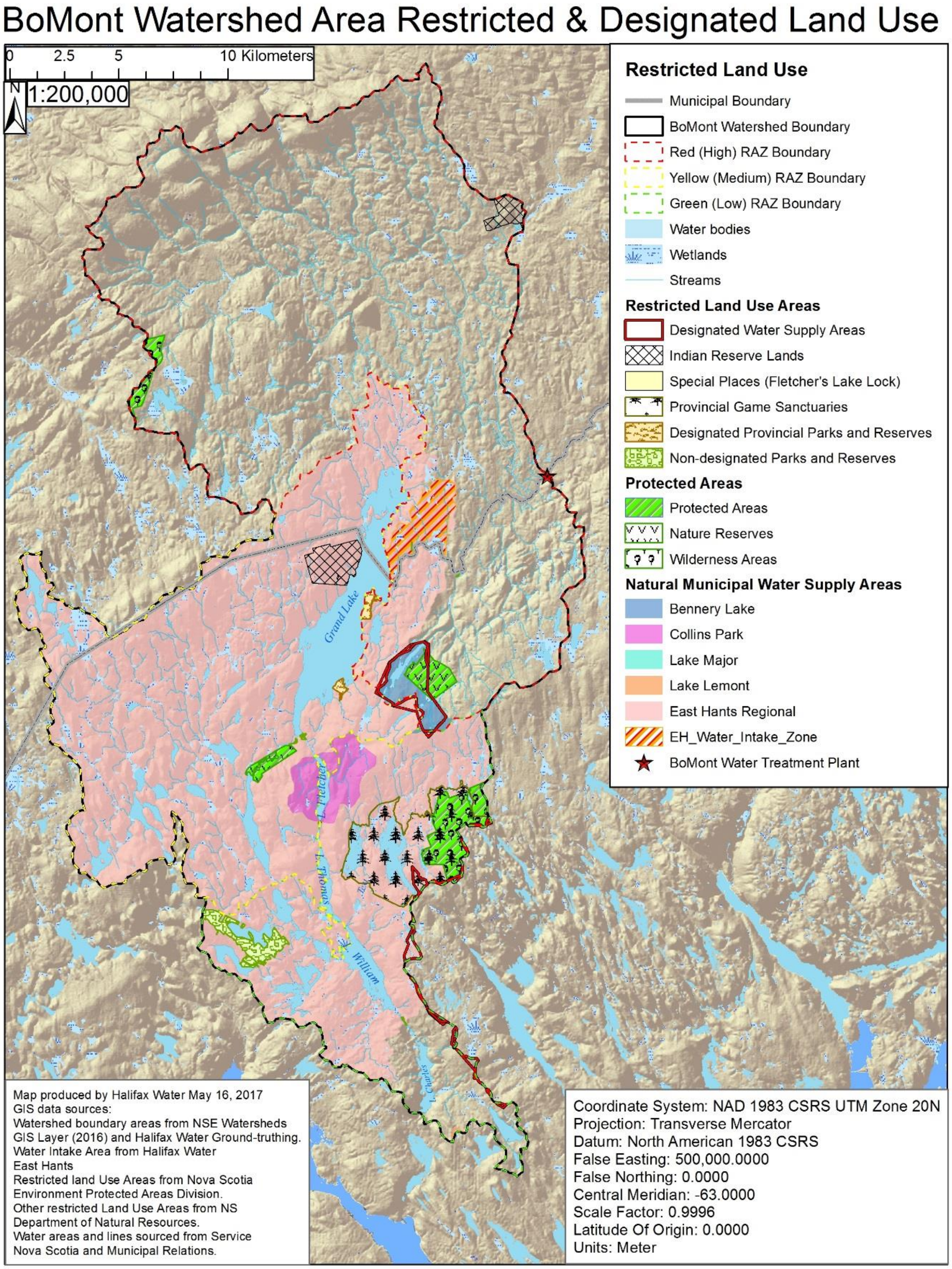
* HRM Community Plan Areas include all water bodies and roadways. East Hants' Community Plan **does *not*** include roads or water areas.

** LUB Areas do not include water bodies or roadways.

Map G: Land Cover in Risk Zone Areas (RAZ)

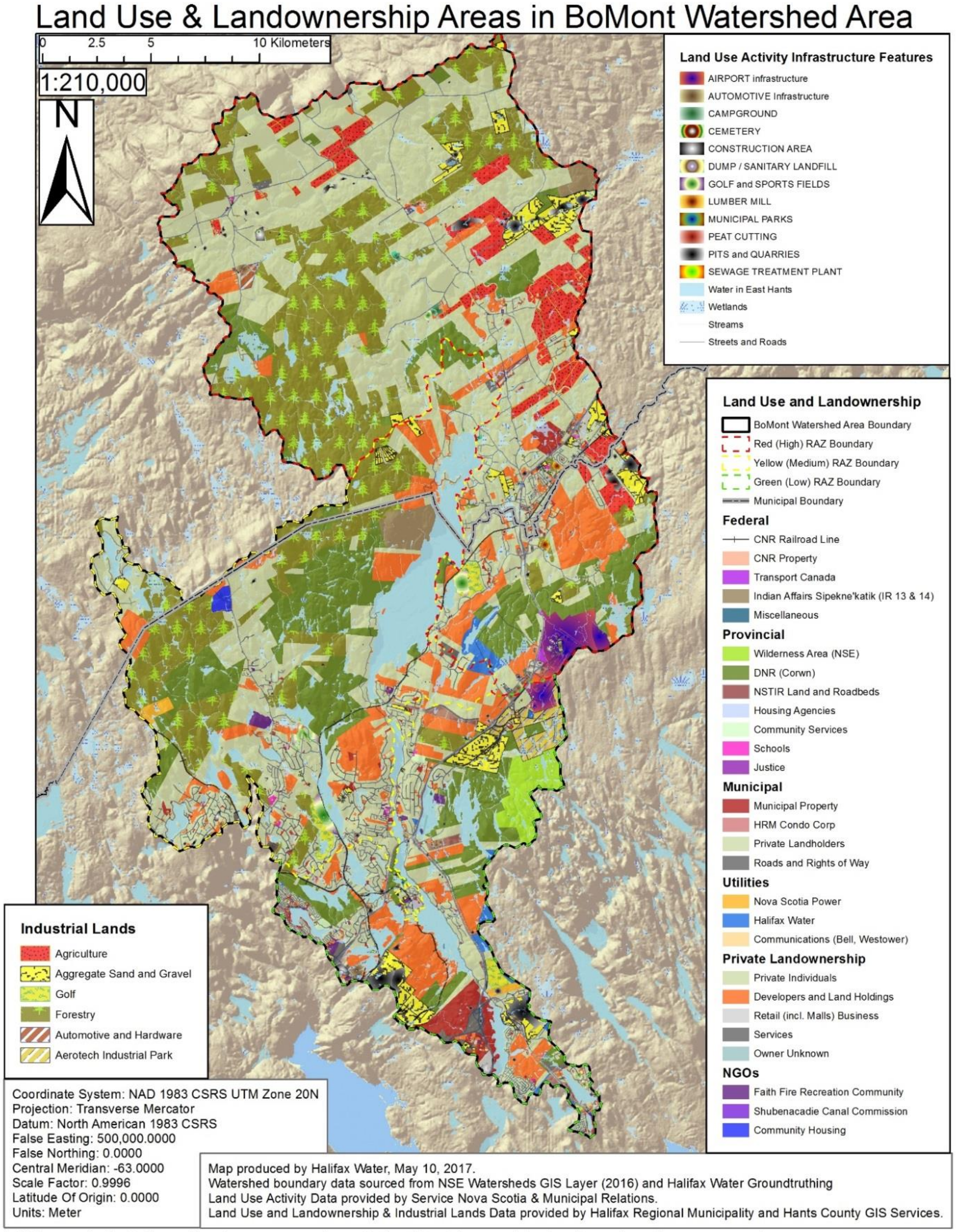


Map H: Restricted and Designated Land Use Areas



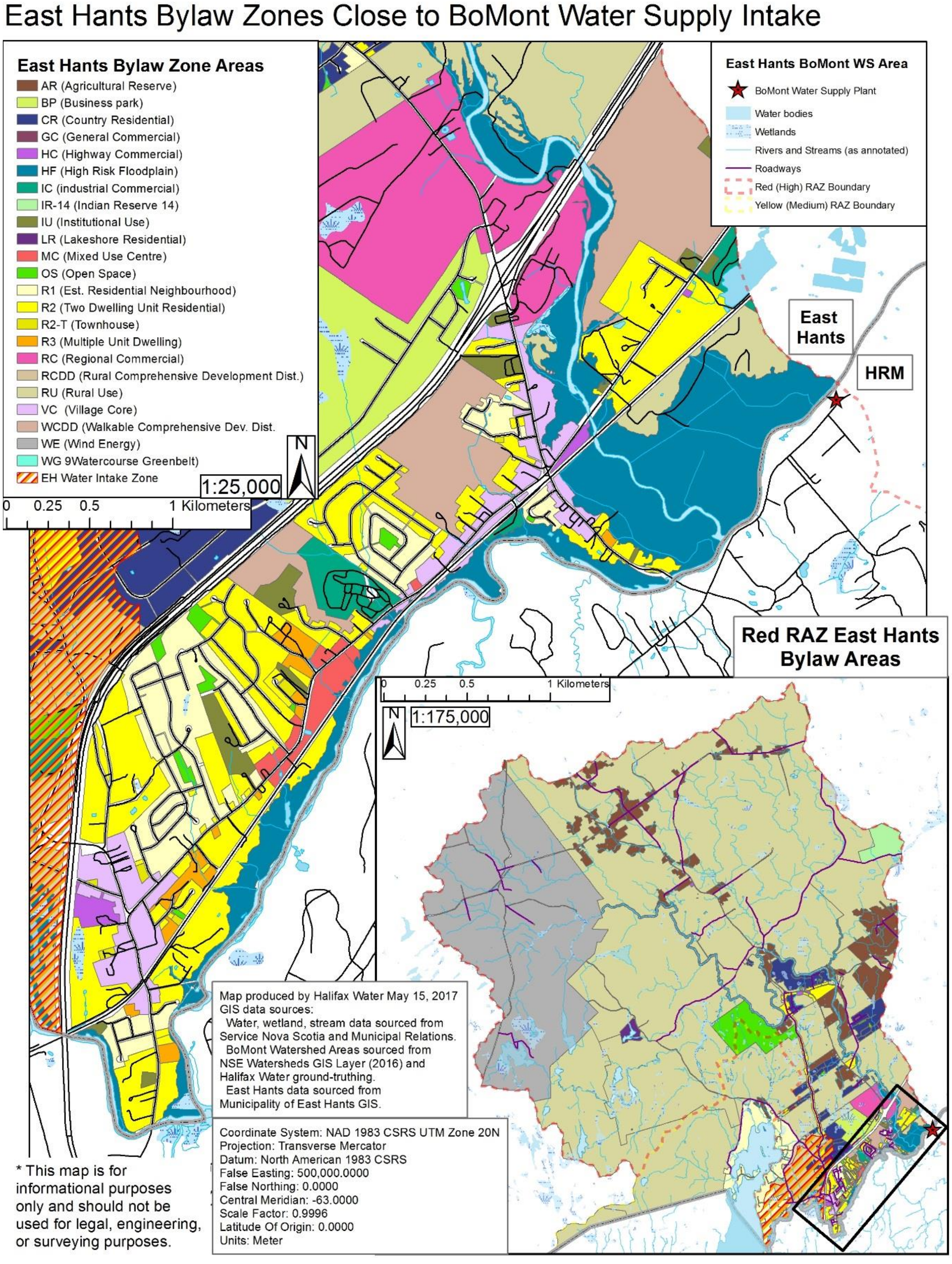
* This map is for informational purposes only and should not be used for legal, engineering or surveying purposes.

Map I: Land Use and Landownership in Risk Area Zones (RAZ)

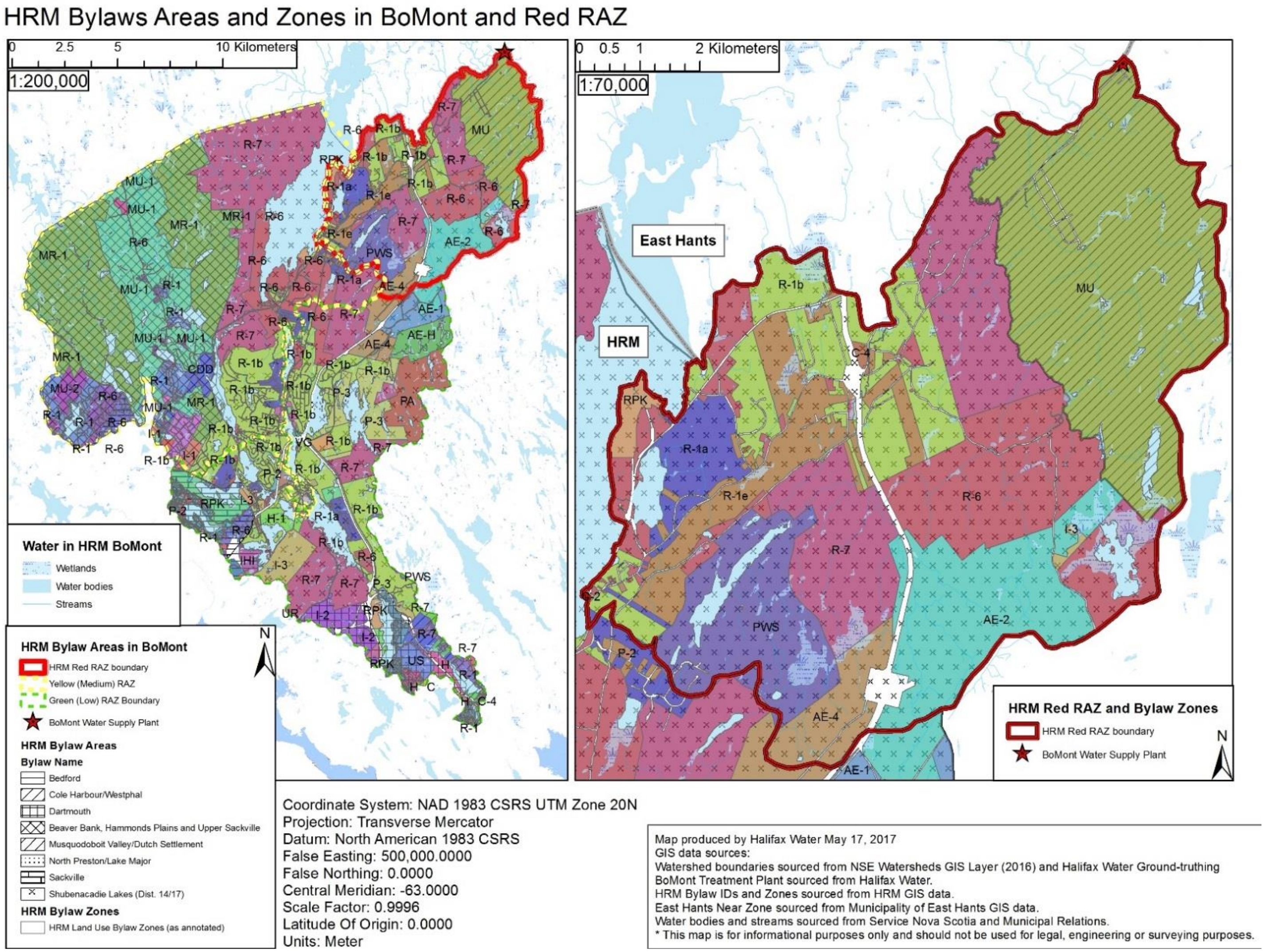


* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

Map J: East Hants Bylaw Zones

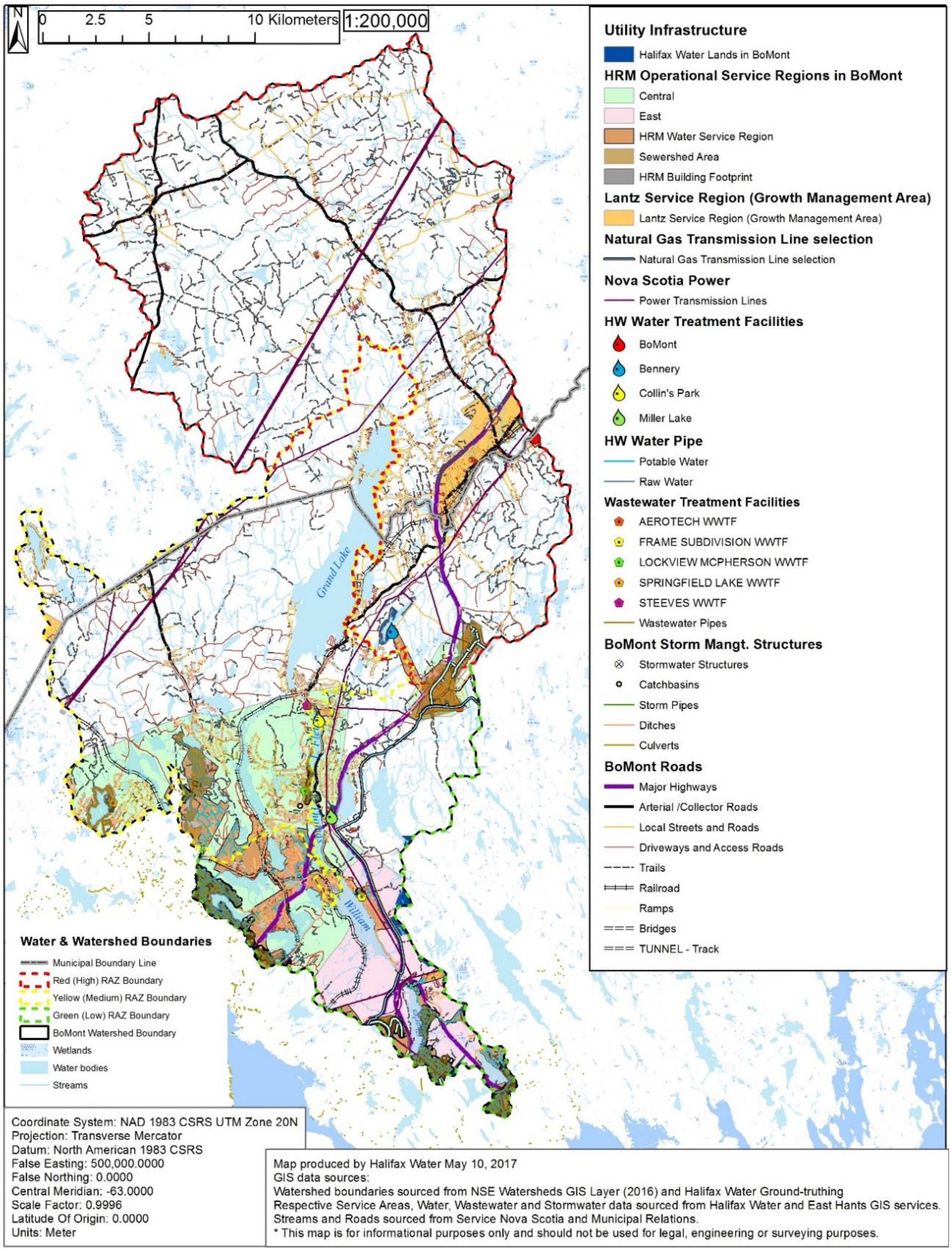


Map K: HRM Regional GFLUM and Community Plan Areas

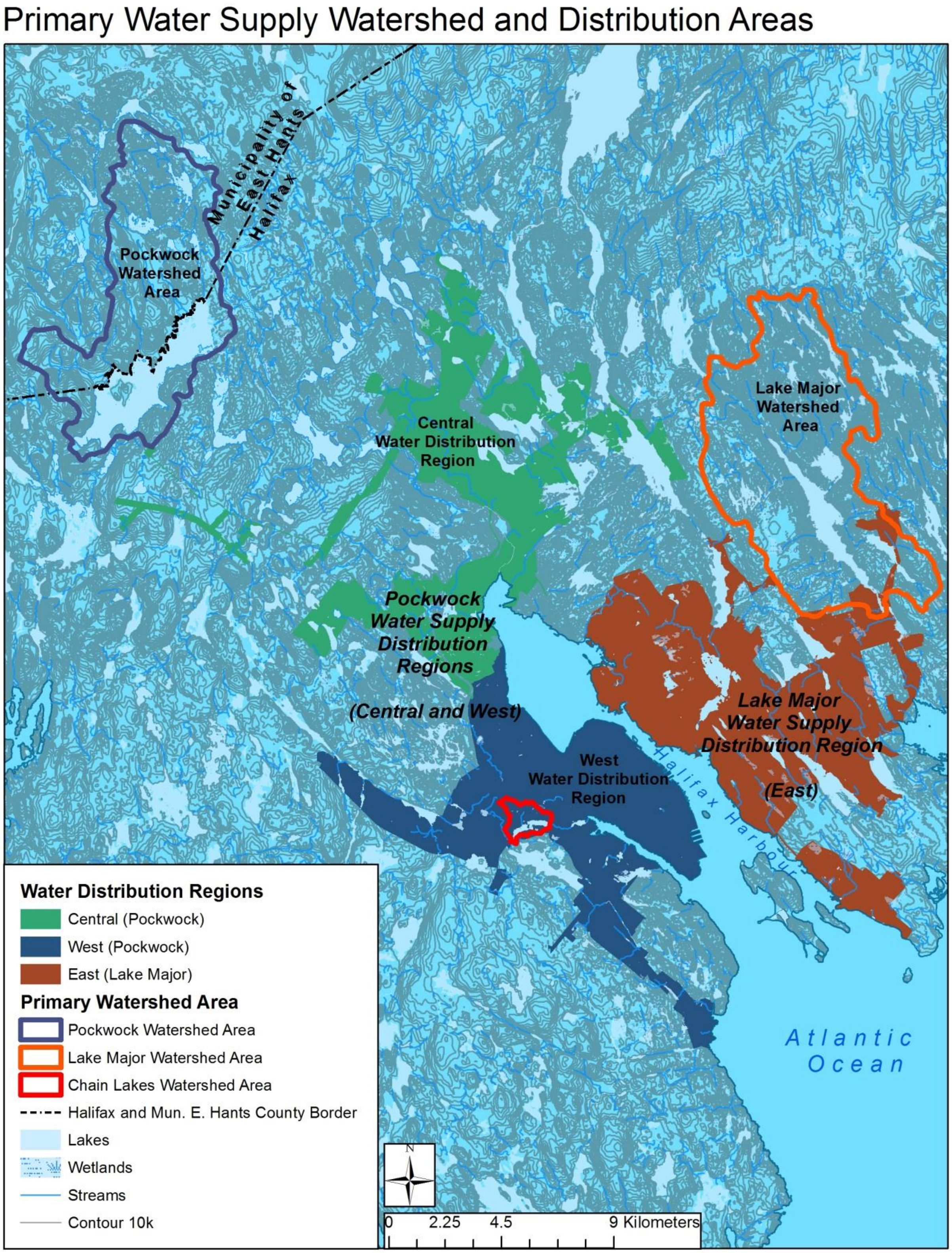


Map L: Utility (Power, Water, Gas) Corridors

BoMont Watershed Area Utilities (Power, Gas, Water, Storm & Wastewater)



Map M: HRM Primary Water Supply Watershed and Distribution Areas



3 Risk Identification and Assessment

The BoMont watershed area (BoMont) is not afforded the same protection as Halifax Water's Protected Watershed Areas; therefore are subject to considerable risk from both anthropogenic and natural sources.

This chapter identifies and assesses, in two sections, the risk factors that have the potential to impact the BoMont watershed area:

- Section *3.1: Inherent Risk Factors* on page 78 describes the inherent and more predictable human activities associated with environmental, political, historic, social or cultural influences, the potential risk factors associated with them and the necessary measures to protect the water supply.
- Section *3.2: Critical Infrastructure* on page 96 describes the hazards and threats to critical infrastructure that are accidental, natural or intentional or deliberate, which are more difficult to predict. Intentional or deliberate risk factors also tend to be more acute, resulting from highly unusual events such as a terrorist attack.

The risk assessment for this SWPP will look at overall impacts from a higher level rather than a micro level based on a number of studies that have already been conducted by consultants for the Halifax Regional Municipality (HRM) and the Municipality of East Hants (East Hants).

3.1 Inherent Risk Factors

The known inherent risk factors to the water quality of BoMont include impacts on the land area from activities associated with residential and commercial development, recreation, motorized vehicle uses, fuel supply and containment, roads and railways; industry activity associated with mines pits and quarries, agriculture, forestry and waste (e.g., active and inactive landfills and C&D sites); and auxiliary risks associated with buildings (e.g., generators), water/wastewater supply and pumping station infrastructure and maintenance (e.g., chemicals, pipes and the potential for wastewater overflow), and utility transmission system and distribution line maintenance (e.g., vegetation removal).

To help scope out the level of risk inside the watershed area, and to prioritize source water protection efforts, BoMont has been divided into Risk Area Zones (RAZ), as illustrated on *Map G: Land Cover in Risk Zone Areas (RAZ)* on page 71. The RAZ were delineated using provincial GIS tertiary subwatershed areas and prioritized based on their proximity to the BoMont intake and water quality results. The RAZ are divided into low, medium and high risk area zones: the low RAZ area (~13,017 ha) is depicted by the green boundary, incorporating the tertiary subwatersheds that drain into four of the five headwater lakes farthest from the intake area (Charles, William, Thomas and Fletcher); the medium RAZ area (~22,526ha) is depicted by the yellow boundary that incorporates the tertiary subwatershed areas draining into Grand Lake and subsequently the Shubenacadie River; and the high RAZ area (~36,333ha) is depicted by the red boundary that incorporates the tertiary subwatershed areas draining directly into the Shubenacadie River (e.g., Nine Mile River), upstream of the BoMont intake area (see *Map E: Watersheds, Hydrology, Elevation and Sampling Points* on page 43 illustrating these areas).

The red RAZ is made up of 29,081.22 (87.27%) of the East Hants region of BoMont and 7251.78ha (18.81%) of the HRM region of BoMont. Landownership within the red RAZ is illustrated on *Map I: Land Use and Landownership in Risk Area Zones (RAZ)*.

The inherent risk factors associated with anthropogenic activities in BoMont are described under the following headings.

3.1.1 General Land-Use

Identification of the general land use patterns within the BoMont watershed area helps identify the inherent risks to the BoMont water supply. For example the headwaters region of the Shubenacadie River which contains many lakes, ponds and rivers around which rapid residential development took place in the 1970s and early 1980s due to the desire to live near water.

The communities north of the headwaters region, namely East Hants, experienced early growth by way of agriculture, forestry, and mineral extraction. To this very day they are still considered important economic drivers to the local East Hants economy however, residential development and small commerce has become more prevalent since the Halifax Stanfield International Airport was built in the 1960's and the continued outward expansion of Halifax since the 1990's.

Development within the watershed is controlled by the HRM RMPS and East Hants Community Plan (see *Table 12: Land Use By-law Zones* on page 68 and *Map J: East Hants Bylaw Zones* on page 74 and *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75).

For inherent risks associated with general-land use development associated with East Hants Community Plan and HRM MPS see *Table 15: Summary of Existing and Potential Inherent Risk Factors Affecting Water Supply Area* on page 101 and *Table 16: Summary of Existing and Potential Critical Infrastructure Risk Factors Affecting Water Supply Area* on page 107; and *Map J: East Hants Bylaw Zones* on page 74 and *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75.

3.1.2 Industrial, Commercial and Institutional (ICI)

BoMont has a number of industrial, commercial and institutional activities that impact the watershed area which are further described in the subsections below.

Forestry

The BoMont watershed area is primarily a forested (~69%) area (see *Map G: Land Cover* on page 71). The province owns 9327.20ha of forested land (including Protected Areas). The private sector owns the remaining ~40,238.82ha of forest area, as outlined in *Table 6: Land Class and Cover Categories in BoMont Watershed Area* on page 45 and *Table 10: BoMont Watershed Area Landownership* on page 60; and illustrated on *Map I: Land Use and Landownership in Risk Area Zones (RAZ) on page 73.* The watershed area is an important source of wood fibre to a number of local sawmills and tree harvesting contractors.

Possible sources of water contamination associated with forest activities include: the release of hydrocarbons due to a fuel or oil spill; sedimentation of streams, post road construction/ maintenance or precipitation event; and negative effects from improper forest management activities or disregard for Best Management Practices (BMPs). Improper forestry operations could include inadequate buffer setbacks near watercourses, poor harvest timing, harvesting in sensitive areas, and incorrect sizing and installation of culverts and bridges. The level of risk depends on the proximity to the intake and which RAZ they occur in.

Forest regulations exist at the provincial level; however their primary intent is to support a sustainable wood supply for future use rather than ensuring a potable water supply.

Mining Pits and Quarries

Mining and pits and quarries played a significant role in BoMont, particularly gold mining in Rawdon, the Montague Mines and Waverley areas where mine tailings from past operations still scatter the water supply area (~1051 mine sites), see on *Map B: Bedrock Geology* on page 40.

Prior to regulations governing disposal of mine tailings, the common practice was to dispose of mill tailings in nearby lakes, ponds, streams and depressions. These practices lead to arsenic, cyanide and mercury contamination of groundwater and lake sediments in the Shubenacadie River watershed system (BoMont water supply). Most of the mine site locations reported in Mudroch and Clair, 1985 have been confirmed from maps from the Nova Scotia Department of Mines.

As well there are a number of pits and quarries throughout BoMont, which are potential sources of sedimentation. *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73.

Mining

Mining is regulated through the *Environment Act: Activities Designation Regulations*. All mining subjected to these regulations require an Industrial Approval and an Environmental Assessment. The *Mineral Resources Act* focuses on the minerals, how they are recovered, and how the land is reclaimed; the Environment Act through the Environmental Assessment process and associated regulations (e.g., water approvals and erosion and sedimentation control) detail how to carry out activities with respect to the environment and communities. In the event of a conflict between the *Environment Act* and any other enactment, the Environment Act prevails, (Sec. 6(1)).

In Nova Scotia mineral exploration and mining companies must consult with DNR and NSE before conducting any exploration activity. The expectation is to take precautions with respect to the environment and affected landowners. When any exploration is being considered within municipal water supply area, in the interest of good relations, companies and prospectors are encouraged to consult with the water utility. Halifax Water actively monitors potential mining activities or expansions through the Department of Natural Resource Geology Maps and database, NovaROC, a Mineral Rights Online Registry System as a means of monitoring potential mineral exploration activity. The level of risk depends on the proximity to the intake and which RAZ they occur in (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

Pits and Quarries

Among the greater risks to the watershed area associated with pit and quarry activities are due to the physical risks associated with changes in grade and the resulting direction of water flow, fuel and oil storage and spills, chemical use (ammonium nitrate) associated with blasting, and regulatory ambiguities.

There are a number of established pits and quarries throughout BoMont and a strong likelihood of there being more. Municipalities have no jurisdiction under the *Municipal Government Act* (nor does HRM have jurisdiction under the *Halifax Regional Municipality Charter* if the province is deemed to have jurisdiction) at the extraction site, but operations (e.g., associated buildings) and reclamation (through the Municipal Excavations By-law) may be controlled by the municipality. The province has approved regulations under the *Environment Act*, which are intended to ensure that extraction activities are environmentally safe and that sites are reclaimed once the operation has ceased. HRM also recognizes that municipal and provincial regulations complement each other such that provincial enforcement is directed towards major developments, while municipal units look after the smaller areas. The level of risk depends in the proximity to the intake and which RAZ they occur on.

Agriculture

Agriculture activities within the BoMont watershed area include sod farms, beef and dairy operations, and crop and pasture lands (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73. Agriculture is mainly restricted to the Nine Mile River subwatershed, which falls within the BoMont red RAZ zone (see *Map G: Land Cover* on page 71). The BoMont WSP is ~1.1km upstream of where the Nine Mile River and enters the Shubenacadie River.

Possible sources of water contamination associated with agriculture activities include: the release of hydrocarbons due to a fuel or oil spills; sedimentation and nutrient loading of streams, due to poor livestock management practices, field operations and water crossings practices; and negative effects from improper agricultural management activities or disregard for Best Management Practices (BMPs). Improper agriculture operations could include inadequate buffer setbacks near watercourses, improper timing during field tillage and fertilization operations, poor crop matching to field conditions, poor fence maintenance practices allowing livestock to gain access to watercourses, and incorrect water crossing sizing and installations (culverts and bridges).

In general, there are no specific pieces of legislation, regulations, or by-laws which deal with soil management. However, "release" of sediment into surface water can trigger charges under three separate pieces of legislation, the *Canadian Environmental Protection Act (CEPA)*, the federal *Fisheries Act*, or the *Environment Act (NS)*. In particular, Fisheries and Oceans Canada, which administers the *Fisheries Act*, is very concerned about sediment entering streams, particularly those which are spawning grounds for salmonoids (salmon and trout). Fisheries and Oceans Canada has set a standard of 25 mg/L of sediment in water. If water running off any farm can be shown to exceed this amount, charges can be laid under the federal *Fisheries Act* or the provincial *Environment Act*.

Commerce

Other small scale commercial land uses are concentrated in the Village Core areas of East Hants, or dispersed throughout the Municipality, especially along the corridor. The largest retail commercial area in East Hants is located in Elmsdale, near Exit 8 on Highway #2. The largest stores in the region are located here which include Sobeys, the Superstore, 3 gas stations, several restaurants and a strip mall.

In the HRM region a small commerce area exists in the village core of Fall River where a Sobeys, several gas stations and small strip malls exist.

Possible sources of contamination include increased sodium concentrations from winter salting practices associated with parking lot management, fuel and oil spills associated with employee and customer vehicles, increased sedimentation through construction activities, and introduction of contaminants through the stormwater system. The level of risk depends on the proximity to the intake and which RAZ they occur in (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

Business Parks

East Hants business parks, which falls within the red RAZ, consists of a mix of industrial, warehouses, transportation and office uses. Most buildings are large, utilitarian buildings. Much of the land is used for outdoor storage. Business parks tend to be separate from residential and other commercial areas and tend to have no street trees.

The Aerotech Business Park located in HRM near Goffs, inside the red RAZ, consists of hotels, large commercial type buildings, service stations and the Aerotech Wastewater treatment plant. While across Highway 102 Adesa and Scotia Speedworld are actively managed.

Possible sources of contamination are similar to that of those listed in Commerce above. The level of risk depends on the proximity to the intake and which RAZ they occur in (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

Institutions

Schools and community use facilities are dispersed throughout the Municipalities, though mainly concentrated along the Corridor region. Community use facilities include places of worship, legions and community halls. The latter are a common feature in the community core. Utility facilities include power, telecommunications, water and waste treatment facilities.

Possible sources of contamination are similar to that of those listed above in Commerce above. The level of risk depends on the proximity to the intake and which RAZ they occur in (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

3.1.3 Residential

Residential development in BoMont is where urban settlement interfaces with rural living. Village cores are characteristic of BoMont with mixed-use development inter-twined. It is common for residential development to have a home-based business on the same parcel of land or next door, for example agriculture. Some residential areas have municipal water and wastewater services while others have private wells and on-site septic systems. The most common activities related to residential development that pose a risk to the watershed area are described below. The level of risk depends on the proximity to the intake and which RAZ they occur in (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73).

Residential development within BoMont is mostly concentrated in the communities of Fall River, Wellington, Grand Lake, Elmsdale, and Enfield and illustrated in *Map J: East Hants*

Bylaw Zones on page 74 and *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75.

Impervious Surfaces

Impervious surfaces that make up roadways, rooftops and driveways, encircle buildings and shopping centres present significant risk to the surface water of BoMont, see *Map J: East Hants Bylaw Zones* on page 74 and *Map K: HRM Regional GFLUM and Community Plan Areas* on page 75. Impervious surfaces facilitate increased water flow which picks up and carries contaminants in stormwater runoff and into the stormwater systems and ditches.

Surface Runoff

Substances, which potentially impact water quality, are transported by runoff during storm events or spring snowmelt, from residential properties, run into the Shubenacadie River (BoMont water supply) which makes their way to the treatment facility. Other sources include spills from traffic accidents near the WSP intake.

Home Heating

Home heating oil tanks that are exposed to weather and/or are not inspected, installed or maintained properly, or have shifted at their base from frost action, have the potential to leak and cause serious environmental and property damage. Further, oil tank spills or failures pose a risk to the water supply due to the potential persistence and movement of petroleum products in the fractured bedrock aquifer, which is characteristic in some areas of BoMont. Due to the extent of residential areas the exact numbers and condition of the tanks have not been assessed. Suffice to say that residential oil tanks are prolific, wherever there is development in the watershed area.

Backyard Fires

HRM has an "Open Air Burning By-law" (O-109) which restricts backyard burning for the purpose of yard maintenance or entertainment. East Hants follows the provincial burning restrictions. Unfortunately, these policies are not always adhered to, which presents an increased risk of accidental fire in the BoMont watershed area.

Automobile Fluids

Release of automobile fluids from parked cars in driveways may include antifreeze, oil, and gasoline (petroleum hydrocarbons). If such fluids are released into the soil this could have a serious impact to the water supply, depending on the amount, location, and type of fuel released.

Household Chemicals

The potential use of household chemicals associated with residential activities including persistent mobile chemicals (e.g., fertilizers, private road and driveway de-icing agents, petroleum products, pesticides, solvents, and other chemicals) could present a risk to surface water quality if used repeatedly or in large quantities.

On-site Private Septic Systems

Private on-site septic systems are the most common type of waste disposal in BoMont. Proper septic tank maintenance and pumping greatly reduces the risk to the water supply area, however age, size of lot, and proximity to watercourse play a major role in failing private septic systems.

Risks include increased *E. coli* and heavy metal counts, nutrient loading and pathogens considered harmful to humans.

The unserviced area of the headwaters region presents a high risk due to small lot size, underlying geology, soil porosity and contains a higher percentage of waterbodies in the BoMont watershed area than the corridor region (see section *2.2.6: Natural Water Bodies on page* 30).

3.1.4 Recreation

Recreational activities occur throughout the watershed area. With careful planning, strong partnerships and open lines of communication, opportunities that benefit both recreational interests and Halifax Water emerge. The most prevalent recreational activities and the potential risks they present to the BoMont watershed area are outlined in *Table 13* below. *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73 help prioritize which areas to focus on when assessing which recreational activities are most important to work with.

Table 13: Impacts to Watershed Area from Recreational Activities

Activity	Negative Impact to water quality	Positive Impacts	Solutions
Trail use	Erosion and sedimentation, tree cutting, fires, garbage.	A formal approach to creating public access could lead to increased reporting, which may help curb some of the illegal and non-compatible activities within BoMont, especially around Provincial Parks.	Signage (informative/educational) Garbage cans. Make available educational watershed pamphlets and drop off to DNR/ HRM/ NGO groups responsible for trails.
Camping	Garbage and camp fires, which increases wildland fire potential.	Increased awareness of the importance of the watershed would increase reporting and may help curb some of the illegal and non-compatible activities.	Signage, patrols and reports from trail users. Educational pamphlets. Make available educational watershed pamphlets and drop off to DNR offices.
Off-highway Vehicles	Petroleum hydrocarbon contamination in the event of a spill or accident, and sedimentation of waterways if vehicles operate in-stream or if riverbanks are damaged.	Increased awareness of the importance of the watershed would increase reporting and may help curb some of the illegal and non-compatible activities.	Signage, patrols and reports from trail users. Educational pamphlets. Make available educational watershed pamphlets and drop off to DNR/ ATV group's offices.
Swimming	Bacteria contamination, lakeshore soil erosion and litter.	Increased awareness of the importance of the watershed would increase reporting and may help curb some of the illegal and non-compatible activities.	Signage (informative/educational). Make available educational watershed pamphlets and drop off to DNR offices.
Boating	Petroleum hydrocarbon contamination. Increased potential for shoreline erosion from wave action and litter.	A formal approach to creating public access could lead to increased reporting, which may help curb some of the illegal and non-compatible activities within BoMont, especially around Provincial Parks.	Install signage at public boat launches (informative/educational). Make available educational watershed pamphlets and drop off to DNR offices. Garbage cans at public boat launches

Golfing	Petroleum hydrocarbon contamination. Increased sedimentation and chemical use from golf course maintenance practices	Golf course fairways are grass covered keeping those areas of the watershed in a vegetative state.	Promote Golf Course Best Management Practices.

3.1.5 Transportation Corridors

As this section describes, BoMont is highly accessible to motorized, non-motorized and pedestrian traffic and also a thoroughfare for the CN Railroad between Halifax and Montreal.

Road types are outlined *Table 9: BoMont Transportation Corridor Length and Agency Responsible for Maintenance* on page 58 and illustrated on *Map F: Communities and Populations* on page 44, *Map G: Land Cover in Risk Zone Areas (RAZ)* on page 71, and *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73 .

Public roads and the railway heighten the risk of:

- hydrocarbon and/or dangerous good spills in the event of a vehicle accident, derailment or other emergency;
- sedimentation and turbidity impacts from vehicles entering a watercourse or from roadway detritus;
- vehicle fluids from stormwater runoff; and
- activities associated with recreational activities facilitated by the various road access points.

The level of risk depends on the proximity to the intake and which RAZ they occur in.

The following subsections describe the types and main risks associated with each.

Major Highways

Sections of two of Nova Scotia major divided highways cross the BoMont watershed area:

- 77.16 km of Highway 102 links Halifax to the northern regions of the province; and
- 39.33 km of Highway 118 allows travellers to bypass the Bedford Basin into Halifax and connects people to the Dartmouth side of the Harbour.

These highways are designed to carry high volumes of traffic at great speeds and are the core trucking routes in and out of Halifax; thereby presenting a high risk of contamination to the water supply from petroleum and chemical spills resulting from vehicular accidents.

The highest risk area is where these highways meet/divide in Fall River - where they cross over where Miller Lake Brook flows into Lake Thomas as illustrated on *Map G: Land Cover in Risk Zone Areas (RAZ)* on page 71.

Waterway Crossings

Bridges and culverts are the two main types of water crossing used in Nova Scotia. The following subsections describe the risks associated with each within the watershed area.

Bridges

Bridges within the BoMont watershed area are regularly maintained by NSTIR, HRM or private individuals; however they still present a risk as they allow road surface runoff that may carry contaminants direct access to the water supply. Furthermore, vehicle accidents are common on bridges especially during winter months when bridge surfaces freeze before the roads sending unaware drivers into the waterway and direct release of automotive fluids into the water supply.

Culverts

Culverts are the preferred choice for small permanent water crossings because they are cheap to buy, cheap to install and cheap to maintain. By sheer number, culverts present a significant risk to the BoMont water supply because many of the culverts are installed and forgotten about until a culvert fails. By this time the damage has already been done by way of sediment release or the cause of the vehicle accident releasing automotive fluids into the water supply.

There are too many culverts to identify in BoMont; however it is worth mentioning that culverts along Hwy 120, 118 and 2 are the responsibility of NSTIR.

Local Access Roads

Many secondary routes, particularly Highway 2, could be considered major highways due to the volume and type of traffic they support. They are also used as alternate routes whenever Hwy 102 or 118 is closed to traffic due to construction or an accident. Many of these routes follow along the major lakes and waterways, particularly the headwater region of the Shubenacadie River (BoMont primary water supply); therefore are considered at higher risk. When used as alternate routes the risk is even higher due to the increased traffic. *Map G: Land Cover in Risk Zone Areas (RAZ)* on page 71 illustrates alternate routes which are used to by-pass accidents or construction on Hwy 102 or 118.Temporary Access Roads

These types of roads present a low to medium-high risk depending on the types of activities, i.e., NSPI uses they types of roads for power line corridor tree and brush removal.

Railway

The rail way corridor (see *Railway Corridor* on page 57) running through the watershed (Map F: Communities and Populations on page 44) presents significant risk to the BoMont water supply. The risks depend on the proximity to the water supply and the type of cargo being transported; therefore the risk is higher in the headwater's region where the railway corridor runs along Grand Lake. The likelihood of an event, whereby there is an accident or spill is not high considering the number of events that have occurred in the past, however the impact would be significant.

The risks associated with rail transport were recently highlighted with the Lac Megantic disaster which occurred on July 6, 2013. The result of this event was catastrophic including 42 casualties, 20 plus homes, and 100,000 litres of oil were released into the Chaudiere River. The spill travelled 80 km to a community downstream who used the Chaudiere River as their drinking water supply. It forced the downstream community to find a temporary water supply elsewhere. A temporary system costing the town $2 million was put in place.

Other potential sources of contamination include past CN maintenance practices where old rail ties were discarded on to the side of the track. The ties are treated with Kresote, a petroleum based preservative, which is considered harmful to the environment. The practice has since changed and requires CN to properly remove and dispose of the old ties; however there are still ties along the tracks. The risk to BoMont is unknown because it is not known how many ties exist or where they are.

Airport

The risks associated with the Halifax Stanfield International Airport (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73 are similar to other commercial sites (see section *3.1: Inherent Risk Factors* on page 78) where risks include petroleum hydrocarbon from poor fueling practices, sedimentation and ARD from development and expansion of the airport services and supporting commercial activities surrounding the airport.

3.1.6 Utilities

BoMont supports a myriad of utility and telecommunications infrastructure belonging to Nova Scotia Power, Heritage Gas, Halifax Water, and communication agencies (radio and television) as described under the corresponding headings below and illustrated on Map L: Utility (Power, Water, Gas) Corridors on page 76. The level of risk associated with each activity depends on the proximity to the intake and which RAZ they occur in.

Nova Scotia Power Inc.

The following subsections describe potential risks associated with NSPI infrastructure and activities that are conducted in the watershed area.

Transmission Lines

Transmission lines carry electricity along large steel or wooden towers and operate at high-voltages from 69KV to 345KV sent through distribution substations and transformers that step the electricity down to a lower voltage level that is safe for delivery to homes and businesses.

Risks associated with transmission lines include petroleum hydrocarbon spills from NSPI staff and contactor vehicles accessing the lines for inspections and maintenance; accidental fire from tower/line failure; and chemical contamination from chemicals used for vegetation control on transmission line right of ways.

Power Poles

NSPI mainly uses poles treated with pentachlorophenol (PCP) and occasionally use poles treated with chromated copper arsenate (CCA). Comparison of the ecotoxicity of each of these treatment types is outlined in on page *Table 14: Ecotoxicity Levels of Wood Preservatives* on page 88.

PCPs target wood destroying organisms and are a known carcinogen. The ecotoxicity of PCPs is classified in a Dalhousie University paper as “medium”. The important factor to consider regarding its chemical toxicity is the likelihood of exposure. Of further consideration, in the event of a release from the utility pole during the life of its service, is that the toxin is rapidly broken down by indigenous soil organisms.

However, through discussions between Halifax Water and NSPI's environmental staff, it is understood that standard practices around utility pole installation and watercourse setbacks decrease the risk of exposure to the water supply by this ecotoxin. Installation of treated poles is dependent on the location and proximity to salt, fresh and/or potable water (drinking wells); otherwise, untreated poles are used where water cannot be avoided. Through application of this standard practice, risks associated with chemically-infused power poles are minimized. For details on the management of treated power poles see section *4.3.5: Power Poles* on page 131.

Table 14: Ecotoxicity Levels of Wood Preservatives

Treatment	Tested Organism	Toxicity Level *LD_{50} (medium)
CCA	Rat	50 mg/kg body weight
	Fish (bluegill sunfish)	0.1 mg/L
PCP	Rat	210mg/kg body weight
	Fish (bluegill sunfish)	0.1 mg/L
	Crustacean (Daphnia)	.04 mg/L

*L = lethality D = dose 50 = % of population

Line maintenance

NSPI has a comprehensive power line maintenance plan; nonetheless the risks associated with line maintenance include sedimentation of waterways, chemical spills and forest fires.

Vehicle Access

Power line access roads are minimally maintained and accessed by motorized vehicle, usually 4x4 truck, ATV or tracked machine. All vehicles types present a risk to the water supply through automobile fluids, sedimentation or fire. To reduce risk all NSP vehicles and contractors are equipped with a means of communication, spill kits and fire equipment.

Chemical Application

Vegetation control is by way of manual brushing crews or mechanical brushing crews or chemical application by mechanical ground crews. The risks associated with the mechanic equipment are similar to those described in the previous section *Vehicle Access;* however the risks associated with chemical application are more of a concern as they relate to watercourse setbacks, weather and wind direction and speed, see section *3.1.7: Nova Scotia Power Inc.* on page 95.

Transformers

Transformers, electromagnetic devices used to control voltage levels, use mineral oil to cool and insulate the windings of the transfer system. The risks posed by insulating oils, as described in the following paragraphs, depend on the type of oil, which is influenced by the age of the transformer, ownership and their location and maintenance schedule.

Until 1983, insulating "oil" contained in pole top transformers typically included Polychlorinated biphenyls (PCBs). New Federal regulation requires power utilities to remove all PCB contaminated equipment (containing >50ppm/L of PCBs) from service by 2025. NSPI estimates there are ~45,000 potentially PCB-contaminated pole top transformers province-wide. Since 1983, NSPI has moved toward using in its transformers a Naptha-based mineral oil, VOLTESSO 35 or a plant-based mineral oil, Envirotemp® FR3™ – a biodegradable, fire resistant, edible seed oil based dielectric coolant – for use in more environmentally sensitive areas. While NSPI prefers to use the Naptha-based mineral oil over other insulating oils because it interferes less with the transformer cooling system, they will typically use the Envirotemp brand name in environmentally sensitive areas, such as drinking water watersheds, when requested.

The MSDS for VOLTESSO 35 suggests there is very little to risk to the water supply in the event of a spill. Regardless, in the event of a land spill event, the MSDS states that any oil should be recovered by pumping, or with suitable absorbent. In the event of a spill in water, the oil should be confined immediately with booms and removed from the surface by skimming or with suitable absorbants. Advice of a specialist should be acquired before using dispersants. The MSDS also recommends preventing entry into waterways, sewers, basements or confined areas. It is not known how many of the transformers use VOLTESSO 35 making it difficult to assess the risk to the water supply.

Natural Gas

With respect to BoMont, as illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76, the natural gas pipeline travels north to south entering at East Hants and travelling to Halifax. The greatest risk to the water supply is where it crosses over the Shubenacadie River in the community of Waverley at the outlet of Lake Charles.

Halifax Water

The following briefly describes the risks associated with infrastructure owned and operated by Halifax Water inside the BoMont watershed area.

Water Supply Infrastructure

The BoMont water supply plant (WSP) is located at 37 Old Trunk Road, Elmsdale which consists of one building including an upgraded water pumping station built in 2012 (see *Map L: Utility (Power, Water, Gas) Corridors* on page 76). Risks associated include minimal chlorine stored on site for water disinfection and backwash water which is discharged back into the Shubenacadie River that is covered under the operating permit.

Wastewater Infrastructure

Management of wastewater upstream of the intake is critical to minimizing risks to the raw water supply. Municipally-owned treatment facilities have the potential to harm the raw water supply if there are overflows or mechanical failures that direct untreated wastes to the river / lake system.

Halifax Water owes and operates four wastewater treatment plants within the headwaters region of the BoMont watershed area, i.e., Springfield Lake, Lockview, Wellington, and Frame

Subdivision as described in *2.3.3:Municipal Wastewater Systems: Halifax Water* on page 54, see *Map L: Utility (Power, Water, Gas) Corridors* on page 76 illustrating municipal wastewater treatment plant locations.

While risk to the water supply was and will be reduced with wastewater system upgrades and improvements, these systems still present risks:

- general maintenance involving vehicle access;
- dependent on proximity and flow rates, future overflow events have the potential to reach the source water supply; and
- increased wastewater flow capacity from the Aerotech Treatment plant.

Measures taken to mitigate the risks presented by the sewer lines are described in section *4.2.11: Wastewater Management* on page 119**.**

Municipality of East Hants Water and Wastewater

The following briefly describes the risks associated with infrastructure owned and operated by the Municipality of East Hants inside the BoMont watershed area.

Water Utility

The Municipality of East Hants owns and operates the East Hants water treatment plant upstream of BoMont in the community of Enfield. Its draws its water from the same source as BoMont, Shubenacadie River, and supplies water to the communities of Enfield, Elmsdale, and Lantz. The risks associated are similar to that of larger Halifax Water WSPs (Bennery Lake, Lake Major and Pockwock) and are considered minor even though it falls within the red RAZ.

Wastewater Collection and Treatment

The Lantz Wastewater Treatment Plant and receiving waters for the treated effluent are located outside of the BoMont watershed area in the community of Lantz. The infrastructure it supports partially lies inside the red RAZ of the BoMont watershed area, therefore presenting a low to high risk to the water supply. The low designation is assigned for day to day operations and maintenance while the high risk is assigned to overflows and breaks in the system that could directly contaminate the water supply.

Private On-site Septic Systems

To reduce the risks from on-site septic systems within the East Hants South Corridor and Commercial water and wastewater district, the planning review process report recommends that East Hants initiate two future projects. The first project would establish a water monitoring program which allows East Hants staff to evaluate changes to the quality of the lake water over a long period of time and it would also permit the Municipality to warn residents if water quality deteriorated to a point where it could impact human health.

The second project would establish Wastewater Management Districts including one for lake front cottage developments. A fee would be paid to the Municipality by each property owner to have their system inspected and pumped over a certain number of years. This would provide East

Hants with the ability to ensure failing septic systems are identified, fixed, and that effluent from the failing systems does not impact the lake water. It would also provide residents with knowledge that East Hants was ensuring septic systems were pumped and that lake water would not be impacted by the effluent.

Stormwater

The BoMont watershed is largely a rural community where stormwater management is mainly by way of roadside ditches which channel water directly into surface waterways, picking up dirt, debris and other contaminants. In other areas, particularly the Nine Mile River watershed area of the red RAZ where there is little vegetation, i.e., freshly tilled pastures and sod fields, problems in terms of flooding and soil erosion occur with or without stormwater systems especially during severe storm events. For these reason stormwater is considered at high risk for source water contamination.

3.1.7 Chemicals

Although there are provincial permitting processes and regulations to control and monitor the use of chemical toxins and biocides or pest control products, the use of any chemical around source water is still considered a risk to the water supply. The level of risk depends on the proximity to the intake and which RAZ they occur in.

General Use

The risk of chemical contamination of the water supply is considered high due to the high percentage of private landownership and different types of land use activities it supports. Residential use of chemical's for lawn maintenance is restricted in the headwaters region through HRM municipal by-law *P-800 Respecting the Regulations of Pesticides, Herbicides and Insecticides*; however this by-law is not always adhered to.

The Corridor region (East Hants section) is at a higher risk of chemical contamination because it does not have specific municipal by-laws respecting the use of chemicals for lawn care; and has a high percentage of industrial and commercial activities that use chemicals in their land maintenance program, i.e., agriculture, forestry, NSPI, and mining, quarries and pits, especially in the red RAZ. The subsections following identify and assess some of the greatest potential risks associated with chemical use from identifiable sources inside the watershed area.

Road De-icing

Road de-icing agents present a risk to water supply sources when chloride, accumulated from road de-icing agent applications, enters surface waterways through stormwater runoff. Evidence of this risk is apparent through the increased levels of surface water chloride concentrations and conductivity levels measured in the samples collected within the BoMont watershed area (see section *5.4.1: Total Chloride* on page 151).

All levels of government have developed road salt application guidelines due to concerns over the natural environment's sensitivity to de-icing agents. The following subsections provide an overview of the various guidelines to manage the risks to water sources associated with road de-icing agents.

Environment Canada's Code of Practice

Environment Canada completed a five-year study in 2001 which determined that in sufficient concentrations, road salts pose a risk to plants, animals and the aquatic environment. It was subsequently recommended that road salts be added to the Canadian Environmental Protection Agency's List of Toxic Substances[19].

In response to the 5-year study, rather than banning the use of road salts and present increasing hazards to the public on winter roads, the Federal Government designed a system to help municipalities manage their use of road salts to reduce harm to the environment, while maintaining road safety through the *Code of Practice for the Environmental Management of Road Salts* (2004)[20]. Within this Code of Practice, Annex B, sections 7 and 8 identify the risk potential for chloride concentrations to drinking water and groundwater sources respectively. Environment Canada also outlines a Road Salt Management Strategy[21]. However, Environment Canada makes it clear that nothing in the Code should be construed as a recommendation to take action to the detriment of road safety.

Environment Canada also notes public expressions of concern regarding the use of ferrocyanide salts in formulations of road salts, given that, in solution, they can photolyse to yield free cyanide ions, which are highly toxic to aquatic organisms. Sodium ferrocyanides are used as an anti-caking agent in road salts in the Atlantic Provinces. See more on ferrocyanides in section *4.2.6: Public Roads and Highways – Road De-icing* on page 118.

Provincial Policy and Regulations

NSTIR has developed road de-icing application standards, which are found in the department's Highway Maintenance Standards. The Standards states the use of salt in environmentally sensitive areas will be monitored and alternatives to salt will be used where practical.

The current definition of "environmentally sensitive areas" with respect to the Provincial Highway Maintenance Standards does not classify surface water supply areas.

Chloride levels in the raw water samples collected for BoMont are measured to better understand natural conditions and as an indicator of anthropogenic activities. Results show chloride levels in the BoMont water supply system to be low compared to other Halifax Water source water supplies. As described in section *4.2.6: Public Roads and Highways – Road De-icing* on page 118, chloride levels in the water are well below levels considered toxic to aquatic life according to Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life (CWQG).

Further, upon consultation with NSTIR and HRM winter road maintenance staff, it was learned that the anti-caking agent sodium ferrocyanide is added by the Canadian Salt Mine to road salt

[19] Environment Canada: Acts and Regulations; Canadian Environmental Protection Agency; Toxic Substances List – Schedule I. Date modified 2013-11-06. Web-accessed May 13, 2015 at: http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=0DA2924D-1.

[20] Environment Canada: Pollution and Waste; Code of Practice: The Environmental Management of Road Salts. Web-accessed April 22. 2014 at: http://www.ec.gc.ca/sels-salts/default.asp?lang=En&n=F37B47CE-1.

[21] Environment Canada: Road Salts: Reducing the risks of road salts to the environment while keeping our roads safe. Web-accessed April 22, 2014 at: http://www.ec.gc.ca/media_archive/press/2001/011130-2_b_e.htm.

prior to delivery to the various destinations to ensure the salt is free flowing. Transportation and Infrastructure Renewal's specification for road salt states that it must be treated with an anti-caking conditioner (YPS or equivalent) at a minimum rate of 50 ppm. NSTIR advised that Canadian Salt typically adds 100ppm. The Material Safety Data Sheet (MSDS) for ferrocyanide received from NSTIR indicates that the reported probable lethal dose in humans is 0.5-5gm/kg. Ferrocyanide salts are rapidly excreted in urine without metabolic alteration. Additionally, according to a Stantec Report:

> "*In the absence of direct sunlight, ferrocyanide complex is stable and low in toxicity. However, exposure to sunlight results in dissociation and release of free cyanide, which can be hydrated to hydrogen cyanide; both compounds are toxic*."[22]

For more information on the management of this compound with respect to the risks to the water supply see section *4.2.6: Public Roads and Highways – Road De-icing* on page 118.

Halifax Regional Municipality Policy Restrictions

HRM has recognized in the RMPS (2014) the "crucial" need to protect water resources for

> "*potable water supply, wildlife habitat, recreational enjoyment, and aesthetic value. ...HRM's strategy aims to protect this resource through land use control and retention of those features that regulate water flow, mitigate flooding, reduce water pollution and protect ecological functions*."

The RMPS(2014) also states as its first objective regarding Municipal Water Services, Utilities and Solid Waste that HRM will "*coordinate municipal initiatives with … (Halifax Water) to:… (c) reduce degradation to the natural environment."*

In response to this need, a water quality monitoring program began in 2006 to identify lake water quality status and trends that included chloride data (chloride is the primary toxic component of road salts from HRM's perspective). Based on the water quality data collected, and to fulfill Environment Canada's Code of Practice (see section *3.1.7*Chemicals*: Environment* Canada's Code of Practice on page 91, HRM has created a salt management plan, identified best management practices and applied innovative techniques to winter works operations. Policy SU-8 of the RMPS (2014) states

> "*HRM may* consider *regulatory and operational measures to reduce the quantity and improve the quality of stormwater entering public stormwater facilities and watercourses including…reduction in road salts. Any such measures may apply in whole or in part of HRM and may require approval of the Review Board*."

Further, HRM Transportation and Public Works are developing a new Winter Works Management Plan to reflect upgrades in policies and practice. For instance, in October 2011, the

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22 Halifax Regional Municipality. Environment and Sustainability Standing Committee, April 16, 2012, Information Report. Attachment 1: Stantec. November 7, 2011. Draft Report: Road Salt – Review of Best Management Practices Prepared for Halifax Regional Municipality Sustainable Management Environment Office. Halifax NS; p. 11. Web-accessed December 23, 2014 at: http://www.halifax.ca/boardscom/swrac/documents/RoadSaltImpactsonLakes.pdf.

HRM Municipal Operations Winter Works Staff initiated and piloted the application of brine (Direct Liquid Brine Application) to HRM roads to achieve enhancements to public safety and a reduction in overall salt usage.

Road De-icing Application Practices and Strategies

A summary of road salt applications and strategies for the province and for HRM are outlined in the subsections below. A map entitled *Winter Maintenance Responsibility in HRM Core* illustrates the agencies responsible for maintaining specific roads under winter conditions and may be viewed online[23].

Halifax Regional Municipality

HRM's Salt Management Strategies[24] and Snow and Ice Service Standards[25] are posted on HRM's website[26].

Nova Scotia Transportation and Infrastructure Renewal

The winter maintenance program conducted by NSTIR is outlined in Chapter 6 of NSTIR's Highway Maintenance Standards[27]. The province adjusted its winter maintenance standards to include Direct Liquid Applications (DLA) (brine) in 2013, decreasing the level of chloride applications on provincially maintained roadways since then.

Standards, strategies, regulatory requirements and management plans from the various levels of government are designed to restrict the application of road salt as a de-icing agent, particularly in "environmentally sensitive" areas. However, various levels of chloride salt concentrations are applied within BoMont which pose a risk to water quality inside the watershed area. Maintaining open lines of communication between Halifax Water and HRM and NSTIR winter road maintenance staff will help to manage these risks.

Water Supply Plant

The only chemical stored on site at the BoMont WSP is minimal amounts of chlorine that is used in the water treatment process which is delivered by the water supply plant operators on an as needed basis.

In the event of a power outage, a portable diesel generator is brought on site. Diesel fuel for the generator is delivered to the site, approximately once a day or as needed.

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23 Halifax: Winter Maintenance Responsibility in HRM Core at: http://www.halifax.ca/snow/documents/WinterMaintenanceResponsibilitymap.pdf.

24 Halifax: Snow: Salt Management Strategies at: https://www.halifax.ca/snow/SaltManagementStrategies.php.

25 Halifax: Municipal Operations: Snow and Ice Service Standards at: http://www.halifax.ca/municipalops/Winter/SnowServiceStandards.php .

26 Halifax: Snow: Salt Management Strategies at: https://www.halifax.ca/snow/SaltManagementStrategies.php.

27 Nova Scotia Department of Transportation and Infrastructure Renewal Highway Programs: Highway Maintenance Standards: Effective 1 July 2009. Chapter 6: Snow and Ice Control. : http://gov.ns.ca/tran/publications/Highway%20Maintenance%20Standards%20Manual.pdf.

The risk to the watershed from chemical contamination associated with the water supply plant is low: due to the small amounts of chlorine (<75litres) stored on site and the proximity to the water supply which is ~45m upslope from the supply. Further there are cement abutments in front of the WSP in the event vehicle roles towards the building.

Chemical quantities associated with the East Hants WSP are unknown; however are assumed to be similar to Halifax Water's larger systems (Bennery Lake, Lake Major and Pockwock) and will be treated as such. Therefore risk is assumed to be low to moderate depending on the amount and proximity to the water supply.

Nova Scotia Power Inc.

Below are the potential risks associated with respect to chemicals associated with Nova Scotia Power Inc. activities to the BoMont water supply. The level of risk depends on the proximity to the intake and which RAZ they occur in.

Transmission Lines

NSPI uses chemical treatment as a cost effective source of pest and vegetation control for transmission and power pole line maintenance with no exception to BoMont. Even with strict standards set in the *Pesticide Regulations*, the risk to the BoMont water supply is moderate to high due to the fact that NSPI is under no obligation to inform Halifax Water of the location or type of chemical being used or contact Halifax Water in the event of a spill.

Transformers

NSPI transformers (pole and pad mount) contain coolant oil, which may contain chemicals that could present a risk to the water supply in the event of a leak. The level of risk presented by leaks is dependent on the type of oil the transformers contain and the location. For details on the different types of transformer oil and the risks they present see section *3.1.6 Transformers* on page 88.

Wildland Fire Fighting

In the event of a wildland fire, risk to the water supply from firefighting activities, particularly those using chemical suppressants, has been greatly reduced through collaborative strategies between the water utilities, NSDNR and NSE (see section *4.4.1: Wildland* Fire on page 132). As a last resort, NSDNR has identified Silv-Ex and/or FIRE-TROL Fire Foam 104 as the type of chemical that should be used inside the watershed area in such events.

The benefits to using an approved fire suppressant chemical outweighs the risks to water quality presented by the aftermath of a fire event when fire suppression chemicals are not used (see section *3.2.1: Wildland Fire* on page 99). The material safety data sheets (MSDS) indicate that the application of these fire suppressants pose little risk of environmental impact because they are biodegradable and exhibit little to no biotic toxicity when used according to the manufacturer's recommendations.

Forest Management

Forestry companies use chemical treatment as a preferred competition control tool for undesirable species. However there has been a move to use less chemical treatment and more manual treatment within the last 10 years. Chemical treatment is no longer allowed on Crown lands, however is still being used on private.

The Corridor region is where most of the industrial forest company lands are located (see *Map I: Land Use and Landownership in Risk Area Zones (RAZ)* on page 73); therefore chemical contamination as a result of forestry practices is at its highest risk in the red RAZ of the Corridor region.

Agriculture

Chemical treatment of agricultural crops is the preferred application as it is the most effective and cheapest. Compared to forestry agriculture may apply chemical treatment a few times per year versus once or twice over the life of the forest making agriculture the highest risk of contamination to the water supply.

Agriculture is mainly restricted to the Corridor region of the watershed (see section Map G: Land Cover in Risk Zone Areas (RAZ) on page 71), therefore chemical contamination as a result of agriculture practices are at its highest risk in the red RAZ of the Corridor region.

Airport Maintenance

Given its past history and location within the red RAZ, airport maintenance chemicals which include airplane de-icing and road salts are considered high risk to the water supply.

There have been cases in the past where airplane de-icing chemicals were responsible for fish kills in Bennery Brook, a tributary to the Shubenacadie River upstream of the BoMont WSP. Furthermore more the risk associated with run-way salt is much the same as road salt described earlier in this section, *3.1.7: Road De-icing* on page 91.

3.1.8 Waste Refuse/ Disposal sites Sites and Infilling

The BoMont watershed, largest of Halifax Water source water areas, is at a moderate-high risk, for illegal dump sites and refuses due to its high number of access roads which are minimally gated.

Infilling is also a concern in BoMont especially along areas under development pressure from housing, business parks as well as agriculture areas. BoMont is not a Protected Water Area, therefore infilling is more likely to occur without consequence than those watershed areas that are protected; thus putting the water supply at a high risk of contamination due to infilling.

3.2 Critical Infrastructure

Public Safety Canada considers water to be "critical infrastructure" and is defined as such

> *"…processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government…. Disruptions of critical infrastructure could result in catastrophic loss of life and adverse economic effects."*[28]

[28] National Strategy for Critical Infrastructure, Public Safety Canada Her Majesty the Queen in Right of Canada, 2009. ISBN: 978-1-100-11248-0; p. 2. Website sources: http://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/srtg-crtcl-nfrstrctr/srtg-crtcl-nfrstrctr-eng.pdf .

BoMont is a considered a small system, less than 20 customers which can easily be manipulated to provide safe drinking water through bulk water deliveries, therefore it should not be considered a critical threat that would result in a serious adverse situation unless the primary water supplies for Halifax and Dartmouth (i.e., Pockwock and Lake Major) are interrupted, in addition to the BoMont water supply. The inability to deliver safe drinking water to the BoMont customers could then be considered, not to the same extent as the larger systems, a disruption[s] of critical infrastructure that could result in catastrophic loss of life and adverse economic effects.

3.2.1 Critical Infrastructure Threats and Hazards

According to Public Safety Canada, the risks to critical infrastructure, which include accidental, natural and intentional hazards (also referred to as threats), are increasingly complex and frequent. Although the list of hazards and threats is never complete, the Public Safety Canada's Risk Management Guide for Critical Infrastructure Sectors has created a list of common threats and hazards that could affect critical infrastructure (found in that document's Appendix B: List of Hazards and Threats[29]). There is no single way to assess the risks presented by hazards and threats; the methods and best practices to assess risks continually evolve.

No matter what technique is used to assess the risks, lessons learned and recommendations for improvement need to be captured to keep abreast of the progression of threats to the water supply as they evolve.

The four factors that have been identified as contributing to Canada's vulnerability to a broad spectrum of threats on critical infrastructure, such as a municipal water supply utility are:

1. population, built environment, and wealth, which are increasingly concentrated in a small number of highly vulnerable areas so that such communities are at risk from multiple hazards;
2. climate change, which may increase the frequency and severity of extreme weather events;
3. infrastructure that is aging and is more susceptible to damage; and
4. communities that are increasingly more reliant on advanced technologies and are frequently disrupted during disasters.

The common threats and hazards that have been considered through accidental emergencies, natural events or intentional threats as having the potential to have the greatest impact to the BoMont water supply system, are described in the corresponding sections following and outlined in *Table 16: Summary of Existing and Potential Critical Infrastructure Risk Factors Affecting Water Supply Area* on page 107.

[29] Public Safety Canada: Risk Management Guide for Critical Infrastructure Sectors. Website source: http://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/rsk-mngmnt-gd/rsk-mngmnt-gd-eng.pdf p. 37.

Accidental Emergencies

Responsibility for emergency measures, including the protection of critical infrastructure (CIP) in Canada is shared among all three levels of government. The federal government provides national leadership and coordinates the overall CIP effort. The federal government lead agencies include the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) agencies, which include but are not limited to Health Canada, Transport Canada, RCMP, Natural Resources Canada, and the Canadian Security Intelligence Service (CSIS). The lead agency in Nova Scotia is the Nova Scotia Emergency Management Office.

An occurrence of any accidental emergencies described under the subheadings below is considered to present great risk to BoMont in terms of impact.

Accidental Fire

BoMont is in a unique position where the natural environment (unoccupied land) interfaces with human development, which is defined as the Wildland –Urban Interface (WUI). Consequently, accidental fire is a moderate-high risk that is exacerbated by various inherent anthropogenic occurrences that are more frequent and varied within the WUI (see section *3.1: Inherent Risk Factors* on page 78).

Aircraft Disaster

The Halifax region's airspace is used by multiple users including domestic and international flights arriving to and departing from the Halifax Stanfield International Airport, Canadian Armed Forces who are training at Canadian Forces Base Shearwater, and helicopter, non-scheduled tourism and non-commercial flights. All things considered, having busy air-space in the vicinity of BoMont presents a low-extreme risk.

In the event of an emergency landing in BoMont, other than the airport, there is risk for water quality impairment associated with the potential for fire and the chemicals to arrest the fire, fuel leakage, and intrusion of sediments and debris into waterways. Depending on the severity of an aircraft disaster, the result could be long term damage to the water supply– an extreme risk. However, the likelihood of such an event is very low, hence the low risk potential consideration.

Chemical and Oil Spills

There is substantial potential for chemical and oil contamination through accidental spills from various sources including vehicle road traffic and maintenance, and private residential and commercial activities inside the water supply area. An oil, fuel, or hydraulic spill likely would be limited to the immediate spill area since there are usually limited quantities of these fluids (unless there was direct discharge near the intake).

Natural Events and Disasters

Natural events and disasters include wind and flooding, fire, drought, natural biological outbreaks and infestations and climate change impacts. These events and disasters are unpredictable and can have long-term negative effects on source water quality. They present a risk to water quality mainly due to the impairment associated with the intrusion of sediments and debris into waterways, and the loss of land cover and infiltration areas. The key natural factors to consider as potential risks to BoMont are described below in more detail.

Wind and Flooding

Wind and rainstorm events resulting from tropical storms, surges and hurricanes are a significant threat in Nova Scotia, and put water quality and subsequently public health at risk. Such events cause flooding, which puts drinking water supplies at risk by way of microbial cross contamination and power outages, which threaten to disrupt water pumping stations and blow down large forested areas that lead to short and long-term water quality impacts such as soil erosion and sedimentation, increase in suspended solids and organic matter levels.

Wildland Fire

Generally, wildland fires in Nova Scotia have become less of a risk due to public awareness and education and a successful Provincial Fire Safety Program. However, forested areas close to the Wildland – Urban Interface (WUI) present a moderate-high risk to the watershed area (see section *3.2.1: Accidental Fire* on page 98).

Wildland fires present a risk because they contaminate water supplies by producing an increase in heterotrophic plate counts caused by woody debris, ash or dissolved nutrients in water and increased opportunity for sedimentation through erosion of fire exposed soils.

Drought

According to Environment Canada, Atlantic Canada may be more susceptible to drought impacts than areas where drought is more prevalent; where drought occurs less frequently there tends to be a lower adaptive capacity. Presently the risk of drought in BoMont is low, but as the climate continues to change risks associated with drought could rise.

Low flow conditions caused by drought increase concentrations of parameters known to impair water quality. Of particular concern are increased concentrations of microorganisms that pose a threat to human health, i.e., cryptosporidium, giardia, listeria, campylobacter, salmonella, and *E. coli*. Under these circumstances a robust water treatment system is vital.

Climate Change

The risks posed by climate change to BoMont is difficult to assess and determine due to varied and multifaceted considerations; however, identifiable climate change effects, as they relate to the water supply area, are discussed throughout this SWPP.

Intentional/ Deliberate Threats

An intentional or deliberate threat involves an attack or a deliberate act for the purpose of doing damage that involves malicious intentional threats on national security such as chemical, physical, cyber or biological attacks; sabotage, crimes, social unrest, strike or labour disruption; or non-malicious intentional actions such as a border closure or regulation change that can affect critical infrastructure. The different types of possible intentional/deliberate threats and their risks on BoMont are described under the next two headings.

Malicious Intent

The BoMont WSP is considered a non-primary target therefore giving the WSP a low risk of malicious intent

Non-malicious Intent

Non-malicious intent could negatively affect BoMont by compromising the ability to protect the watershed area. Considering that BoMont is not protected under its own legislation, unlike Pockwock, Lake Major and Bennery Lake, there is impetus for non-water utility interests to acquire and/or use watershed lands for other than watershed protection purposes. Therefore, risk of non-malicious intent to BoMont is directly related to ownership and the regulations and by-laws in place.

3.3 Risk Assessment Summary

Table 15: Summary of Existing and Potential Inherent Risk Factors Affecting Water Supply Area on page 101 and *Table 16: Summary of Existing and Potential Critical Infrastructure Risk Factors Affecting Water Supply Area* on page 107 outline the activities described in this Chapter that have inherent potential to contaminate the BoMont watershed area, the potential contaminants involved, whether they are a point or non-point pollutant source (or both), and the potential impact they have on the watershed area.

Table 15: Summary of Existing and Potential Inherent Risk Factors Affecting Water Supply Area				
Activity	**Potential Contaminant**	**Point Source**	**Non-Point Source**	**Potential Impact**
General Land–use				
Regional Plan guiding policy designating permissible land use planning and development activity in HRM, compounded by landowner type. East Hants Community Plan guiding document and compounded by landowner type. Applicable Provincial Regulations.	Automotive Fluids and petroleum products; sedimentation due to soil exposure; bedrock - acid (pyritic) slate – exposure promoting ARD; commercial and residential chemicals/fertilizers; nutrients and bacteria from sewage system failure; and petroleum products from fuel spills.	X	X	Increased sedimentation through stormwater runoff and turbidity; ARD lowering pH of water and causing fish kills; chemical run off from vehicular fluids; eutrophication of water bodies; hydrocarbon contamination from fuel storage and motorized vehicles; fecal bacteria and nutrient contaminants from sewage treatment infrastructure breaks and overflow escaping into water source.
Commercial/ Industrial/ Institutional				
Forestry Operations: including harvesting, silviculture, road maintenance and construction.	Petroleum hydrocarbons/fluids	X	X	Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
	Soil erosion and sedimentation		X	Sedimentation of streams may occur through poor harvesting practices and/or improper road construction and maintenance and watercourse crossings.
	Chemical sprays related to silviculture practices	X	X	The use of chemicals for forest management has the potential to impact water quality through poor timing and disregard of watercourse setbacks.
Mining and pits and quarry operations	Petroleum hydrocarbons/fluids	X	X	Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
	Soil erosion and sedimentation		X	Sedimentation of streams may occur through normal pit and quarry operations through the removal vegetation and soil, blasting practices and/or improper road construction and maintenance and watercourse crossings. Erosion and sedimentation are controlled through the permitting process which requires the approval holder to monitor water quality leaving the site. Should approval conditions be exceeded the holder is required to report it to NSE and remedy the problem.

	Bedrock/Acid (pyritic) slate exposure causing ARD.	X		ARD lowering pH of water and causing fish kills. The effect is long lasting.
	Mine Tailings		X	There are numerous mine tailing sites spread throughout BoMont of which many are in swamps, wetlands and lakes. Disturbance of these areas could lead to the release of arsenic, mercury or other heavy metals which would impair water quality. Not all sites have been identified making the risk of contamination to the BoMont system difficult to assess.
Agriculture operations: including sod farms, dairy, beef, crop and pasture land	Petroleum hydrocarbons/fluids	X	X	Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
	Soil erosion and sedimentation	X	X	Sedimentation of streams may occur through poor field maintenance practices, in-water crossings (fording), poor installation/maintenance of roads, bridges and culverts, poor feedlot management practices, and livestock drinking from watercourses which erode watercourse banks.
	Chemical sprays related to crop management		X	The use of chemicals such as pesticides, fungicides, herbicides and other fertilizers for crop management has the potential to impact water quality through poor timing, not respecting watercourse setback and poor feedlot management practices.
	Nutrient Loading and E.coli.	X	X	The use of liquid manure and other fertilizers for crop management has the potential to impact water quality through poor timing, not respecting watercourse setback and poor feedlot management practices.
Commerce: including Village Core and Business Parks	Stormwater management		X	Large parking lots for staff and customer parking promote runoff into the surrounding area by stormwater systems at higher than normal rates carrying sediment and other deleterious substances considered sources of contamination.
	Petroleum hydrocarbons/fluids	X	X	Parking lots where staff and customer vehicles are parked are subject to leaky vehicles which have the potential to be washed away into the stormwater system contaminating the water supply.
	Home heating oil	X		Spills can occur during tank fueling operations, improper tank maintenance and/or tank failure over time. Release of hydrocarbons into the soil for any length of time could have a serious impact to the water supply.
	Storage facilities	X	X	Gas stations and other storage facilities have the potential to spill product during deliveries and handling. Underground fuel tanks potentially could leak into the surrounding soils, groundwater or nearby surface waterways through improper maintenances and monitoring practices.
Institutional: Including schools and community facilities	Stormwater management	X		Large parking lots for staff and visitor parking promote runoff into the surrounding area by stormwater systems at higher than normal rates carrying sediment and other deleterious substances considered sources of contamination.

	Petroleum hydrocarbons/fluids	X	X	Parking lots where staff and visitors vehicles are parked are subject to leaky vehicles which have the potential to be washed away into the stormwater system contaminating the water supply.
	Home heating oil	X		Spills can occur during tank fueling operations, improper tank maintenance and/or tank failure over time. Release of hydrocarbons into the soil for any length of time could have a serious impact to the water supply.
Residential				
Backyard fires	Contaminated water run-off from burnt materials, potentially containing hazardous chemicals, organic matter and sedimentation	X		Short and long-term impact on water quantity and quality depending on severity.
Home heating fuel	Home heating oil fuel	X		Spills can occur during tank fueling operations, improper tank maintenance and/or tank failure over time. Release of hydrocarbons into the soil for any length of time could have a serious impact to the water supply.
Parked cars in driveways	Petroleum hydrocarbons/fluids	X	X	Petroleum hydrocarbons/fluids could be released into the soil surrounding homes and could have a serious impact to the water supply depending on the proximity to water supply, amount and type of fuel released.
Household chemicals / fertilizers	Fertilizers, pesticides, soaps	X	X	Household chemicals used in gardens and on lawns or to wash vehicles in the driveway could be a source of contamination.
Impervious Surfaces	Roofs and driveways are contributing factors	X	X	Impervious surfaces promote runoff into the surrounding soil at a higher rate than if these areas were covered with vegetation.
On-site Septic	Poor maintenance practices leads to failing septic systems causing nutrient loading and fecal contamination of water supply.	X		Increase in heterotrophic plate and coliform counts
Recreation				
Trail-use	Garbage, bacteria contamination from pet droppings and-off-trail pedestrian activity causing soil erosion and sedimentation.	X	X	Pedestrian traffic increases the potential for garbage and bacteria from pet droppings and soil sediments to enter source water.
Camping	Increased heterotrophic plate counts caused by woody debris, ash or dissolved nutrients in water as well as garbage left behind.	X		Camp fires associated with camping increase the risk of wildland fires which elevates the impact of contamination over time; and elevated bacteria and nutrient counts caused by garbage and potential interference with the water treatment process (garbage becoming clogged in pumps).
Off Highway Vehicles (OHVs)	Petroleum hydrocarbons/fluids and soil erosion and sedimentation.	X	X	Petroleum hydrocarbons/fluids contamination to water supply plus sedimentation.
Swimming	Bacteria contamination from human and pet body contact.		X	Bacteria released into source waters.

Boating	Petroleum hydrocarbons/fluids/ erosion	X	X	Fuel released into waterways could have a serious impact on the water supply. Wave action from boating activities increase shoreline erosion.
Golfing	Petroleum hydrocarbons/ liquids	X	X	Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
	Soil erosion and sedimentation.		X	Sedimentation of streams may occur through poor golf course practices, road maintenance practices and/or shoreline vegetation removal to improve skyline views.
	Chemical and/or biocide, fertilizers pest control use products.	X	X	The use of chemicals such as pesticides, fungicides, herbicides and other fertilizers for golf course management has the potential to impact water quality through poor timing, not respecting watercourse setback and poor golf course management practices.
Transportation Corridors				
Public roads and highways	Hazardous chemical and dangerous goods spills; chlorides from road de-icing; petroleum hydrocarbons; automotive fluids contained in runoff; and sedimentation due to soil erosion.	X		Contamination of water supply depends on retention time, location and type of contamination, which could render the water supply unusable and force the shutdown of the WSP.
Road Construction	Petroleum hydrocarbons/fluids	X		Oil, fuel or hydraulic spill would likely be limited to immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a tributary stream.
	Soil erosion and sedimentation.	X		Sedimentation of streams may occur through poor road and water crossing construction and maintenance practices.
	Bedrock/Acid (pyritic) slate exposure causing ARD.	X		ARD lowering pH of water and causing fish kills. The effect is long lasting.
Controlled access for utility uses	Petroleum hydrocarbons/fluids	X		Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
Railway	Hazardous chemical and dangerous goods spills; petroleum hydrocarbons; and sedimentation due to soil erosion.	X	X	Contamination of source water: depending on retention time, location and type of contamination, there could be direct contamination of the water supply which could render the source water unusable and force the shutdown of the WSP.
Utilities				
BoMont Water Supply Plant	Diesel fuel and lube oil; vehicle fluids from trucks delivering chemicals or collecting water samples.	X	X	Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
	Water-treatment chemicals (Chlorine).	X		Chlorine readily dissipates in water and air; therefore, the impact to the watershed is measured according to the spill amount and its proximity and contact time with living organisms.

Municipal wastewater treatment infrastructure	Untreated sewage entering waterways from aging pump stations and leaky or broken pipes.	X		Increase in heterotrophic plate and coliform counts.
Power Utility Transformers	Pole and Pad Mount Transformers: Pole top transformers made prior to 1983 likely contain Polychlorinated biphenyls (PCBs).	X		Depends on the type of oil, age of the transformer, ownership, and their location and maintenance schedule. PCB-containing transformers could contaminate the watershed (known to be toxic to fish) if they leak. All PCB-containing transformers must be replaced by 2025. The commonly used replacement coolant oil is VOLTESSO 35 which is not considered harmful to aquatic organisms.
Utility distribution and infrastructure corridors (construction and maintenance) (NSPI/ telecommunications and Halifax Water)	Soil erosion and sedimentation.	X		Sedimentation of waterways, which may be minimized through the use of BMPs including those created by NSPI and Halifax Water.
	Petroleum hydrocarbons/fluids	X		Any oil, fuel or hydraulic spill would likely be limited to the immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to a stream.
	The activity of cutting the vegetation could ignite a fire in dry weather.	X		Increased heterotrophic plate counts caused by woody debris, ash or dissolved nutrients in water.
	Pentachlorophenol (PCP) or chromate copper arsenate (CCA) is used to treat utility poles to guard against wood destroying organisms, unless within 15 metres of a watercourse. Poles in latter case are not treated with chemicals that may impact waterways.	X		The ecotoxicity of PCPs, a known carcinogen, is classified as medium and is targeted at wood destroying organisms.
Chemicals				
General use of chemicals permitted through provincial and/or municipal legislation.	Chemical and/or biocide pest control use products.	X	X	The risk of using any chemical and/or biocide pest control products depends on its properties and reaction with the surrounding environment.
Road de-icing and storage	Chloride, accumulated from road de-icing agents entering surface waterways through stormwater runoff.	X	X	Increased levels of surface water chloride concentrations and conductivity levels measured in collected watershed samples provide evidence of current contamination.
Water Supply Treatment Plant	Chlorine	X		Chlorine readily dissipates in water and air; therefore, the impact to the watershed is limited to the spill amount, its proximity to and contact time with living organisms.
Waste Refuse Sites and Infilling				

Illegal garbage and refuse dumping	Garbage, hazardous materials, and household items.	X	X	Release of hazardous materials and household chemicals into the watershed area is moderate due to high percentage of private lands and unrestricted access.
Infilling	Infilling of low lying areas including wetlands and marshes.	X		Sedimentation and infilling of low lying area such as wetlands and marshes is considered high due to high percentage of developable land available in the watershed area.

Table 16: Summary of Existing and Potential Critical Infrastructure Risk Factors Affecting Water Supply Area				
Activity	**Potential Contaminant**	**Point Source**	**Non-Point Source**	**Potential Impact to Water Supply**
Accidental Emergencies				
Accidental Fires	Water run-off from burnt materials that potentially contain hazardous chemicals; nutrient loading caused by organic matter; and soil erosion and sedimentation.	X		Short or long-term impact on water quantity and quality depends on fire severity which could lead to shut-down of the BoMont WSP. Such events could lead to increased levels of colour, turbidity, bacteria, suspended solids, organic matter, nutrients and possible chemical contamination.
Aircraft disaster	Chemicals associated with burning materials and those used to arrest the associated fire; fuel leakage; and associated intrusion of sediments and debris into waterways.	X		Short and long-term impact on water quantity and quality depending on severity of disaster which could lead to shut-down of the BoMont WSP. The emphasis is on chemical contamination; however, increased levels of colour, turbidity, bacteria, suspended solids and organic matter should be considered.
Chemicals and oil spills.	Fuel, vehicular fluids, and other chemical spills that threaten water quality, as determined by *Health Canada Canadian Drinking Water Guidelines* and *CCME's* WQGPAH.	X		Short and long-term impact on water quantity and quality depending on severity of spill which could lead to shut-down of the BoMont WSP. The emphasis is on chemical contamination; however increased levels of colour, turbidity, bacteria, suspended solids and organic matter should be considered.
Natural Events & Disasters				
Wind and floods resulting from tropical storms, surges and hurricanes	Microbial cross contamination from flooding and storm surges; disruption of water treatment from power outages; soil erosion and sedimentation from tree blow down.	X		Short or long-term impact on water quantity and quality depending on severity of event, which could lead to shut-down of BoMont WSP. Such events could lead to increased levels of colour, turbidity, bacteria, suspended solids and organic matter.
Wildland Fire	Water run-off from burnt materials that potentially contain hazardous chemicals; nutrient loading caused by organic matter; and soil erosion and sedimentation.	X		Short or long-term impact on water quantity and quality depending on fire severity. Such events may lead to increased levels of colour, turbidity, bacteria, suspended solids, organic matter nutrients and possible chemical contamination.
Drought	Promotes growth and concentrations of microorganisms; and increased concentrations of non-microorganism contaminants.	X		Short or long-term impact on water quantity and quality depending on extent of drought and demand on water supplies.
Climate Change	Difficult to assess and determine due to varied and multifaceted considerations.	X		Dependent upon rate and severity of extreme weather events, although impacts would be consistent with those already described throughout Chapter 3.
Intentional / Deliberate Events				

Table 16: Summary of Existing and Potential Critical Infrastructure Risk Factors Affecting Water Supply Area				
Activity	**Potential Contaminant**	**Point Source**	**Non-Point Source**	**Potential Impact to Water Supply**
Malicious intent: Terrorism, Vandalism, or Sabotage; crimes, social unrest, strike or labour disruption	Difficult to assess and determine due to varied and multifaceted considerations. Priority consideration of contaminants includes chemical, physical, cyber or biological materials.	X		Catastrophic loss of life, adverse economic effects, and significant harm to public confidence creating partial or total shutdown of WSP and long or short-term damage to the water supply.
Non-malicious Intent	Difficult to assess and determine due to varied and multifaceted considerations.	X		Regulation or by-law change initiated by the municipal or provincial government which creates negative impact(s) to the protection of the source water supply due to inability to provide maximum protection to the water supply.

Potential Sources of Contamination

Table 17 below lists the problem and priority rankings of the inherent and critical infrastructure risk factor activities within the watershed.

Table 17: Scale of Problem* and Priority Rank of Activities and Threats to Critical Infrastructure of the BoMont Watershed Area**

Activity	Contamination Issue	Scale of Problem*	Priority Rank**
Municipal Land Use Planning and Development			
Policy and regulation set out in Regional Municipal Planning Strategy Halifax Regional and City By-laws, Halifax Community MPS and LUB, and East Hants Community Plan	Petroleum hydrocarbons	4	2
	Soil erosion and sedimentation	1	1
	Household chemicals/ fertilizers and pesticides	4	4
	Bedrock – acid (pyritic) slate ARD	1	1
	Stormwater runoff	1	1
	Sewage	2	1
Commercial/ Industrial/ Institutional			
Forestry Operations	Petroleum hydrocarbons/fluids	5	3
	Soil erosion and sedimentation	4	2
	Chemical sprays related to silviculture activities	4	1
Mining and pits and quarry operations	Petroleum hydrocarbons/fluids	5	3
	Soil erosion and sedimentation	2	1
	Acid (pyritic) slate(Low pH)	1	1
	Mine Tailings	3	1
Agriculture operations	Petroleum hydrocarbons/fluids	4	3
	Soil erosion and sedimentation	1	1
	Chemical sprays related to crop management	1	1
	Nutrient Loading and E.coli.	1	1
Commerce	Stormwater management	2	1
	Petroleum hydrocarbons/fluids	5	3
	Home heating oil	4	3
	Storage facilities	3	2
Institutional	Stormwater management	2	1
	Petroleum hydrocarbons/fluids	5	3
	Home heating oil	4	3

Residential			
Home Heating Fuel Tanks	Fuel oil leakage	4	3
Automobile Fluids	Petroleum hydrocarbons/fluids	5	3
Household Chemicals	Spills and improper or excessive use of fertilizers, pesticides, soaps	4	3
Impervious Surfaces	Increased stormwater flow and volume	4	3
Backyard Fires	Contaminated water run-off from burnt materials, potentially containing hazardous chemicals, organic matter and sedimentation	4	2
On-site Septic	Failing on-site septic systems	3	1
Recreation			
Trail use	Pet droppings	5	5
	Garbage	4	3
	Soil erosion and sedimentation	4	3
Swimming	Bacteria	3	2
Camping (fires)	Increasing heterotrophic plate counts	4	3
OHVs	Petroleum hydrocarbons/ liquids	5	5
	Soil erosion and sedimentation	4	3
Boating	Petroleum hydrocarbons/ liquids	4	3
	Shore line erosion	4	3
Golfing	Petroleum hydrocarbons/ liquids	5	4
	Soil erosion and sedimentation	3	3
	Chemical sprays related to golf course management activities	3	1
Transportation Corridors			
Public roads and highways	Hazardous chemicals (fuels, transported/dangerous goods)	2	1
De-icing salt	Chloride and conductivity	1	1
Road construction	Soil erosion and sedimentation	3	1
	Bedrock- Acid (pyritic) slate ARD	3	2
Controlled access for utility use	Petroleum hydrocarbons/ liquids	4	1
	Water treatment chemicals	5	3
Railway	Petroleum hydrocarbons/ liquids	4	2
	Soil erosion and sedimentation	4	2
	Hazardous chemicals (fuels, transported/dangerous goods)	4	1
Airport	Stormwater management	2	1
	Petroleum hydrocarbons/fluids	5	3
	Road de-icing agents	4	3

	Airplane- de-icing agents	2	2
	Storage facilities	3	2
Utilities			
BoMont Water supply plant	Chemicals delivered to pumping station	5	5
Wastewater treatment infrastructure	Leaking / Broken pipes	4	1
Power transformers	PCBs	4	1
	Naphtha-based mineral oil	4	4
Distribution corridors	Soil erosion and sedimentation	5	4
	Accidental fire	5	3
	PCP or CCA wood preservative on poles	4	3
Chemicals			
Pest control chemicals and biocides	Chemicals that impair water quality and/or are toxic to living organism	1	1
Road de-icing salt	Chloride and conductivity	2	1
Water Supply Plant	Chlorine used to treat the water before distribution	5	5
Transmission/utility distribution line	PCP or CCA	4	3
Power transformers	PCBs	4	1
	Transformer coolant (naphtha-based mineral oil)	4	4
Wildland fire retardant	Silv-Ex and/or FIRE-TROL Fire Foam 104	5	3
Waste Refuse Sites and Infilling			
Waste Refuse Sites and Infilling	Illegal Dumping	3	1
	Infilling	3	1
Accidental Emergencies			
Fire	Soil erosion and sedimentation	3	1
	Petroleum hydrocarbons/ liquids	3	1
	Hazardous chemicals	3	1
	Nutrient loading	3	1
Aircraft disaster	Petroleum hydrocarbons/ liquids	3	1
	Hazardous chemicals	3	1
	Nutrient loading	3	1
	Soil erosion and sedimentation	3	1
Accidents and Spills	Petroleum hydrocarbons/ liquids	3	1
	Soil erosion and sedimentation	5	2
	Fungicides, insecticides, herbicides	3	1
	Dangerous Goods	3	1
Natural Events and Disasters			

Wind and flood	Microbial cross contamination	4	1
	Soil erosion and sedimentation	3	2
Wildland Fire	Petroleum hydrocarbons/ liquids	3	1
	Hazardous chemicals	3	1
	Nutrient loading	3	1
	Soil erosion and sedimentation	3	1
Drought	Ideal conditions for microbial and pathogen growth	3	1
	Soil erosion and sedimentation	3	1
	Nutrient loading	3	1
	Increased metal concentrations	3	1
	Increased demand on water supply (secondary objective – water quantity)	3	1
Natural biological	Water and airborne biological outbreak	3	1
	Water quality degradation and ecosystem disruption	3	1
Climate Change	Water quality degradation and ecosystem disruption	4	1
Intentional / Deliberate Events			
Malicious intent	Water quality contamination through biological and/or chemical attack	4	1
	Infrastructure disruption through Cyber and/or physical attack	4	1
Non-malicious intent	Landownership with respect to regulations and/or by-laws with the potential to negatively impact the watershed area.	1	1

4 Management Plan

This section describes the management aspect of the Source Water Protection Plan (SWPP) which addresses the risks and issues identified in *Chapter 3: Risk Identification and Assessment* on page 78. The primary goal of the management plan is source water protection, implemented through a multi-barrier approach that ensures the source water is clean and safe for consumption, and that the mechanisms are in place to prove it is safe, as directed by the Nova Scotia Department of Environment's Drinking Water Strategy for Nova Scotia. Descriptions of the components of the implementation strategy and the contingency measures in place follow.

4.1 Background

Stakeholder collaboration and cooperation provide the means to evaluate the risks to water quality and help contribute to the development of methods that overcome the obstacles to ensuring clean, safe potable water is provided for Halifax Water clients.

Consistent and sustained communication between those who have a responsibility to ensure clean, safe water is paramount. Meetings between Halifax Water, NSE, HRM, and East Hants help to achieve this goal.

Progress of the BoMont SWPP is reported annually to NSE as part of the *Annual Drinking Water Quality Report*. The report is used to measure the successes of the BoMont SWPP and make adjustments where necessary. A major review is conducted when a significant change is required or on a 7-year review schedule, whichever comes first.

4.2 Implementation Strategy

Halifax Water uses the multi-barrier approach, a system of checks and balances to ensure the highest water quality possible is delivered to its customers; source water protection being the first step.

Source water quality of the BoMont watershed is under constant risk of contamination because of its large size and lack of protective watershed regulations. The implementation strategy will take into consideration all those risks identified in this SWPP (see *Chapter 3: Risk Identification and Assessment* beginning on page 78) and, where reasonable, mitigate as many as possible. In most cases Halifax Water will call upon provincial and municipal government agencies that have the authority to respond to sources of contamination through legislation that otherwise Halifax Water does not have authority over.

In addition to source water quality mitigation efforts, Halifax Water will investigate new technologies aimed at treating the water at the plant or find alternative sources which may prove to be less expensive and more effective as the BoMont SWPP.

Source water protection implementation timelines have been developed by Halifax Water and are included with this SWPP as an addendum. Halifax Water will inform NSE if changes to those timelines are required.

4.2.1 Land Acquisition Program

Early acquisition of key watershed lands has laid the foundation for effective source water protection in other Halifax Water source water areas. By purchasing land, Halifax Water has been able to reduce risks associated with anthropogenic activity(ies) inside many of its water supply areas. Halifax Water's strategy is to continue to investigate and to purchase watershed lands where possible to provide the highest water quality protection possible. However, purchasing land may not be a practical method of protecting the BoMont watershed area due to its large physical size and the minimal number of water supply connections.

4.2.2 Best Management Practices

A best management practices (BMP) manual has been jointly developed by Halifax Water staff, NSE, DNR, forest industry companies, and other watershed advisory boards/committees. The BMPs are not meant to replace, but rather to enhance, existing legislation for persons working on lands managed by Halifax Water. For lands not under Halifax Water management, BMPs are to be used as an educational tool and guiding document for activities which may pose a risk to the watershed.

The latest version of the BMP manual is available online at: www.halifax.ca/hrwc/documents/2010ApprovedBMPs.pdf.

4.2.3 Public Communication, Education and Awareness

Public communication, education and awareness are key components in BoMont's source water protection strategy. Currently, Halifax Water's communication and awareness program includes:

- posting information and regulatory signage;
- conducting and/or supporting educational programming;
- developing source water protection publications (e.g., brochure, public notifications and reports);
- publishing information on Halifax Water's website; and
- placing advertisements in periodicals.

The objectives of communicating information about the watershed area are:

- to inform users of the location of the watershed area boundaries;
- to outline the potential impacts of detrimental activities on the water supply; and
- to promote what measures are required to avoid such occurrences.

Public communication, education and awareness outreach will continuously be developed to encourage cooperation between Halifax Water, customers and stakeholders to ensure quality drinking water.

Signs

Currently, there are no signs identifying BoMont as a public drinking water supply area.

Halifax Water to install signage at the BoMont WSP and investigate other opportunities to install signs throughout the watershed to improve public awareness and emergency responsiveness.

Educational Programming

Halifax Water has supported the development of watershed protection education programs by non-government organizations such as Clean Nova Scotia (CNS) and the Discovery Centre. These agencies deliver water education programs to elementary, junior and senior high school students in accordance with the curriculum.

Other educational program development activities involve supporting community groups and associations in their efforts to conduct community clean-ups, open houses, surveys, and to develop publications that serve to educate residents about the importance of protecting drinking water at the source. Spin-off benefits to programs supported by Halifax Water come through the leveraging of watershed area education and awareness to other groups and agencies that are exposed to such programs.

Discovery Centre

Halifax Water has granted the Discovery Centre development support for their Water Gallery exhibit in their science centre project. The exhibit explores the properties of water, demonstrates the importance of sustainable consumption and returning water to nature as it was taken, encourages conservation through instilling a sense of pride in Nova Scotia's water resources, and will relate to other areas of the centre, i.e.; Energy.

Publications

Publishing newsletters and advertising in local newspapers, outdoor magazines and in the provincial fishing manual are other tools that Halifax Water uses to promote awareness of the water supply area and communicate protection techniques to the broader community.

Brochure

A source water protection brochure was created in the spring of 2016 to increase public knowledge of the water supply areas and show how various agencies work together to protect drinking water supplies.

Website

Halifax Water maintains and regularly updates its website www.halifaxwater.ca to provide public notifications and important information on source water protection.

4.2.4 Management Committee

A watershed management board/ committee is an effective way to increase communication and create awareness amongst stakeholders.

Halifax Water to investigate creating a BoMont Watershed Advisory Board/ Committee.

4.2.5 Regulations and Land-use By Laws

Within the BoMont watershed area, land use activities are subject to provincial, federal, and municipal regulations as outlined in section *2.4: Governance* beginning on page 62.

Halifax Water continually explores opportunities to strengthen or create provincial legislation and local by-laws to enhance the protection of Halifax's (HRM's) drinking water supply areas.

HRM Planning and Development Processes

Through the Regional Municipal Planning Strategy review process (RP+5), Halifax Water presented the following recommendations that were subsequently endorsed in the RMPS (2014):

- conforming with any Statement of Provincial Interest (SPI) Regarding Drinking Water, which is endorsed under Policy E-14 of the RMPS (2014);
- mapping delineated water supply areas, which are illustrated on Map 12 of the RMPS (2014);
- establish a minimum 30.5m riparian buffer around water supply sources, consistent with provincial water supply protection policy, which is endorsed under Policy E-13 of the RMPS (2014);
- by-laws that consider non-designated municipal water supply areas and wellheads, which is provided for under Policy E-14 of the RMPS (2014), such that these areas are afforded Council's consideration through amendments to land use by-laws;
- opportunity for Halifax Water to review all applications within their regulatory regime, which is provided for under Policy E-14 such that there is a consistent regulatory approach within each watershed;
- afford respective watershed advisory boards opportunity to exercise their function to make recommendations regarding land use activities within their respective watershed areas, which was provided for through policy E-14; i.e., Council shall consider amendments to land use by-laws to protect the water supply, ensure consistent regulatory approaches and conform to any SPI regarding drinking water; and
- wetland protection which has been afforded through Policy E-15 which allows amendments to land use by-laws to conform to any provincial guidelines (e.g., Wetlands of Special Significance such as those in designated protected water areas, or SPIs).

Halifax Water endeavors to further ensure, especially through land use by-law review processes that

1. developers are aware of the regulations associated with drinking water supply areas;
2. Halifax Water and applicable water supply advisory groups are recognized as authorities to review and provide comment on land use planning and development applications;
3. all building permits include an attached copy of the applicable provincial regulations respecting drinking water supply areas;
4. all building permits are copied to Halifax Water and reviewed by the applicable water supply advisory group as per municipal policy and by-laws; and

5. collaborative opportunities to review applicable SOPs, by-laws and possible developments related to relevant source water areas and maintain emergency contact lists are facilitated between Halifax Water and HRM community development staff.

With respect to development impacts to surface water quality, HRM has the following policies:

> *P-46 In recognition of the need to protect surface water quality, it shall be the intention of Council to consider the application of site grading and drainage controls for development adjacent to watercourses within the Plan Area. Until such time as these controls are effective, it shall be the intention of Council to establish a minimum building setback from lakes and streams of fifty (50) feet except for private boathouses, boat docks, float plane hangars. Furthermore, it shall be Council's intention to establish a lesser setback for existing lots of land which would not otherwise be eligible for development.*[30]
>
> *P-47 In the interests of maintaining water quality it shall be the intention of Council to investigate storm water control measures for both subdivision and development and to consider amendments to the Top Soil Removal By-law in order to provide for a review of all development within the environmentally sensitive areas described on the Environmental Features Map (Map 4).*[31]*Natural Networks Policy.*

East Hants Planning and Development Services

With respect to the East Hants Planning review process which was conducted in 2015-2016, Halifax Water consulted with and participated in the Plan review process and provided input through that process with regard to protecting the BoMont water supply; however the new East Hants Community Plan (2016) does not specifically recognize the BoMont water supply area. The East Hants Municipal Planning Strategy does recognize Pockwock.

Halifax Water to investigate a similar arrangement with East Hants as HRM to allow Halifax Water to review and provide comments to development applications that impact the BoMont watershed area.

4.2.6 Public Roads and Highways

As described in section *3.1.5: Transportation Corridors* on page 85 *and described in Table 9: BoMont Transportation Corridor Length and Agency Responsible for Maintenance* on page 58 and illustrated on *Map G: Land Cover in Risk Zone Areas (RAZ)* on page 71 and Map F: Communities and Populations on page 44, the road network in BoMont presents a high level of risk to the water supply from accidental traffic spills and/or road maintenance activities. Due to its proximity to the Shubenacadie River (BoMont water supply) Highway 2 presents the highest risk of contamination from accidental or maliciously intentional contamination from vehicle and/or chemical entry into the water supply.

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30 Halifax Municipal Planning Strategy for Planning Districts 14 and 17 (Shubenacadie Lakes) with amendments to October 18, 2016. p. 42 Website accessed April 6, 2016 at http://www.halifax.ca/planning/documents/PlanningDistricts14and17_MPS.pdf.

31 Ibid.

Guard rails exist along areas where Highway 2 runs next two the Shubenacadie River system; however the risk still remains high

Halifax Water has established a five-part Source Water Quality Monitoring Program to monitor effects on water quality (see section *5.4: Source Water Quality Monitoring Program* beginning on page 138).

To help manage the risks presented by road use, Halifax Water will collaborate with HRM, Municipality of East Hants and NSTIR staff to provide updated contact lists and water quality data regarding the effects on the water supply and continue to maintain open lines of communication.

Further, in the event of a roadway emergency with the potential to impact the BoMont water supply and/or water pumping station, the *Emergency Response Plan for Halifax Water* (ERP) is followed. A copy of the ERP is at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

Road De-icing

Halifax Water collects monthly total chloride samples from November to April of each year at locations associated with winter road maintenance activities. All of the water sample sites in the BoMont watershed area i.e., BMG1, BMG2, BMG3 and BMG4, BMG6, BMG7, BMG8 include chloride samples (see section see section *5.4.3: Total Chloride* on page 158).

According to samples collected to date Chloride levels are generally low-medium compared with other water supply area samples, i.e., chloride is rarely found in BoMont water quality samples in excess of 20 mg/L, compared with the highest chloride levels which have been found in the Chain Lakes water supply above 400 mg/L and low chloride levels found in the Pockwock water supply as low as 3 mg/L.

The Material Safety Data Sheet (MSDS) for sodium ferrocyanide, a required road salt anti-caking agent (see section *3.1.7: Provincial Policy and Regulations* on page 92) states that the potential health effects on humans for handling the product are relatively minor. However, there is concern about the use of ferrocyanide salts in formulations of road salts given that in solution, ferrocyanide can photolyse to yield free cyanide ions, which are highly toxic to aquatic organisms. Not enough is known about ferrocyanide and its impact to water supplies. Halifax Water is working toward gaining a better understanding of ferrocyanide impacts, concentrations and risks it presents to water supplies. If ferrocyanide is found to pose a threat to the water supply, Halifax Water will contact NSTIR and HRM to discuss ways to mitigate or eliminate any threats.

Halifax Water to investigate adding ferrocyanide to its source water quality sampling program.

4.2.7 Physical Barriers and Signage

Access to the WSP is restricted to authorized personnel only; however there are no physical barriers including fences, gates, barriers or signs to limit access to BoMont WSP lands. Halifax Water will continue to monitor these areas and enhance security measures as required.

4.2.8 Boundary Maintenance

BoMont boundary line maintenance is not feasible considering the large size of the watershed and that most land is privately owned.

4.2.9 Enforcement

Halifax Water's regulatory authority over the BoMont watershed area is very limited; however maintains watch over the watershed through routine patrols and water quality sampling. Halifax Water will contact Federal, Provincial, and Municipal government agencies to enforce activities beyond Halifax Water's authority.

- Collaborate with local enforcement authorities including Halifax Police, RCMP and municipal by-law officers to enforce Acts, regulations, and by-laws applicable to the watershed, and collaborate with other agency(ies) to ensure their activities do not put the water supply at risk.

Halifax Water will continue to educate watershed users through signage, during patrols and public awareness initiatives. If activities that pose a risk to water quality increase within the watershed area, Halifax Water may seek assistance through increased patrols, and request changes in regulations and an increase in penalties.

4.2.10 Water Supply Plant

The BoMont WSP, intake and distribution pipes are considered significant aspects of Halifax Water's critical infrastructure (see section *2.3.3: BoMont Water Supply* System on page 53). The BoMont WSP station and other infrastructure are located inside the watershed area; the building is accessible only by authorized personnel.

Halifax Water plans and operating procedures are reviewed as required. All plant operators and contractors working in and around the WSP are made aware of surrounding risks and educated on response plans and procedures at the relevant treatment facility per the ERP.

Generators

To provide power to the pumping station during an electrical power outage, Halifax Water uses a portable generator. Fuel and lubricants required to run the generator are delivered daily or as needed. Standard Operating Procedures (SOPs) are followed while the generator is in operation.

4.2.11 Wastewater Management

Municipal Wastewater Treatment Facilities

There are five (5) municipal wastewater treatment plants within the BoMont watershed area which include Aerotech, Lockview, Wellington, and, Frame WWTP. For further details of each system see section *2.3.3: Municipal Wastewater Systems: Halifax Water* on page 54 and online at http://www.halifax.ca/halifaxwater/Wastewater/treatment-facilities.php, and illustrated on *Map L: Utility (Power, Water, Gas) Corridors* on page 76.

As a requirement compliance sampling is carried out at each facility and reported to NSE. The risk of sewage contamination to the BoMont WSP due to these WWTP is distant, however as a precaution, Halifax Water routinely monitors for parameters associated with sewage contamination through its source water quality sampling program; which include *E.coli*, nitrate, phosphate, pH, conductivity and metals (see *5.4: Source Water Quality Monitoring Program* beginning on page 138).

In the event of a Halifax Water municipal wastewater treatment failure, Halifax Water's *Emergency Response Plan* (ERP) will be followed. A copy of the ERP is at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

On-site Septic Systems

On-site private septic systems largely service the BoMont watershed and are distributed throughout; therefore they present a greater risk of sewage contamination to the BoMont watershed then failure of municipal wastewater treatment facilities. As a precaution, Halifax Water routinely monitors for parameters associated with sewage contamination through its source water quality sampling program; which include *E.coli*, nitrate, phosphate, pH, conductivity and metals (see *5.4: Source Water Quality Monitoring Program* beginning on page 138). Should Halifax Water find sources of sewage contamination as a result of private on-site septic failure, Halifax Water will contact NSE to follow up with the home owner.

Halifax Water will contact NSE and seek larger setbacks from water ways to reduce the risk of water contamination through failure of private on-site septic systems.

In the event of an on-site septic failure Halifax Water's *Emergency Response Plan* (ERP) will be followed. A copy of the ERP is at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

Manure and Fertilizer Management

Agriculture, which includes sod farming, is an important economic driver to the Municipality East Hants and for the most part is isolated to the Nine Mile River subwatershed of BoMont. Halifax Water routinely monitors for parameters associated with manure and fertilizer contamination through its source water quality sampling program; which include *E.coli*, nitrate, phosphate, pH, conductivity and metals (see *5.4: Source Water Quality Monitoring Program* beginning on page 138). Should Halifax Water find sources of manure and/or fertilizer contamination, Halifax Water will contact NSE to follow up with the landowner or company applying the manure and/or fertilizer.

The key method of ensuring effective protection management of potential risks due to manure and/or fertilizer application is effective communication between the agencies responsible for the land use activities taking place in the watershed area.

Halifax Water will contact NSE and Nova Scotia Agriculture to seek larger setbacks from water ways to decrease the risk of water contamination through manure and/or fertilizer application.

4.2.12 Stormwater Contamination

Sources of stormwater contamination is primarily associated with erosion and sedimentation due to land clearing practices for agriculture, forestry or development purposes and roadside maintenance and construction projects. Halifax Water routinely monitors for parameters associated with stormwater contamination through its source water quality sampling program;

which include total suspended solids and turbidity (see *5.4: Source Water Quality Monitoring Program* beginning on page 138). Should Halifax Water find sources of stormwater contamination, Halifax Water will contact NSE to follow up with the landowner or company in charge of the project.

The key method of ensuring effective management of potential risks due to stormwater runoff is consistent communication between the agencies responsible for the land use activities taking place in the watershed area.

4.2.13 Chemical, Biocide and Pest Control Use

For the most part, chemical use inside the BoMont watershed area is allowed. Due to the nature and size of the BoMont watershed and industries supported within, chemical use is assumed to be moderate-high.

Agriculture and Forestry

Agriculture and Forestry use chemicals to control pests and as source of fertilizer. Halifax Water routinely monitors for parameters associated with chemical contamination through its source water quality sampling program; which include nitrate, phosphate, pesticide and hydrocarbons(see *5.4: Source Water Quality Monitoring Program* beginning on page 138). Should Halifax Water find sources of chemical contamination, Halifax Water will contact NSE to follow up with the landowner or company in applying the chemicals.

The key method of ensuring effective protection management of potential risks due to chemical application is effective communication between the agencies responsible for the land use activities and the regulator who approves application permits in the watershed area.

Wildland Fire

The general practice of fighting forest fires inside Halifax Water's primary watersheds (i.e., Pockwock, Major and Bennery) is water as a fire suppressant is first priority, followed by firefighting chemicals should the benefits outweigh the consequences. This may not be practical due to the size of the watershed and the number of firefighting jurisdictions the watershed crosses. Through internal provincial firefighting protocol, DNR is aware of the public drinking water supplies and will use best judgement.

Halifax Water will follow up with DNR to confirm their firefighting practices and awareness of the BoMont watershed boundary.

In the event of a fire emergency, the ERP will be followed, and target-based water quality sampling will be conducted at the regular source water sample points by Halifax Water.

NSPI

NSPI uses chemicals as a cost-effective tool to control pests and vegetation along its transmission main and power pole corridors with no exception to the BoMont watershed area. Halifax Water routinely monitors for parameters associated with chemical contamination through its source water quality sampling program; which include nitrate, phosphate, pesticide and hydrocarbons (see *5.4: Source Water Quality Monitoring Program* beginning on page 138). In the event that Halifax Water finds sources of chemical contamination associated with transmission main or power pole maintenance, Halifax Water will contact NSE to follow up with NSPI in applying the chemicals.

The key method of ensuring effective protection management of potential risks due to chemical application is effective communication between the agencies responsible for the land use activities and the regulator who approves application permits in the watershed area.

Halifax Water will contact NSE seek larger setbacks from water ways to reduce the risk of water contamination through chemical application.

Halifax Water will add pesticides sampling to sample point BMG3 to gain a better understanding of the level of risk pesticides and fungicides present to the BoMont WSP.

4.2.14 Source Water Quality Monitoring

As described in Chapter *1: Introduction* on page 7, the primary objective of this plan is to comply with NSE requirements and to provide the highest water quality possible to our customers. Halifax Water formalized its Source Water Quality Monitoring Program in 2009 to better understand existing baseline conditions in the BoMont watershed area and to meet the primary objective (see section *5.4.1: Baseline Sampling* on page 139). In 2011, Halifax Water reached its two-year goal of setting water quality baselines for all source water sample sites, i.e., BMG1 through BMG3 (see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43). The decision to change the monitoring program from baseline to risk-based in the fall of 2011(see section *5.4.2: Risk-Based Sampling* on page 157) was supported by the data gathered during the two year baseline collection program. Unlike many of the other watershed monitoring programs, all sample points that were used to collect baseline data remain active due to the level of risk from anthropogenic activities that influence this watershed area.

The data collected suggests water quality from the Nine Mile River subwatershed area is of poorer quality than the headwaters region of BoMont; therefore 4 new sites were added, BMG4 in 2012 and BMG 6, BMG7, and BMG8 in 2016 (see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43). These sites were strategically chosen to better understand the water quality at certain locations along the Nine Mile River. For more details on the Source Water Quality Monitoring Program please refer to *Chapter 5: Monitoring and Evaluation* beginning on page 137.

4.3 Contingency (Mitigation, Preparedness and Response)

The following describes the contingency plans regarding impacts from various land-use activities within the BoMont watershed area (BoMont). Halifax Water does not have specific watershed regulatory authority in BoMont; however most activities within BoMont are governed through provincial legislation, municipal by-laws and community plans.

At the moment the BoMont WSP can only be shut down manually. As a recommendation to improve emergency shut-down responsiveness, Halifax Water will consider installing remote communications to shut down the plant immediately by telecommunications via computer or smart phone.

Halifax Water is prepared for spill containment and cleanup through the guidance of contingency plans for such incidents as per the *Emergency Response Plan*, copies of which are found at 450

Cowie Hill Road in Halifax, and using Halifax Water's BMPs. Additionally, Halifax Water will continue to evaluate any threat to the water supply through the Source Water Quality Monitoring Program as described in *5.4: Source Water Quality Monitoring Program* beginning on page 138.

In case of an emergency (e.g., contamination, security, disaster), affecting the functionality of the BoMont Water Supply Plant whereby senior management would decide to shut it down, there is no formal emergency plan in place to deliver water to our BoMont Customers.

Halifax Water to develop a comprehensive emergency back-up plan for the BoMont system which ensures Halifax Water is meeting its minimal obligation to its customers until the plant is functional.

4.3.1 Industrial, Commecial and Instutional Uses

There are significant commercial and industrial activities within the BoMont watershed area that present different levels of risk (see section 3.1.2: Industrial, Commercial and Institutional (ICI) on page 79). In the event such activity takes place within the watershed area, accidental contamination must be reported immediately to appropriate agencies (i.e., Halifax Water, HRM, NSE, RCMP, and/or the local fire department).

Below describes the contingency plans for the most notable activities which include forestry, agriculture, mines, pits and quarries, business parks, institutions, waste disposal sites.

Forestry

A high percentage of BoMont forest land is privately owned (~69%) and considered vital to Nova Scotia's economy. Forest regulations exist at the provincial level; however their primary intent is to support a sustainable wood supply for future use rather than ensuring a potable water supply. Risks associated with forestry activities are listed in section *3.1.2: Forestry* on page 79.

Should forest management practices impact the BoMont watershed area the contingency plan is similar to section *4.3.1: Agriculture* beginning on page 123; in the short term bulk water will be delivered to the BoMont WSP from the Pockwock and/or Lake Major water system until the river water returns to baseline conditions. In the long term Halifax Water is investigating a solution which would move the intake or seek other alternatives.

Mining and Pits and Quarries

BoMont is identified as a municipal water supply area on the Nova Scotia Registry of Claims map. Therefore, mining or quarrying interests should contact Halifax Water to indicate their interest in exploring the area as per the Nova Scotia *Mineral Resources Regulations*.

Mining

Mining within the Shubenacadie River watershed area dates back pre-confederacy. In BoMont alone there are 1051 mine sites identified; 1043 gold mine sites, 2 arsenic mines, 2 iron mines; 4 tungsten mines. No regulations governing disposal operation of mill tailings existed at the time of mining. Consequently, nearby lakes, ponds, streams and depressions served as convenient disposal sites for contaminated tailings.

Past mining practices are recognized as a primary source of arsenic, cyanide and mercury contamination in the Shubenacadie River watershed (BoMont). Leachate from exposed bedrock, mine waste and tailings dump sites have led to contamination of groundwater and lake sediments in the Shubenacadie River watershed (BoMont); including Lakes William, Thomas, Fletcher, Powder Mill and Muddy Pond. *Map B: Bedrock Geology* on page 40 illustrates where mill and mine site tailings are located throughout the BoMont watershed area.

Underground mine workings provide channels of least resistance for groundwater flow, frequently in a direction other than that predicted by hydrogeological assessment. Most of the mine site locations reported in Mudroch and Clair, 1985 have been confirmed from maps from the Nova Scotia Department of Mines.

Halifax Water is concerned with the disturbance of areas where concentrations of contaminants came to rest. Land management and planning exercises should consider the locations of mine tailings to indicate where land disturbances should not occur or be avoided, or where extra precautions are required to minimize disturbances that could release contaminants associated with mine sites including arsenic, cyanide and mercury that could in turn impact water quality.

Halifax Water to contact NSE, HRM and East Hants to propose known mine and tailing sites within municipal water supplies to be left undisturbed or remediated pre-mining days.

Today's mining legislation is more stringent; however mining is still allowed within BoMont. Halifax Water believes that mining activities should be prohibited from municipal water supply areas.

Halifax Water to contact NSE to propose prohibiting any new mine sites within municipal water supply areas.

Pits and Quarries

There are 6 medium to large extraction quarries in the BoMont watershed area of which two (2) exist in the headwaters region, three (3) exist in the Nine Mile River watershed area and one (1) just east of the intake; each one presents its own set of risks and are provincially regulated through an approval process which requires the operations to monitor and report on conditions laid out in the approval to the regulator (NSE). See *Map K: HRM Regional GFLUM and Community Plan Areas* for locations.

The two quarries in the headwaters region are drill and blast operations where bedrock is removed via blasting and crushed on site to the desirable size and sold accordingly. The rock type the quarries are working are less erosive, however the means of removal and processing creates fine sediment that can be transported to the tributaries and make their way down stream via runoff. In both cases the quarry operations are <1km away from large water bodies of the headwater region of BoMont.

Two (2) of the three (2) sites located in the Nine Mile River watershed area are sand and gravel operations where material is excavated and separated using screens. The third operation, in the far reaches of the western section of the Nine Mile River watershed, is similar to the headwaters area quarries, but much smaller in size. All three (3) of these operations may also contribute to the sediment runoff however it is less likely because of their remote location and no immediate large waterbodies in the vicinity.

The quarry operation closest to the BoMont WSP, medium in size and similar in nature to the two (2) headwater quarries, is located <1km south east of the WSP. The risks to the WSP are much the same as the headwater quarries, but much closer making their impact felt almost immediately should a contamination of some type makes its way to the Shubenacadie River.

The contingency plan is much the same as described under the headings *Forestry* above and *Agriculture* below; short term bulk water will be delivered to the BoMont WSP from the Pockwock and/or Lake Major water system until the river water returns to baseline conditions. In the long term Halifax Water is investigating a solution which would move the intake or seek other alternatives.

Agriculture

There is no clear distinction between high and low intensity agriculture in East Hants. For the purpose of this SWPP it is assumed all agricultural operations within East Hants are high intensity.

Agriculture within BoMont, which is mainly restricted to the Nine Mile River subwatershed, includes sod farms; beef and dairy operations; and crop and pasture lands. The convergence of the Nine Mile River and the Shubenacadie River is ~1.1km upstream of the BoMont WSP. Risks associated with agriculture activities are listed in section *3.1.2: Agriculture* on page 81.

Halifax Water will continue to monitor strategic sample points to better understand the impact of agriculture activities and report non-conforming activities to the appropriate agencies.

The following sections describe the potential effects related to agriculture activities and the contingency plans associated with each operation.

Sod Farms

Due to soil characteristics, sod farms for the most part are restricted to the Nine Mile River subwatershed of BoMont; however theses soils are highly erosive and contribute to sediment loading of the Shubenacadie River which impacts the BoMont WSP. Sod farming expedites sediment loading through runoff caused by sod farm operations which remove the grass layer and expose the mineral soil underneath.

Through source water quality monitoring, Halifax Water has found that during heavy rainfall events, >20mm in a 24hr period turbidity and colour dramatically increase to the point where the BoMont WSP struggles to effectively treat the raw water without additional costs. The source water sampling program confirms the Nine Mile subwatershed area is the highest contributing factor of turbidity and colour at which the point of convergence for the Shubenacadie River and Nine Mile River is ~1.1km upstream of the BoMont WSP. In the short-term the safest and most effective solution is to temporarily turn the intake off and truck treated bulk water from Lake Major or Pockwock into the plant to be distributed to the customers. This continues until the Shubenacadie River water quality returns to baseline conditions.

Halifax Water is investigating a long-term contingency plan which may include moving the intake from the exposed mid-river channel location to a buried pipe in the river bank below the water level (bank infiltration system). This would provide the BoMont WSP with a consistent higher water quality easier to treat. This new intake location would decrease the risk sod farming presents to the BoMont WSP at in terms of turbidity and water colour.

Chemicals used in sod farming such as pesticides and herbicides are also threats to the BoMont WSP. Through the Compliance Monitoring Program, beginning in 2015, pesticide and herbicide samples are collected once per year at the raw water intake (see section *5.4.5: Operational/ Compliance Raw Water Sampling* on page 160).

Beef and Dairy

Like sod farming, beef and dairy operations are restricted to the Nine Mile River subwatershed for the same reason as125 *Sod Farms*; due to soil characteristics. In add to sediment loading, manure management is a big concern with beef and dairy operations in BoMont. Poor manure management practices can lead to nutrient loading of ground water systems or through channelization of surface water runoff into nearby waterways. Livestock can cause shoreline erosion and sedimentation of waterways when they access the waterways drinking.

Farming operations have access to funding to improve their impact on the environment through the Nova Scotia Federation of Agriculture. In order to qualify for the funding, farm operators must voluntarily complete an Environmental Farm Plan (EFP). Each EFP is independently developed, at no cost to the farm operator, for each farm which identifies and assesses environmental risk for each property(ies). The EFP’s are subject to auditing, however only a fraction of EFP’s are audited. The concern is that the EFP is completely confidential which makes it difficult to know who has a plan, if it is being followed and if it is working.

The watershed sampling program indicates the highest levels of *E.coli* is experienced during heavy rainfall events (>20mm in 24hr) which is when the BoMont WSP intake is closed and treated water is trucked in. The practice of turning off the intake during heavy rainfall events does not address the water quality concerns upstream, nor does Halifax Water have authority to address the source.

Halifax Water will recommend to NSE that EFP’s should be mandatory in municipal water supply areas and all EFP’s within a municipal water supply area undergo an audit at least once in their 5-year planning period.

Crop and Pasture Lands

Much the same as the previous section *Beef and Dairy*; EFP’s apply. In the case of cropland mitigation measures include; timing of working on cropland helps reduce nutrient and sediment loading of runoff; respecting setbacks from watercourse to act as buffer between cropland operations and the watercourse; installing proper watercourse crossing to minimize direct contact with the farming equipment and water supply.

Similar to sod farming chemicals are commonly used for cropland maintenance. Through the Compliance Monitoring program, beginning in 2015, pesticide and herbicide samples are collected once per year at the raw water intake.

Business Parks

East Hants and HRM business parks consist of a mix of industrial, warehouses, transportation and office uses. Most buildings are large, utilitarian buildings. Much of the land is used for outdoor storage. Business parks tend to be separate from residential and other commercial areas. Business parks tend not to have street trees and act as source of contamination for sedimentation, petroleum products and other deleterious substances through stormwater runoff (see section *3.1.2: Business Park* on page 79).

Should source of contamination associated with this area impact the water supply the contingency plan is much the same as the subsections above.

Institutional

Schools and community use facilities are dispersed throughout the Municipality, though concentrated along the Corridor. Community use facilities include places of worship, legions and community halls. The latter are a common feature in the community core. Utility facilities include power, telecommunications, water and waste treatment facilities. Risks associated with agriculture activities are listed in section *3.1.2: Institutions* on page 82.

Waste Disposal Sites

Through research efforts waste disposal sites have been uncovered throughout BoMont. Many of these sites were privately operated with or without permits from the NSE.

Halifax Water will forward the potential disposal sites to NSE for further investigation.

4.3.2 Residential Development

Residential development is wide spread throughout BoMont making it perhaps the greatest risk to the watershed area as a whole (see section *3.1.3: Residential* on page 82). Ideally, through consultation with Halifax Water and the proposed watershed advisory committee upon which there will be HRM and East Hants Development Officer representatives, and as per the applicable Plan Area By-laws, HRM and East Hants will consider threats to BoMont when applications are being made for new residential development.

In the event of an emergency, *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed. Copies of the manual are at the Lake Major Water Supply Plant or Halifax Water's main office at 450 Cowie Hill Road in Halifax.

Activities on existing residential properties need special consideration in terms of contingencies as described in the following subsections.

Garbage and illegal dumping

The HRM Dangerous and Unsightly Premises Administrative Order (Number AO30) provides authority to Halifax By-law Services to deal with property-related public safety and quality of life issues including enforcing exterior property legislation on private property such as dangerous or unsightly premises; and the East Hants administers section 3(r) of the *Municipal Government Act (2011)* of Nova Scotia for "Dangerous or Unsightly Premises"; however, a written complaint must be received prior to any action being taken.

Home Heating Oil:

Nova Scotia Environment is responsible for enforcing the *Environmental Emergency Regulations N.S. Reg. 16/2013* which states:

3 (1) These regulations apply to a release of a substance or impending release of a substance into the environment, including all of the following:

(a) an environmental emergency;
(b) a reportable release;
(c) an unauthorized release;
(d) a release of a substance or impending release of a substance into the environment on lands owned or claimed by Her Majesty in the right of Canada.

If the owner(s) does not comply, NSE or the Minister responsible could impose penalties or perform the clean-up for which the owner must reimburse the Minister or NSE. Residents with concerns or regarding an oil spill emergency should contact their respective municipal office/first responders at 911.

As part of the education and communications program, Halifax Water will encourage proper maintenance practices of furnace oil holding tanks through education and awareness programming.

Halifax Water will prepare a general letter to its customers with oil tanks within the vicinity of the BoMont water supply intake informing them of the potential impact of leaks to surface water supplies and recommend measures to prevent such events to encourage homeowners to protect their water supply.

Chemical Household Products:

Not all homeowners are aware which products that are commonly used around their home, such as lawn and garden fertilizers, can seep into the ground water and affect their groundwater drinking supply.

Halifax Water will prepare a general letter to its customers with consequences of using harmful chemicals within the vicinity of the BoMont water supply.

On-site Septic Systems

Homeowners are responsible for the condition and functioning of their septic systems NSE is responsible for approving on-site septic systems and ordering landowners who have malfunctioning septic systems to repair them under the *On-site Sewage Disposal Systems Regulations* (*May 2016*) .

Halifax Water will prepare an information package for customers who are in the vicinity of the intake about the proper maintenance of septic systems and the potential impacts that failed system have on waterways and the water supply.

Accidental Fire within Residential Areas

To address wildfire safety concerns when siting and designing houses, applicants are encouraged to review the Nova Scotia Department of Natural Resources: *How to protect your home and* *property from Wildfire*. Further, the province and HRM and East Hants have developed by-laws and regulations concerning open fire burning.

4.3.3 Recreation

BoMont is open to recreational activities; however the land nearest the intake is privately owned with limited access; therefore implying that recreational activities near the intake are restricted to fishing, canoeing and kayaking. These activities by themselves present very little risk to the water supply.

To help reduce impacts related to other recreational activities, it is recommended that working relationships be established with recreational groups to help build respect and a collaborative approach to overall watershed protection. Communication with users also helps to promote cooperation and the eventual development of best management practice guidelines for various recreational pursuits.

Halifax Water has included in its Source Water Protection Brochure information about which activities may present risks to the water supply.

Golfing

The act of golfing does not present a risk to the watershed rather than golf course maintenance practices (see *Table 15: Summary of Existing and Potential Inherent Risk Factors Affecting Water Supply Area* on page 101). To reduce the potential for water quality impacts Halifax Water will contact golf courses within the watershed area and offer to share golf course BMP's which have are aimed at reducing water quality issues.

Halifax Water to contact golf courses within BoMont and share golf course BMPs.

4.3.4 Transportation

The major highways that are prevalent throughout BoMont present a high risk to the source water supply because there are no immediate mitigation measures to limit contamination from entering the watercourse through vehicular accidents or stormwater runoff. Halifax Water's source water quality monitoring program measures road effects on watercourses as described in section *5.4.2: Risk-Based Sampling* on page 157.

Road Construction

There are no watershed area-related regulations restricting the time period in which road construction and the amount of exposed roadway sub-base or right-of-way clearing for BoMont as there are for the designated *PWA*s (i.e., Pockwock and Bennery Lakes, and Lake Major).

NSTIR requires that its construction contractors attend an erosion and sediment control (ESC) course to ensure the protection of the construction site and adjacent properties and water bodies. The course instruction materials are found on NSTIR's website. Further, the province has a Standards Specification: Highway Construction and Maintenance Manual, updated annually in February and a Management Guide for Construction and Demolition Debris including road construction debris, which was developed by the Regional Waste Reduction Coordinators of Nova Scotia. These documents provide other resources for mitigating the impacts of road construction.

Road Transportation Routes

BoMont is a major through fair for motorized vehicles which include 100 series highways, provincial secondary routes, and municipal and provincial streets and roads. The risk to the water supply is significant due to the complexity of roadways and highways that cross-cross the watershed area. Emergency preparedness and response falls to the provincial and/or municipal agency responsible for maintaining them.

By way of this SWPP Halifax Water is notifying NSE if an emergency along the transportation route occurs which triggers an environmental response in the BoMont watershed area that Halifax Water will need to be notified in order to respond accordingly.

Controlled Access

Access to the BoMont WSP is restricted to authorized personnel; however the WSP grounds are accessible to the public. Halifax Water plant staff visit the facility every other day to maintain and operate the plant and report any activities that may put the plant and the water supply at risk. Local RCMP detachment is contacted when required. Halifax Water will continue to monitor these areas and will enhance security measures as needed.

Railway

Map F: Communities and Populations on page 44 on page outlines the railway system within the BoMont watershed area. Risks presented by railways are outlined in *3.1.5:* Railway on page 86.

Halifax Water will contact the railway operator to improve communications, provide emergency contact information, and provide boundary information.

Airport

Map I: Land Use and Landownership in Risk Area Zones (RAZ) on page 73 outlines the location of the airport within the BoMont watershed area while risks presented by airport are outlined in *3.1.5: Airport* on page 87. Halifax Water has no regulatory in regards to the Airport authority. Should non-conforming activities be monitored NSE, Transport Canada and HRM will be contacted.

In the event of an emergency inside the BoMont watershed area related to the Halifax Stanfield International Airport, Transport Canada and the HIAA are responsible for responding. Halifax Water will follow its ERP and responding accordingly. A copy of the ERP can be found at 450 Cowie Hill Road.

4.3.5 Utilities

Utility activity within BoMont and their associated risks are described in section *3.1.6: Utilities* on page 87. The following subsections describe how utilities mitigate specified activities with BoMont.

Halifax Water

Halifax Water operations inside the BoMont watershed area include water quality monitoring and operating and maintaining water and wastewater infrastructure. All facilities must operate within the conditions outlined in the Approval to Operate. Failure to do so will result in license cancellation and possible penalties.

All plant operators and contractors working on behalf of Halifax Water are made aware of surrounding risks and are educated on the response plans and procedures outlined in Halifax Water's ERP, copies of which are found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

Nova Scotia Power

Nova Scotia Power (NSPI) maintain significant infrastructure within BoMont such as transformers, and distribution and transmission poles and lines that present risks to BoMont. Contingency plans to manage the risks are outlined below.

Transformers

NSPI is federally required to replace all transformers containing PCB's by 2025. If any of the pole-top transformers contain PCBs and have been compromised such that there is a release of oil to the environment, spill response is immediate. All releases are reported immediately to area Transmission & Distribution Supervisors and the Territory Environmental Coordinator.

Power Poles

NSPI adheres to the Industrial Treated Wood Users Guidance Document as prepared by the Wood Preservation Strategic Options Process' Guideline Development Working Group, in 2004. Internal NSPI policy regarding pole treatment and installation dictates that all treated poles are set a minimum distance from the high water mark of any fresh water resource; a minimum of 15 m for PCP treated poles and a minimum of 5 m for CCA treated poles. Untreated cedar poles are used within 15 m of a drinking water well. When a pole is replaced, the old pole is most often completely removed from the ground and properly disposed of.

Transmission Lines

When planning vegetation management projects on distribution lines, members of the NSPI forestry group consult GIS mapping to determine where any designated or municipal watershed interacts with infrastructure.

It has been the general practice that any distribution line area that crosses through a PWA is not treated with any herbicide or pesticide. Halifax Water will contact NSPI to see if this same practice is applied to for BoMont.

4.3.6 Chemical Use

No watershed specified-regulations exist for chemical use and setbacks in the BoMont watershed area. Similar to the rest of the province, chemical applications that require approval are the responsibility of NSE including enforcing minimal setbacks from water courses. If a chemical enters a watercourse inside the watershed and threatens the source water supply, the ERP is used to respond, minimize and clean-up the impact to source water. A copy of the ERP is at 450 Cowie Hill Road, Halifax.

4.3.7 Public Awareness

Halifax Water will continue to post signs, conduct patrols, and distribute information to increase public awareness of the BoMont watershed area. Halifax Water may seek the province's assistance to enhance regulations and stiffen penalties within BoMont.

4.4 Emergency Response Management for Critical Infrastructure

Water is listed as one of the ten critical infrastructure sectors in the National Strategy and Action Plan for Critical Infrastructure [32] and in Public Safety Canada's Risk Management Guide for Critical Infrastructure Sectors – Appendix B: List of Hazards and Threats[33]. A key principle of the National Strategy is

> "*Critical infrastructure roles and activities should be carried out in a responsible manner at all levels of society in Canada…"* whereby the responsibilities are shared by *" federal, provincial and territorial governments, local authorities and critical infrastructure owners and operators – who bear the primary responsibility for protecting their assets and services. Individual Canadians also have a responsibility to be prepared for a disruption and to ensure that they and their families are ready to cope for at least the first 72 hours of an emergency*."

Considering Halifax Regional Water Commission is the caretaker of critical infrastructure, the National Security's principles and statements should be adhered to such that Halifax Water should be prepared for a 72 hour National Security critical infrastructure disruption scenario that could result in "*catastrophic loss of life, adverse economic effects, and significant harm to public confidence*."

4.4.1 Critical Infrastructure Management of Security Threats and Hazards Management

Halifax Water's ERP attempts to identify and categorize all emergencies that could affect its operations including stormwater, wastewater and drinking water services. To help sort and identify potential emergency scenarios, this SWPP's Emergency Response management subsection on management is divided into four sections: accidental, natural event, intentional threats and hazards, and backup emergencies.

Emergencies caused by natural disasters, accidents or spills, and malicious intent pose serious threat to water quality because they are often unpredictable and difficult to prepare for. Further, considering, "*disasters most often occur locally, the first response to a disruption is almost always by the owners and operators, the municipality, or the province or territory*." Also, the smaller the party affected, the fewer resources may be available to effectively and quickly deal with the emergency.

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[32] Public Safety Canada: National Strategy for Critical Infrastructure. Web-accessed August 8, 2014 at: http://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/srtg-crtcl-nfrstrctr/srtg-crtcl-nfrstrctr-eng.pdf.

[33] Public Safety Canada: Risk Management Guide for Critical Infrastructure Sectors; p. 37. Web-accessed August 8, 2014 at: http://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/rsk-mngmnt-gd/rsk-mngmnt-gd-eng.pdf .

Security against malicious intent is taken very seriously at Halifax Water. However, "[i]mproving the resilience of Canada's critical infrastructure will always be a work in progress. It will never be possible to protect against every threat or hazard and mitigate against every consequence."[34]

For specific types of emergencies, the following subsections describe Halifax Water's response and contingency plans according to whether it is an accidental, natural or malicious type of emergency.

Accidental Emergency Response

The emergencies described under the following subheadings are considered to be the greatest threat to BoMont.

Accidental Fire

Due to the Wildland-Urban Interface (WUI), a characteristic of BoMont, especially in the more populated communities of Dartmouth, Waverley, Fall River, Elmsdale and Enfield, there is substantial potential for accidental fire from various sources including residences, recreational pursuits, highway or railway mishaps, distribution line maintenance activity and other anthropogenic activities (*3.2.1: Accidental Fire* on page 98).

In the event of a fire, emergencies are addressed through 911 services and Halifax Water will cooperate with the appropriate agency(ies), and follow the outlined procedures documented in the *Emergency Response Plan for Halifax Water* located at 450 Cowie Hill Road, Halifax.

Aircraft Disaster

NavCanada is the agency responsible for safe and efficient traffic flow in Canadian airspace. Transport Canada is responsible for licensing pilots and other aviation specialists as well as registering and inspecting aircraft. The Transportation Safety Board of Canada is responsible for advancing transportation safety in Canada.

Through meetings with HIAA Security staff and by regularly reviewing its emergency-response plans, Halifax Water continues to assess the possibility of an event occurring. More details on the risks of aircraft disasters are found in *3.2.1: Aircraft Disaster Accidental Fire* on page 98.

Halifax Water has offered to supply the HIAA with GIS shape files of the watershed areas to use as a reference layer, especially in case of a catastrophic event, to add to their mapping system. The HIAA recognizes the importance of the water supply areas, but places greatest priority on ensuring flight safety.

In an aircraft emergency, Halifax Water will cooperate with the appropriate agency(ies), and follow the outlined procedures documented in the *Emergency Response Plan for Halifax Water* located at 450 Cowie Hill Road, Halifax.

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[34] Her Majesty the Queen in Right of Canada. Public Safety Canada: Action Plan for Critical Infrastructure (2014 – 2017). 2014. Web-accessed August 21, 2014 at: http://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/pln-crtcl-nfrstrctr-2014-17/pln-crtcl-nfrstrctr-2014-17-eng.pdf

Chemical or Oil Spill

In the event of a chemical spill inside BoMont, emergencies are addressed through 911 services. Emergency response protocols include Halifax Water's ERP and Halifax Water's BMPs, Nova Scotia Environment's ***Environmental Emergency Regulations***, the Nova Scotia Emergency Management Office and those in cooperation with Transport Canada, the agency responsible for an accident or spill occurring on roadways.

Erosion and Sedimentation

In the event of a sediment release inside BoMont, emergencies are addressed through 911 services. Emergency response protocols include Halifax Water's ERP and Halifax Water's BMPs, Nova Scotia Environment's Environmental Emergency Regulations, the Nova Scotia Emergency Management Office and the agency responsible for the sediment release into the waterways. Natural Event Response

Natural events and disasters that could occur within BoMont include wind, flooding, fire, drought, natural biological outbreaks and infestations, and climate change impacts. Management considerations for such events are described in the subsections below.

Wind and Flood

Wind and flood

- put drinking water supplies at risk through microbial cross-contamination;
- cause power outages that threaten to disrupt water pumping stations; and
- cause forest blow down that lead to short and long-term water quality impacts such as soil erosion and sedimentation, increased colour, suspended solids and organic matter levels.

Halifax Water will manage the risks presented by these events to the BoMont water supply by following the ERP and continuously improving response procedures and readiness in preparation for such events. Communication with other first responders will help to ensure Halifax Water is connected to the appropriate agencies to ensure timely response in such events.

Wildland Fire

In 2012, a *Provincial Forest Fire Watershed Protection Policy (FFWPP)* was created as an internal government document regarding how to respond to and fight fires within municipal water supplies. The protocol includes applying water first, only using the "Primary" drinking water supply source as a water source to fight fire as a last resort and using only those chemicals described in section *3.1.7: Wildland Fire Fighting* on page 95 NSDNR staff is aware of these protocols. Another tool available is the *Renewable Resources Municipal Source Water Protection Wildfire Management Manual IV6*, which is available on the provincial government's intranet site. There is also an updated GIS layer available showing watershed boundary's to help NSDNR staff define fire suppression limits.

Halifax Water will evaluate any threat to the raw water supply through the Target-Based Sampling Program *5.4.4: Targeted-Based Sampling* on page 158.

Drought

As indicated in section *3.2: Drought* on page 99, according to Environment Canada, Atlantic Canada may be more susceptible to drought impacts than are areas where drought is more prevalent because it occurs less frequently in Atlantic Canada, resulting in a lower adaptive capacity. Drought also makes forests more susceptible to fire and puts more pressure on water use and more demand on the water supply.

The *Emergency Response Plan for Halifax Water* (ERP) outlines the procedures in a drought or water rationing situation that includes banning of non-essential water use (e.g. lawn watering, car washing etc.) and the procedures to implement in the event of wildfire that may or may not be caused by drought conditions. A copy of the ERP is at 450 Cowie Hill Road, Halifax.

Climate Change

Regarding the impacts associated with climate change events (e.g., precipitation, sea level rise and temperature fluctuations), Halifax Water will continue to collaborate with other agencies to keep abreast of new challenges and techniques that limit the impacts on water infrastructure and impact the ability to adapt to climate change.

Intentional/ Deliberate Threat Response

In this document an intentional threat is considered to be one that involves an attack or a deliberate act for the purpose of doing damage. Protecting against an intentional or deliberate attack on the water supplies in the event of war or sabotage is perhaps more difficult than protecting against more predictable events such as social unrest and labour disputes.

Maintaining open lines of communication and fostering new opportunities for cooperation with the various agencies that affect or would be affected by the inability to use the BoMont water supply will help to continuously decrease the risk level of malicious intent and non-malicious intent attacks.The next two subsections describe these two forms of intentional threats; and how Halifax Water may manage them.

Malicious Intent

Halifax Water has completed an industry-developed risk assessment for its facilities. The security measures procedures were designed based on this assessment to reduce the probability, increase the likelihood of detection and lessen the impact of a malicious event. In the event of an emergency resulting from malicious intent, Halifax Water will follow the ERP to continue operations during an emergency. A copy of the ERP is located at 450 Cowie Hill Road in Halifax.

Halifax Water posts signs, maintains fences and gates, installs security cameras at main operating locations, performs patrols, conducts routine intense water sampling to ensure the safety of HRM’s drinking water and encourages watershed users to report any suspicious activities within the watersheds. Contact information can be found on signage at the BoMont WSP as well as listed on Halifax Water’s website, www.halifaxwater.ca.

Non-malicious intent

An example of non-malicious intent that could occur in the BoMont watershed area is in the event that lands near the water intake are developed in a manner that is not consistent with source water protection efforts, which may pose a negative impact to the protection of the source water supply or a change in provincial legislation that reduces protection mechanisms (as described in section *3.2.1: Non-malicious Intent* on page 100). The most important tool to manage for non-malicious intent is open communications and "*cooperation with Canada's international partners, all levels of government, security intelligence and law enforcement agencies, industry stakeholders and civil society*"[35].

[35] Her Majesty the Queen in Right of Canada. Public Safety Canada: Action Plan for Critical Infrastructure (2014 – 2017). 2014. p. 4. Web-accessed August 21, 2014 at: http://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/pln-crtcl-nfrstrctr-2014-17/pln-crtcl-nfrstrctr-2014-17-eng.pdf

5 Monitoring and Evaluation

Halifax Water is responsible for monitoring, reporting and enforcing activities that may impair water quality within the BoMont watershed area. Monitoring consists of maintaining a presence through patrolling, encouraging public reporting of unauthorized or suspicious activities, conducting raw water sampling, and liaising with various governing agencies and stakeholders to ensure a clean and safe drinking water supply. This chapter describes and outlines the monitoring and evaluation techniques implemented by Halifax Water to ensure clean, safe, potable water is being delivered to its customers.

5.1 Reporting

Monitoring the watershed involves reciprocal reporting processes. Halifax Water provides annual reports to governing agencies and to the public via publications, including those found on Halifax Water's website http://www.halifax.ca/HalifaxWater/SourceWater/index.php. Halifax Water also relies on and encourages the public to act as a "watch dog" and to report activities that could adversely affect source water quality.

5.1.1 Annual Reports

Annually, in March, Halifax Water prepares and provides a Source Water Protection Report (SWPR) to fulfill obligations to NSE as part of the *Annual Drinking Water Quality Report*. The report includes, but is not limited to the status of current risks, identification of new risks, results of the previous year's monitoring program, activities within the watershed and recommended changes to the SWPP for continuous improvement.

5.1.2 Public Reporting

Currently, there are no signs identifying BoMont as a public drinking water supply area.

Halifax Water to install signs at the BoMont WSP and other strategic locations throughout the watershed area for public information purposes. Information includes restricted activities, applicable legislation and contact information. Contact information includes, but is not limited to, applicable civic addresses, emergency spill contact numbers (e.g., 911) and Halifax Water's 24hr emergency hotline 902-420-9287.

5.2 Meetings

Consistent and sustained communication between those who have a responsibility to ensure clean, safe water is paramount. Meetings between water users who impact or have the potential to impact the watershed area allow potential risks to water quality to be evaluated and the opportunity to contribute to the development of methods to overcome obstacles in ensuring that clean, safe, potable water is being provided to Halifax Water clients. Water users who help to attain this goal include Halifax Water, the Municipality of East Hants (East Hants), NSPI, NSDNR, HRM and NSTIR and representatives of the local community.

5.2.1 Scheduled Meetings

Halifax Water and HRM maintain a close working relationship regarding possible development or scheduled events that could pose a threat to water quality. As part of the development application review process, HRM Community Planning department staff forward proposed development applications to Halifax Water for comment, which include applications that may impact the BoMont watershed area. Each party has agreed to work together through a series of scheduled meetings to mitigate or eliminate the impact of any concerning issues.

5.2.2 Management Committtee Meetings

Although no official watershed management committee exists for the BoMont watershed area, Halifax Water is represented on the Collin's Park Watershed Advisory Committee, established in February 2016, which provides advice on water quality protection of approximately half of the HRM portion of the BoMont watershed area**.**

5.3 Patrolling

Halifax Water routinely patrols the BoMont watershed mainly by marked vehicle to identify and respond to activities of concern.

5.4 Source Water Quality Monitoring Program

In September 2009, Halifax Water updated its raw water sampling program to include a proactive five-part Source Water Quality Monitoring Program (SWQMP) to measure the health of the watershed with respect to baseline, risks, activities, targets and operations. The initial BoMont watershed sample sites were BMG1, BMG2, and BMG3. Sample site BMG4 was established on the Nine Mile River in 2012, a major tributary to the Shubenacadie River, to monitor highly turbid water flowing into the Shubenacadie River, approximately 1.1 km upstream of the BoMont WSP intake. In November 2016, sample sites BMG6, BMG7 and BMG8 were added to establish baseline conditions and help determine inputs further upstream along the Nine Mile River (see *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43); **however they are not included in this SWPP as only one sample point has been collected prior to the submission of this plan.**

The Collin's Park watershed area (Lake Fletcher), which covers approximately 20% of the BoMont watershed area, supports the BoMont SWQMP by providing 6 supplemental sample sites (CPG1-CPG6) upstream of the BoMont WSP. For the purpose of this SWPP, all sample points will be covered under the "BoMont SWQMP".

Water Quality samples are collected pending weather and safety conditions and analyzed to help determine the effectiveness of the Source Water Protection Program. The sampling parameters are measured and assessed, where possible, according to the CCME CWQG. Halifax Water considers these to be the highest standards available to assess the health of its watersheds. In cases where aquatic life parameters do not exist, Halifax Water uses GCDWQ.

Sampling procedures are included in the current *Water Quality Sampling and Permit Compliance Manual* which can be found by contacting the Water Quality Manager. The manual is revised on an as-needed basis. BoMont sampling sites are illustrated on *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43) and listed in *Appendix 2: BoMont Water Sampling Locations, Frequency and Parameters* on page 162

5.4.1 Baseline Sampling

Baseline sampling is used to set water quality parameter baselines within the watershed area. Each baseline parameter is measured monthly, except for the metals scan which is measured twice per year. Subsequent water quality parameter data results are compared with the baseline data to determine if an investigation is required and whether parameter changes are associated with land use activities.

As previously mentioned, to better understand the raw water quality of the BoMont watershed area, baseline sampling was initiated in the fall of 2009. Subsequently, new sites were added to better understand water quality across the watershed – BMG4 in 2012 (as well as CPG3, CPG4, CPG5 and CPG6) and BMG6, BMG7, BMG8 in 2016.

The general baseline SWQMP is divided into four sections: 1) *Field Tested* (in-situ) and 2) *Lab Tested*, both of which are tested monthly; 3) *Metals Scan*, tested twice per year; and 4) *Deep Lake Sampling*, ideally collected quarterly weather pending. The first set of parameters consists of dissolved oxygen, pH, turbidity, temperature, specific conductivity, and colour which is measured in the field (in-situ) using portable hand held water quality equipment. The second set of parameters consists of total suspended solids (TSS), *E. coli*, Nitrate / Nitrite, Total Phosphorus (TP), and Total Organic Carbon (TOC) and are tested by a third party accredited laboratory. Both sets of parameters are collected in the same location and at the same approximate time. The following subsections describe the parameters and purpose for the four types of monitoring program methodologies, outlined in *Appendix 2: BoMont Water Sampling Locations, Frequency and Parameters* on page 162.

The following is a summary of the highlights of the baseline water quality data collection program findings which provide:

- TOC and color are highly variable in the source water ranging between **3 – 30 mg/L and 13 -171 TCU respectively**. The highest values are typically observed in summer/late fall **(Lake Fletcher area)** and after heavy rainfall events **(Nine Mile River subwatershed);**
- *E.coli* is highly variable in the source water ranging from non-detectable limits to **>2,400 CFU/100 ml (BMG4-Nine Mile River subwatershed)**. Highest *E.coli* counts are typically observed in summer/late fall and after heavy rainfall events;
- Metals analyses have revealed aluminum concentrations in the range **of 22 – 581 µg/L**, with the highest concentrations present at sample location **BMG3 and BMG4 (Nine Mile River subwatershed).**
- Sample site **CPG6 (Lizard Lake Brook-Tributary to Lake Fletcher off of Kinsac hill)** is of natural poor water quality due to shallow soil conditions, bedrock geology and forest cover (coniferous and wetlands) and is not ideal to support fish habitat. Any change in the existing landscape could have a negative impact on water quality and aquatic life present.
    - DO ~7mg/L
    - pH range 3.86 to 6.72
    - Aluminum 400-565

Field Tested

The following describes the significance of sampling for each set of in-situ-tested parameters.

Dissolved Oxygen

Dissolved Oxygen (DO) is essential to the metabolism of aerobic aquatic organisms. Concentrations of DO are indicative of a stream or lake system's overall health. Minimum DO levels are required to support fish and other aquatic life. Dissolved Oxygen also plays a key role in the chemical form and solubility of many inorganic nutrients (i.e., measuring shifts between aerobic and anaerobic aquatic conditions that influence the biological availability of nutrients and metals). Therefore, long-term changes in DO conditions can drastically alter the productivity and function of an entire lake or stream. *Table 18* below outlines DO concentrations in the BoMont watershed area since 2009.

Table 18: BoMont DO Results* (Average by Year 2009-2016) mg/L

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	11.57	10.96	10.38	11.28	10.74	10.76	10.51	11.71
BMG2	11.75	9.98	9.75	10.75	9.81	10.32	10.57	11.30
BMG3	11.25	10.46	9.81	11.02	10.48	10.9	10.84	11.58
BMG4	-	-	-	12.21	11.32	11.91	11.91	11.72
CPG1	11.08	10.42	9.69	11.17	10.72	10.43	11.19	12.91
CPG2	11.81	9.51	10.12	11.37	10.52	10.21	13.65	9.28
CPG3	-	-	-	12.31	11.60	12.28	12.42	11.25
CPG4	-	-	-	12.25	11.28	12.12	11.96	10.89
CPG5	-	-		11.65	10.74	11.24	11.91	11.73
CPG6	-	-	-	7.35	7.45	6.49	6.57	6.65
CPDL1	-	8.51	-	10.29	-	8.31	8.04	9.47
HRMCP^	11.09	10.78	9.63	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

As shown in *Table 18* above, DO levels in the BoMont watershed area are relatively consistent. However, there were noticeable declines in the DO level at CPG6, (Lizard Lake Brook). There were 10 instances, all occurring in July, August and September, where the DO sample levels reached between 0 and 3 mg/L, the point where "*mortality and/or loss of equilibrium*" occurs in fish. Given the topography and geology in the area, water quality available is considered less than ideal for fish habitat. This area is also planned for development which will have a high probability of negatively impacting water quality to a point where it may no longer support fish life.

pH

Within an aquatic environment, pH is a measurement of hydrogen ions in water and an indicator of acidity or alkalinity. A reading between 0 and 7 is considered acidic and contains more hydrogen. A reading between 7 and 14 is considered basic or alkaline and contains more hydroxyl groups. Acidification from land use activities, soil conditions and precipitation can negatively impact aquatic biota, contribute to the mobilization of toxic metals and affect drinking water aesthetics. Halifax Water's SWQMP is intended to establish baseline conditions and track changes in pH to determine which, if any, watershed activities are affecting pH levels.

Surficial geology has considerable impact on the water quality within the BoMont watershed area as described in sections *2.2.2: Geology*, beginning on page 16, and illustrated on *Map C: Surficial Geology* on page 41. With respect to pH levels, when rainwater falls on exposed bedrock in the Halifax Formation portions of the BoMont watershed area that may contain pyritic slate (which has a tendency to consist of acid-bearing slates), the rainwater reacts with acidic rock, creating a mild sulphuric acid which lowers the pH of the water.

The industrialization of North America from the mid-west to the east resulted in industrial gases being released into the atmosphere that fell in the form of acid rain, which particularly affected the Eastern Atlantic Region. Further, forestry, farming, mining, quarrying and residential developments have been and still are practiced within the BoMont watershed area. These types of industries typically alter the landscape and expose bedrock and soils. The combination of these activities together with areas that contain exposed acid-bearing bedrock and shallow soils are believed to have expedited the acidification of the BoMont system.

The CCME CWQG indicates optimum pH levels should be within the range of 6.5 to 9.0. According to AECOM (2016), most of the lakes sampled "*show pH units within the accepted guideline range of 6.5-9.0. Bell Lake, Cranberry Lake, Loon Lake and Grand Stn-1 show elevated pH in the order of 8.5 to 9.0 during the spring sampling event, with pH decreasing in the summer event to 6.5 to 7.0 and slightly increasing to 7.0 to 7.5 during the fall sampling event. The inverse relationship is observed for pH measured in 2 lakes, Rocky Lake and Charles Lake, with pH units approximately 7.0 during the spring sampling event, increasing (i.e. becoming more basic) in the summer towards 7.5 to 8.0 and slightly decreasing in the fall to 7.5. During the summer sampling, the pH measured in A Lake and Grand Lake Stn 3, 6.34 and 6.45, are slightly below the lower limit of 6.5 to 9.0 guideline range.*"[36]

As shown in *Table 19: BoMont pH Results* (Average by Year 2009 – 2016)* on page 142, pH levels for the most part, trend toward the lower spectrum (acidic) of this range and in some cases fall below this range, especially at CPG6 where levels trended between 3.86 – 6.72, with higher ranges (more basic) during the summer months (as AECOM found for Lake Charles and Rocky lakes), and lower ranges (more acidic) in the early spring and winter months. All of the BoMont sample points trended slightly lower than the norm for HRM lake systems, trending between 5.5 and 8.49 (all at BMG4) while the pH at other sample sites BMG1, BMG2 and BMG3 is at the lower end of that range. Sample site pH readings range between 3.62 and 7.23. At CPG3 and CPG4 and CPG6 the higher readings occur during the summer months, while readings at CPG1, CPG2 and CPG5 are relatively consistent.

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36 AECOM. April 2016. Halifax Regional Municipality *Surface Water Quality Monitoring – 2015 Annual Report*. p. 14.

Table 19: BoMont pH Results* (Average by Year 2009 – 2016)								
Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	-	6.52	6.64	7.15	7.0	6.69	6.6	5.87
BMG2	-	6.47	6.83	6.65	6.69	6.95	6.78	6.94
BMG3	-	6.53	6.75	6.64	6.99	7.17	6.89	6.86
BMG4	-	-	-	7.01	7.12	7.83	7.05	6.64
CPG1	-	6.52	6.91	6.49	6.91	6.97	7.10	6.72
CPG2	-	6.95	6.99	6.31	7.05	6.80	6.99	6.56
CPG3	-	-	-	6.12	6.86	7.03	6.84	6.66
CPG4	-	-	-	5.13	5.91	5.79	6.08	5.67
CPG5	-	-	-	6.27	6.82	6.68	6.96	6.78
CPG6	-	-	-	5.37	6.47	6.15	6.36	6.33
CPDL1	-	6.47	-	6.75	-	7.01	6.78	6.59
HRMCP^	6.94	7.28	6.82	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

The Halifax Formation bedrock (see section *2.2.2: Halifax Formation* on page 16) underlies the BoMont watershed area at sample sites CPG1, CPG2, CPG4 and CPG5 (see *Map E: Watersheds, Hydrology, Elevation and Sampling Points* on page 43 and *Map B: Bedrock Geology* on page 40) above shows that each year, pH at CPG4, an area least impacted by human disturbance, consistently has the lowest pH level within the watershed area, averaging 5.72. Conversely, the sample site with the most consistently high pH levels, at a mean average of 7.13, is BMG4, located below Highway 2 at the Nine Mile River Bridge in Lantz. This site was previously the only site to record water quality sourced from the Nine Mile River, which flows through the Windsor Group compound formation rock, which includes limestone (see section *2.2.2: Windsor Group* on page 17).

Temperature

Temperature affects many biological (e.g., biotic growth and decay, uptake of toxins, organism behaviour) and chemical (e.g., solubility, rate of reaction) processes. Monitoring the source water temperature allows Halifax Water to establish normal baseline conditions, adds context to some of the water quality parameters and tracks changes resulting from anthropogenic activities.

The BoMont water supply (Shubenacadie River) is a large-shallow river system that is highly influenced by seasonal temperatures; however from water quality samples measured, one can suggest that water temperatures could also be influenced by development within the watershed area. Areas where large asphalt surface areas exist tend to portray higher temperatures compared to those locations were development is limited or non-existent. For example the headwaters region which includes Lake Fletcher is moderately developed, but still has areas of good tree canopy cover. Temperatures range from 0.11 degrees Celsius in January (CPG2) to 25.31 degrees Celsius in August (CPG1) in the areas where large asphalt surfaces exist. In contrast, in areas where water is minimally influenced by asphalted surfaces (still good tree canopy cover), i.e., sample sites CPG3 and CPG6, temperatures ranged from -0.01 (CPG3) degrees Celsius in

January to 18.12 degrees Celsius (CPG3) in August. Temperature will continue to be monitored for future research or reference.

Specific Conductivity

CCME CWQG for specific conductivity has yet to be specified. However, the impact that human activities have on specific conductivity levels may be formulated through measurement.

Specific conductivity measures water's ability to conduct electricity and is highly dependent on the concentration of dissolved solids such as salt. Monitoring specific conductivity is useful for detecting the effects of road de-icing and other pollution inputs such as on –site sewage malfunction. Specific conductivity deviations from normal baseline conditions are used to assess the effects of cold-weather treatment of roads and highways within the watershed, and provide an indication of events causing potential source water contamination.

The BoMont watershed area is transected by 100 series and secondary highways, a railway, an International Airport as well as numerous roadways connecting the 43 communities within the watershed area. However, when compared to other watersheds, the average specific conductivity in the BoMont watershed area measures higher than the ~30μs/cm that is typical for most low to non-impacted Halifax Water source water areas. The only BoMont watershed sample site with a specific conductivity that meets this range is CPG4 which monitors an area that is not significantly affected by development. In contrast, the highest readings occur at sites BMG4 and CPG2, where the water quality is most heavily impacted from anthropogenic activities; BMG4, where the highest one-time reading (September 2014) 551μS/cm occurs, is highly impacted from inputs from the Nine Mile River; and CPG2 is surrounded by a significant amount of asphalt, which can provide a conduit for stormwater containing pollutants to enter the waterway at that site. *Table 20* below outlines the specific conductivity measurements recorded in the BoMont watershed area.

Table 20: BoMont Specific Conductivity Results* (Avg. by Year 2009 - 2016) (μS/cm)

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	107	106	100	93	92	87	99	98
BMG2	119	111	106	102	104	102	103	110
BMG3 (intake)	128	130	121	122	118	132	131	144
BMG4	-	-	-	248	208	292	185	329
CPG1	167	172	153	151	159	166	180	181
CPG2	162	189	160	205	162	180	190	196
CPG3	-	-	-	65	60	76	77	80
CPG4	-	-	-	27	26	25	26	26
CPG5	-	-	-	120	150	130	137	116
CPG6	-	-	-	94	98	90	117	165
CPDL1		170	-	147	-	164	183	184
HRMCP^	172	170	135	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

Turbidity

Turbidity is a visual property of water and a measurement of light scattered and absorbed due to the presence of suspended material (e.g., organic or inorganic particles originating from the erosion of soil or re-suspension of bottom sediments). Through turbidity monitoring, Halifax Water can set a baseline to determine whether land use activities in the watershed are linked to turbidity changes, and whether changes in land management should be considered.

The freshwater CCME CWQG index level for turbidity is set at 8 nephelometric turbidity units (NTU)'s above background conditions. Health Canada's GCDWQ for visual aesthetics (after treatment) is set at 0.1NTU. *Table 21* below outlines the average turbidity found through the BoMont SWQMP.

Table 21: BoMont Turbidity Results* (Avg. by Year 2009 – 2016) (NTU)

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	3.28	1.19	2.24	0.95	0.92	0.97	0.74	0.91
BMG2	4.28	2.70	4.05	2.09	4.82	2.07	1.43	5.18
BMG3	3.79	3.64	6.37	2.78	4.03	2.52	4.09	2.70
BMG4	-	-	-	3.22	6.25	3.49	6.03	4.43
CPG1	1.27	1.04	1.40	1.27	1.34	1.21	1.02	0.90
CPG2	1.93	1.91	2.00	2.33	2.83	1.33	1.38	2.50
CPG3	-	-	-	1.30	1.90	1.34	0.96	1.55
CPG4	-	-	-	0.55	0.64	0.75	0.80	0.69
CPG5	-	-	-	1.88	2.72	2.04	1.65	1.56
CPG6	-	-	-	1.93	2.20	1.10	1.47	0.70
CPDL1	-	0.74	-	2.35	-	1.62	0.95	1.28
HRMCP^	0.80	0.97	1.15	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

In general, turbidity results are below the CCME CWQG index of 8 NTU except where sites BMG2, BMG3, and BMG4 experienced heavy rainfall. It is believed local soil conditions and anthropogenic activities (development, sod farming and other agriculture practices) are causing high turbidity at these points. *Table 22* below outlines high turbidity captured during heavy rainfall events between 2010 and 2016

Table 22: Highest Turbidity Level Results with Associated Rainfall (2010 – 2016)

Sample Date	Sample Location	Reading (NTU)	Rain Date	Total (mm)
December 15, 2010	BMG2	9.18	December 13 to December 15, 2010	65.7
	BMG3	13.9		
March 8, 2011	BMG2	9.17	March 6 to March 7, 2011	24.8
	BMG3	26.0		
October 21, 2011	BMG2	21.9	October 19 to October 20, 2011	111
	BMG3	21.5		

July 24, 2013	BMG3	19.4	July 23, 2013	22.5
	BMG4	18.5		
November 19, 2013	BMG2	31.4	November 18 to November 19, 2013	24.6
	BMG3	10.4		
	BMG4	24.6		
November 19, 2014	BMG2	8.94	November 17 to November 18, 2014	58.6
	BMG3	9.44		
July 23, 2015	BMG3	15.1	July 18 and July 22, 2015	25.6
	BMG4	21.3		
May 5, 2016	BMG2	11.8	May 5, 2016	29.8
	BMG4	8.13		

Colour

Colour is an aesthetic parameter and is normally present in surface water. Colour is not a concern to human health however a change in colour may be the first indication of a water quality problem. Further testing is required to tell the type of contaminant and to identify the source.

Colour was added to the Halifax Water SWQMP in 2013 to tract changes over time and to improve source water protection planning and the management of water treatment plants. See *Table 23* below for Colour samples collect since 2013 in the BoMont watershed.

Table 23: BoMont Colour Results* (Avgerage by Year 2013 – 2016) (TCU)

Year / Sample Site Name	2013	2014	2015	2016
BMG1	24	28	25	23
BMG2	25	39	29	25
BMG3 (intake)	28	45	47	32
BMG4	88	54	64	49
CPG1	-	25	19	23
CPG2	-	23	16	20
CPG3	-	42	26	19
CPG4	-	35	33	21
CPG5	-	54	55	50
CPG6	-	169	147	82
CPDL1	-	-	-	9

* All results are Baseline Conditions unless otherwise indicated

Colour for sample site BMG4 is consistent with the turbidity levels collected at the same time (see *Table 21*), and mimic the peaks during the rainfall events as outlined in *Table 22*. Sample sites BMG6, BMG7, and BMG8 have been added to further investigate the idea that Nine Mile River water quality is highly impacted by local soil conditions and nearby anthropogenic activities (development, sod farming and other agriculture operations). Sample location CPG6 is a consistent colour with very little deviation. The water colour in this area is tea coloured which is characteristic of the bedrock, swamps and wetlands in this area.

Lab Tested

Lab tested parameters described in the following subsections are used to set water quality baselines to compare with water quality samples tested during changes in watershed activities. These parameters include Total Suspended Solids (TSS), *E. coli*, Nitrate/Nitrite, Total Phosphorus (TP), Total Sulfur (S), and Total Organic Carbon (TOC). The samples are collected at the same sample point as the in-situ parameters (see section *5.4.1: Field Tested* on page 140), are contained in appropriate bottles and delivered to an independent laboratory for analysis. Results will help direct investigations of changes in water quality, which may be associated with land use activities.

Total Suspended Solids (TSS)

Total Suspended Solids (TSS) is solids found in water that can be trapped in a filter. Increased suspended solids change a stream's ecological integrity by filling in interstitial spaces between rocks, altering the stream bottom and affecting light penetration in the water column. These effects have a cascading effect (i.e., there is a decrease in dissolved oxygen, causing stress on aquatic biota and an increase in TSS-associated substances). Changes in TSS can be indicative of erosion and run-off. For example, land-use activities such as forestry, agriculture and residential development can increase the amount of sediment released into a stream or lake. CCME CWQG for TSS is based on the following:

Clear flow Conditions

A maximum increase of 25mg/L from background levels for any short-term exposure (i.e., a 24 hour period) and/or a maximum average increase of 5mg/L from background levels for longer term exposures (i.e., inputs lasting between 24 hours and 30 days); and/or

High flow Conditions

A maximum increase of 25mg/L from background levels at any time when background levels are between 25 and 250mg/L. TSS background levels should not increase more than 10% when the background level is ≥ 250mg/L.

Background conditions indicate that TSS levels for the BoMont watershed area fall within the CCME CWQG index standard for clear and high flow conditions, except in the following cases:

- Where increases in TSS levels correspond to heavy rainfall events described in the turbidity (previous) section. The highest TSS reading collected was 35mg/L at BMG4 on November 19, 2013, which corresponds to a rainfall event and the highest turbidity level (24.6 NTU) recorded of all BoMont sample sites.
- TSS levels collected on September 10, 2014 for CPG6 were 36mg/L and corresponded to a turbidity reading of >9.99. Note: rainfall was **not** a factor in this TSS reading. This may be due to the surrounding geology, topography and wetlands in the area

See *Table 24* below for average annual TSS levels since 2009. Halifax Water will continue to monitor TSS levels to better understand baseline conditions and what their influences on BoMont water quality area may be.

Table 24: BoMont TSS Results* (Avg. by Year 2009 - 2016) (mg/L)

Sample Site Name / Year	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	5.0	1.71	4.14	1.52	2.47	1.15	1.3	ND
BMG2	3.67	4.5	3.38	3.91	2.7	2.48	3.01	3.6
BMG3 (intake)	5	3.9	4.78	2.62	2.9	8.07	5.03	2.67
BMG4	-	-	-	5.07	2.15	7.58	2.57	8.87
CPG1	ND	5.0	2.0	2.06	3.12	1.87	1.5	ND
CPG2	2	3.14	3.17	2.4	6.13	2.2	1.5	3.7
CPG3	-	-	-	1.45	2.89	3.6	1.5	ND
CPG4	-	-	-	1.7	1.44	1.8	2.8	1.2
CPG5	-	-	-	2.85	2.26	2.25	8.9	7.6
CPG6	-	-	-	1.93	2.20	2.21	1.47	0.7
CPDL1	-	ND	-	1.7	-	ND	ND	1.8
HRMCP^	ND	ND	ND	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

E. coli

E. coli is an indicator of how much fecal contamination is entering the water system through human or animal waste. However, recent research[37] suggests *E. coli* may not be the best indicator of fecal contamination as it mutates over time, making it difficult to identify where the contamination originated. CCME CWQG for *E. coli* is not specified. Until an alternative cost-effective and qualitative scientific method is identified, Halifax Water will continue to gather *E. coli* samples and report results. *Table 25* below outlines *E. coli* levels collected across the BoMont watershed from 2009 to 2016.

Table 25: BoMont *E. Coli* Results* (Average by Year 2009 - 2016) (CFU/100 ml)

Sample Site Name / Year	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	51.33	20.89	57.1	8.36	18.09	23.28	16.4	35
BMG2	82.33	61.5	56.4	23.5	21.7	40.38	32.57	45
BMG3	74	61.91	76.4	20.33	230.92	50.63	379.14	23.33
BMG4	-	-	-	45.64	304.1	82.88	404.29	136.67
CPG1	6.33	10.67	7.55	9.57	10.7	25	16.67	50

37 Stea, Emma. 2013. *Microbial Source Tracking in Two Nova Scotia Watersheds*. Master of Science Thesis, Dalhousie University. Halifax, Nova Scotia. Web-accessed March 6, 2017 at https://dalspace.library.dal.ca/bitstream/handle/10222/40648/Stea-Emma-MSc-FOODSCIENCE-November-2013.pdf?sequence=1.

Table 25: BoMont *E. Coli* Results* (Average by Year 2009 - 2016) (CFU/100 ml)								
Sample Site Name / Year	2009	2010	2011	2012	2013	2014	2015	2016
CPG2	40	21.44	37.09	22.64	109.3	44.57	98.57	116.67
CPG3	-	-	-	41.22	81.6	52.5	121.43	50
CPG4	-	-	-	18.2	34.5	48.6	56.67	120
CPG5	-	-	-	15.45	78.09	42.71	17.5	45
CPG6	-	-	-	31.6	27.75	72.86	10	30
CPDL1	-	1	-	ND	-	ND	ND	ND
HRMCP^	-	-	-	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

Sample site BMG4 experienced the highest *E. coli* readings from 2010 to 2016. This further supports the idea that the Nine Mile River watershed is highly impacted by local soil conditions and anthropogenic activities (development, sod farming and other agriculture operations). *Table 26* below demonstrates the correlation between E. coli, TSS, Turbidity and rainfall.

Table 26: *E. coli*, TSS and Turbidity levels with Associated Rainfall (Average by Year 2009 – 2016)						
Sample Date	Sample Location	*E. coli*	Turbidity (NTU)	TSS (mg/L)	Rainfall (mm)	Rain Date
July 24, 2013	BMG4	2400	18.5	15	22.5	July 23, 2013
Nov 19, 2013	BMG4	470	24.6	35	24.6	Nov 18 to Nov 19, 2013
July 23, 2015	BMG4	>2500	21.3	15	25.6	July 18 and July 22, 2015

There were some high *E. coli* readings where TSS and turbidity levels were low or non-detect, specifically sample site CPG3. Sample site CPG3 is in the middle of an older subdivision/ cottage retreat area where on-site septic systems are present. These high readings often occurred in June and July and could be attributed to lower water levels and/or when cottages/summer homes, which may have malfunctioning on-site septic systems, would be in use. *Table 27* below demonstrates elevated E. coli levels experienced in Lake Fletcher area of the BoMont watershed.

Table 27: *E. coli* levels associated with potential seasonal uses on Lake Fletcher (Average by Year 2009 – 2016)					
Sample Date	Sample Location	*E. coli*	Turbidity (NTU)	TSS (mg/L)	Total (mm)
26-Jul-12	CPG3	220	2.09	ND	0.0
18-Jul-13	CPG3	490	1.64	1.8	0.0
24-Jul-15	CPG3	380	1.01	ND	0.0

Total Phosphorus and Nitrate-Nitrogen

Total phosphorus and nitrate-nitrogen concentrations are measured to monitor nutrient loading in a freshwater system. Excess nutrient loading is harmful to an aquatic ecosystem and promotes an increase in trophic status, which can result in algal and plant growth. These conditions are a concern for drinking water quality due to the difficulty in removing nitrate-nitrogen through the water treatment process, and loss of aquatic habitat biodiversity. Excessive growth places oxygen demands on aquatic systems during organic breakdown of material, and can promote the secretion of algal toxins.

Total Phosphorus (TP)

Phosphorus is not considered to be toxic by itself. However, phosphorus is the key limiting nutrient that determines the trophic status of aquatic ecosystems.

The CCME CWQG TP trigger range is 20µg/L (0.02mg/L). Recorded ranges for TP that indicate trophic status levels are:

- ultra-oligotrophic <4
- oligotrophic 4-10
- mesotrophic 10-20
- meso-eutrophic 20-35
- eutrophic 35-100
- hyper-eutrophic >100

The water quality TP levels observed in the BoMont watershed area system is frequently near or above the TP 20µg/L (0.02mg/L) trigger range, especially at BMG2 (Elmsdale Bridge) and CPG6 (Lizard Lake Brook, which flows into Lake Fletcher) as outlined in *Table 28* below and illustrated on *Map E: Watersheds, Hydrology, Elevation and* Sampling Points on page 43.

Table 28: BoMont TP Results* (Avg by Year 2009 - 2016)

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	0.02	0.007	0.012	0.008	0.007	0.005	0.006	0.006
BMG2	0.03	0.014	0.14	0.011	0.024	0.008	0.0085	0.011
BMG3	ND	0.015	0.019	0.01	0.017	0.009	0.020	0.007
BMG4	-	-	-	0.013	0.018	0.007	0.025	0.012
CPG1	ND	0.008	0.012	0.016	0.006	0.007	0.007	0.007
CPG2	ND	0.013	0.015	0.019	0.018	0.006	0.009	0.012
CPG3	-	-	-	0.015	0.008	0.008	0.011	0.007
CPG4	-	-	-	0.017	0.007	0.009	0.008	0.006
CPG5	-	-	-	0.018	0.010	0.012	0.012	0.011
CPG6	-	-	-	0.029	0.017	0.023	0.019	0.018
CPDL1	-	0.006	-	0.008	-	0.003	0.005	0.007
HRMCP^	0.012	0.016	0.009	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

The highest levels of TP have been consistently recorded at CPG6, which is located at the top of the intrusive igneous or granitoid rock pluton –a barren granite hill – situated between Kinsac and Fletcher lakes (see *Map B: Bedrock Geology* on page 40). The lack of soil cover to absorb and filter on-site septic field effluent from development that currently exists on this site may be influencing the TP levels. If this is the case, TP levels will only be exacerbated by further development that is slated to occur on this pluton, according to development concept plans for in this area that have already been approved by HRM. Changing how household wastewater and human waste is typically treated could mitigate this impact.

From samples collected at BMG2 (Elmsdale Bridge) on October 21, 2011, the day after a 104.4 mm rain event, the TP reading was 1400 µg/L – more than 700 times the trigger range; and on July 23, 2015 at BMG3 and BMG4 following a moderate rain event, readings were 85µg/L and 97µg/L respectively– more than 4 times the trigger range and within the eutrophic range.

Nitrate-Nitrogen

Nitrogen is the second limiting nutrient in influencing trophic status of freshwater systems. Nitrogen occurs in freshwater in numerous forms; the major form of inorganic nitrogen is likely found in the nitrate form.

GCDWQ standards for nitrate concentrations are 10 mg/L which is a higher standard than CCME's CWQG, at 13mg/L. Halifax Water uses GCDWQ minimum baseline for acceptable nitrogen concentration levels (10mg/L).

Studies suggest there is a link between nitrate and nitrite and health issues such as Blue Baby Syndrome as well as possible links to cancer if consumed. Nitrate is difficult and expensive to remove from untreated water; therefore, it is best to avoid increases in nitrogen levels in the water supply. Halifax Water will continue to monitor phosphorus and nitrate-nitrogen concentrations. If water quality becomes impacted, water quality background information will assist Halifax Water in developing effective solutions. *Table 29* below displays nitrate levels in the BoMont system.

Table 29: BoMont Nitrate Results* (Avg by Year 2009 - 2016) (mg/L)

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	0.077	0.114	0.107	0.109	0.114	0.094	0.104	0.098
BMG2	0.08	0.11	0.102	0.114	0.117	0.085	0.097	0.089
BMG3	0.09	0.102	0.099	0.107	0.113	0.085	0.123	0.088
BMG4	-	-	-	0.085	0.125	0.089	0.200	0.07
CPG1	0.163	0.169	0.176	0.170	0.187	0.143	0.130	0.171
CPG2	0.25	0.163	0.207	0.327	0.198	0.155	0.143	0.293
CPG3	-	-	-	0.139	0.095-	0.147	0.118	0.153
CPG4	-	-	-	0.083	ND	0.058	ND	0.075
CPG5	-	-	-	0.134	0.16	0.135	0.157	0.167
CPG6	-	-	-	0.072	0.097	0.059	0.074	0.062
CPDL1	-	0.06	-	ND	-	0.079	ND	0.055
HRMCP^	0.153	0.103	0.150	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

Total Organic Carbon (TOC)

Total organic carbon concentration is indicative of organic matter loading into source water supplies. Elevated organic matter concentrations can result in taste and odour issues and lead to the formation of disinfection by-products. Dissolved organics can also play a role in the transport and availability of metals (i.e., methyl mercury). There is no maximum allowable concentration (MAC) for TOC for either the CWQG or GCDWQ because there is no known health concern directly related to elevated TOC concentrations. Detection limits are at 0.5 mg/L.

BoMont water sample TOC concentrations are generally lower compared to other surface source water areas averages; i.e., Pockwock ~15mg/L and Lake Major ~7mg/L, except during rainfall events. For example at BMG2 the TOC readings were 9.2mg/L and 9.8mg/L in June and July. However, TOCs recorded on October 21, 2011 at BMG2 were 30mg/L which was recorded following a major rain event that dropped 104.4 mm of rain. *Table 30* below displays TOC concentrations in the BoMont raw water supply from 2009-2016.

Table 30: BoMont TOC Results* (Avg by Year 2009 - 2016) (mg/L)

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	8.2	4.53	4.64	4.52	4.17	3.91	3.85	3.83
BMG2	9.83	5.33	7.19	4.73	4.34	4.31	4.18	4.27
BMG3	6.47	6.34	6.5	5.11	5.18	4.75	5.66	4.57
BMG4	-	-	-	6.38	7.05	5.56	9.26	5.43
CPG1	4.53	4.09	4.5	3.93	4.3	3.34	3.29	3.67
CPG2	4.85	4.12	4.63	4.03	4.51	3.45	4.0	3.5
CPG3	-	-	-	3.05	3.81	4.11	4.1	2.73
CPG4	-	-	-	3.13	3.66	3.99	4.25	2.73
CPG5	-	-	-	6.38	7.21	5.83	7.23	5.37
CPG6	-	-	-	10.63	12.56	10.89	14.27	9.87
CPDL1	-	3.40	-	4	-	3.1	3.4	3.2
HRMCP^	4.53	4.85	6.95	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

Halifax Water will continue to collect TOC to properly assess the health of the water supply. If CCME CWQG or GCDWQ change, Halifax Water will have adequate water quality information available to aid in water quality management decision-making.

Total Chloride

Chloride is measured across the watershed to better understand natural conditions and to indicate anthropogenic activities. CCME CWQG short-term concentration is 640 mg/L and long-term concentration is 120 mg/L. *Table 31* below displays the chloride levels in the BoMont watershed.

Table 31: BoMont Chloride Results* (Avg by Year 2009 - 2016) (mg/L)

Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG1	20	22	8.71	6.67	7.72	18.67	20	20
BMG2	22	25.67	8.71	19.83	19.8	20	21.2	21
BMG3	29	22.17	16.5	16.83	18.67	17.33	19.4	19

Table 31: BoMont Chloride Results* (Avg by Year 2009 - 2016) (mg/L)								
Year / Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
BMG4	-	-	-	14.67	22.2	13.53	22.25	21
CPG1	40.05	40.67	-37.17	45.5	40.8	34.33	41.17	37
CPG2	34	40.4	40.33	50.33	28.1	34.0	37.17	64
CPG3	-	-	-	10.13	10.38	13.67	13.6	16
CPG4	-	-	-	-	-	-	4.25	4.5
CPG5	-	-	-	27.2	36.0	27	26.5	38
CPG6	-	-	-	6.37	13.74	6.3	6.08	10
CPDL1	-	39	-	32	-	33	42	41
HRMCP^	39	38	29	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

The chloride levels in the BoMont watershed area are wide-ranging, from 3.4 mg/L at CPG4 (Holland Brook at Holland Road culvert), which is among the lowest among all of Halifax Water's source water areas, to 100 mg/L at CPG1 (Fall River bridge). At this point, the levels are not considered toxic to aquatic life over the long-term; however are approaching the long-term toxic level of 120mg/L.

Halifax Water will continue to monitor chloride levels and identify possible sources of contamination. Should sources be found Halifax Water will make those parties aware including NSE to improve best management practices apply applicable legislation.

Metals Scan

Metals occur naturally within soils and bedrock and can present a negative impact to drinking water quality. Therefore, it is important to determine which metals are detectable in the BoMont source water supply, whether they are within the recommended GCDWQ and CCME CWQG, and/or whether they are present as a result of watershed area activities.

Water chemistry of surface waterways is highly influenced by the kind of soil and rock through or over which the water flows (see section *2.2.6: Water Quality* on page 36). The main physical, chemical and biological parameters that influence water composition are temperature, pH, redox potential, adsorption and desorption processes from inorganic or organic suspended matter or bottom sediments, cation exchange, dilution, evaporation, and presence of organisms. These conditions are the product of natural background conditions and/or anthropogenic activities that cause heavy metals to accumulate to critical levels in the food web and damage to organisms on a higher trophic level (see section *3.1: Inherent Risk Factors* on page 78).

Generally, water quality sample results reflect natural soil and rock formation-types that are typical of the area which is described in this section *(5.4.1*).

Metal samples are collected twice a year; once during low-flow conditions (typically in July) and once during high-flow conditions (typically in September) at each of the BoMont sample point locations. The following are the most prevalent metal concentrations found within the BoMont water supply.

Lead

According to Health Canada, human activities release more lead into the environment than do natural processes such as soil weathering, erosion and volcanic activity. Lead can be a significant contaminant in the environment because of its toxicity and persistence in the environment. It is taken up by the body and stored in bone and other tissues for many years. Under certain conditions, lead can leach into drinking water through corrosion of distribution pipe systems. Exposure to lead can be harmful to human health, particularly in pregnant women, infants and young children who absorb lead most readily. The nervous and reproductive systems and kidneys are most vulnerable. Lead can also cause high blood pressure and anemia.

The CCME CWQG MAC for lead is dependent on water hardness ($CaCO_3$). When the hardness is 0 to ≤ 60mg/L, the CCME CWQG MAC is 1 µg/L. When hardness is >60 to ≤ 180mg/L the GCDWQ is calculated using this equation CWQG (µg/L) = e{1.273[ln(hardness)]-4.705}. At hardness >180mg/L, the GCDWQ is 7µg/L. If hardness is unknown, the GCDWQ is 1µg/L.

Based on the hardness levels in BoMont (0 to ≤ 60 mg/L), and samples collected, the following locations experienced lead levels above the CCME CWQG limit of 1µg/L.

- On July 14, 2016, a lead sampled of 1.6µg/L was collected at CPG5.
- At CPG6 on July 26, 2012 the lead level was 1.24µg/L and on July 18 the level was 0.99µg/L.
- The most significant lead reading (28.4µg/L) was collected August 31, 2010 at CPDL1 4m below the surface; however has never reached this level again. The sample could have been collected improperly or contaminated at the lab where it was tested. *Table 32* below outlines Lead levels throughout the BoMont watershed.

The BoMont WSP is capable of removing any lead that may be present in the raw water.

Table 32: BoMont Lead Results* (Avg by Year 2010 - 2016) (µg/L)

Sample Site Name \ Year	2010	2011	2012	2013	2014	2015	2016
BMG1	ND	ND	0.325	ND	ND	ND	ND
BMG2	ND	ND	ND	ND	0.26	ND	ND
BMG3	ND	ND	ND	ND	0.255	ND	ND
BMG4	-	-	ND	0.25	ND	0.33	ND
CPG1	-	-	ND	ND	ND	ND	ND
CPG2	-	-	ND	ND	ND	ND	ND
CPG3	-	-	ND	ND	ND	ND	ND
CPG4	-	-	ND	ND	ND	ND	ND
CPG5	-	-	0.27	0.285	ND	ND	1.6
CPG6	-	-	1.065	0.88	0.825	0.735	0.82
CPDL1	ND	-	ND	-	ND	ND	ND
HRMCP^	28.4	ND	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

Aluminum (Al)

Aluminum is the most abundant element on earth, making up about 8% of the earth's crust and is found naturally in foods such as spinach, potatoes and tea. It is widely used throughout the world in manufacturing processes, agriculture industries and as a coagulant in the treatment of drinking water to reduce the organic matter, colour, turbidity and microorganisms contained in raw water.

Aluminum concentrations in natural waters "can vary significantly depending on various physicochemical and mineralogical factors". Also, "acid environments caused by … acid rain [accumulated in the soil] can cause an increase in the dissolved aluminium content of the surrounding waters (ATSDR, 1992; WHO, 1997)."[38] PH influences the solubility of aluminum such that in pure water, aluminium has a minimum solubility in the pH range 5.5–6.0; and concentrations of total dissolved aluminium increases at higher and lower pH values (CCME, 1988; ISO, 1994). The main sources of aluminum in the environment are from fertilizers, sewage sludge, mining and smelting.

The CCME CWQG recommends maximum aluminum concentration levels at: 5µg/L where pH is <6.5 and 100µg/L where pH is >6.5. Studies associating the link of human health effects due to the consumption of high levels of aluminum found in drinking water (<2000µg/L) are inconclusive, therefore, there is no recommended MAC for Aluminum. *Table 33* below outlines aluminum levels recorded in the BoMont system since 2010.

Table 33: BoMont Aluminum Results* (Avg by Year 2010 - 2016) (µg/L)

Sample Site Name \ Year	2010	2011	2012	2013	2014	2015	2016
BMG1	55.1	50.3	50.65	37.75	38.5	41	46
BMG2	106.1	69.3	109	39.3	47.5	52.5	56
BMG3	212.5	63.65	98.9	275	45.5	224.5	44
BMG4	-	-	135.6	324.5	27.5	380	37
CPG1	12.7	46.1	25.1	34.6	20.5	20.5	24
CPG2	23	33.25	29.7	143.5	24.5	29	57
CPG3	-	-	314	245.5	135.5	175	110
CPG4	-	-	203.5	188	169.5	180	150
CPG5	-	-	144	145	91.5	82	170
CPG6	-	-	565.5	546.5	400	430	510
CPDL1	10.2	-	44.9	-	19	18	31
HRMCP^	70	69	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

With reference to *Table 19: BoMont pH Results* (Average by Year 2009 – 2016) on page* 142, where BoMont's source water pH levels are >5, aluminum levels should not exceed 100µg/L

[38] "Dissolved aluminium concentrations in waters with near-neutral pH values usually range from 0.001 to 0.05 mg/litre but rise to 0.5–1mg/litre in more acidic waters or water rich in organic matter. At the extreme acidity of waters affected by acid mine drainage, dissolved aluminium concentrations of up to 90 mg/litre have been measured (WHO, 1997)." Source: See previous footnote, p. 2.

according to the CCME CWQG. As *Table 33* above outlines, BoMont' s average aluminum readings range from 12.7 – 565.5µg/L, the high end of which encompasses, in some cases, two to four times that of its closest source water supply counterparts; i.e., Bennery (126.7µg/L), Pockwock (139.7µg/L) and Lake Major (226.4µg/L). High aluminum concentrations are released through acid rain and acidic soil runoff and bond with low phosphorus levels to settle out at the bottom of the lake.

Arsenic

Arsenic, particularly soluble inorganic arsenic is acutely toxic. The effects of the toxin include a number of symptoms and depend on the level of exposure. Human activities responsible for arsenic contamination include mining, smelting, combustion of fossil fuels, agricultural pesticide production and use of timber treated with preservatives; disturbance of historic sources such as mine drainage water; and mobilization into drinking water from geological deposits through well drilling activities.

Results from the sampling program indicate that Arsenic is present throughout the Bomont watershed:

- At sample sites BMG2 and BMG3 **arsenic is consistently detected** at high levels relative to the MAC of 10 µg/L, with readings as high as 10µg/L (September 30, 2016) and 7.3µg/L (September 10, 2010) respectively.
- At sample sites, CPG2 and CPG6, there are consistent readings of arsenic with levels as high as 14.1µg/L (September 14, 2010) and 12µg/L (> MAC) respectively. The latter result occurred after a high rainfall event in September 2014.

Arsenic is not evident in the treated potable water results, indicating that the water treatment system is removing arsenic that may be getting into the water treatment plant.

Zinc (Zn)

Zinc (Zn) is fourth in the world among annually consumed metals behind Iron (Fe), Aluminum (Al), and Copper (Cu). It is extensively used in automobile manufacturing and agriculture industries. The main sources of zinc in the environment are fertilizers, sewage sludge, and mining and smelting.

Zinc is essential for both plants and animals. Zinc toxicity in humans is very rare. High intake of this metal may affect cholesterol levels. As shown in *Table 34: BoMont Zinc Results* (Avg by Year 2009 - 2016) (µg/L)* on page 156, zinc levels collected in the BoMont watershed area are well below the GCDWQ maximum concentration (5000µg/L).

CCME CWQG's MAC zinc concentration depends on the hardness of the water sampled. Recommended CCME CWQG zinc concentrations are not to exceed 30µg/L at any one time or 7.5µg/L on a 30-day average when water hardness is less than or equal to 90 mg/L. The average raw water hardness of Lake Fletcher is 22.75µg/L (from deep lake samples collected between 2009 and 2012) which does not exceed the CCME CWQG. *Table 34: BoMont Zinc Results* (Avg by Year 2009 - 2016) (µg/L)* on page 156 outlines BoMont watershed area zinc levels since 2009.

Table 34: BoMont Zinc Results* (Avg by Year 2009 - 2016) (µg/L)							
Sample Site Name \ Year	2010	2011	2012	2013	2014	2015	2016
BMG1	3.05	ND	18.6	ND	7.5	4.1	ND
BMG2	3.5	ND	3.35	ND	7	4.3	ND
BMG3 (intake)	2.7	ND	4.3	ND	6.5	4.8	ND
BMG4	-	-	3.5	ND	ND	5	ND
CPG1	ND	ND	ND	ND	3.7	3.4	ND
CPG2	ND	ND	ND	4.6	3.1	6	ND
CPG3	-	-	10.8	6.1	3.9	4.7	ND
CPG4	-	-	4.15	ND	5	4.2	ND
CPG5	-	-	3.8	2.8	3.6	4.15	5.4
CPG6	-	-	13.55	9.55	10.85	14.2	9
CPDL1	ND	-	ND	-	6.7	ND	ND
HRMCP^	112	ND	-	-	-	-	-

* All results are Baseline Conditions unless otherwise indicated
^ Halifax Regional Municipal water quality data for Lake Fletcher

Zinc concentrations at the BoMont water sample sites range from non-detect to 18.6 µg/L, averaging 3.0µg/L. The highest range is 3 to 4 times higher than its larger source water counterparts; Bennery (<5µg/L), Pockwock (<5µg/L) and Lake Major (<5µg/L). On average, most of the BoMont watershed area tributaries reflect the same zinc concentrations (see *Table 34* above), indicating zinc sources are evenly distributed across the watershed, except at CPG6 where the average range is consistently higher than at all the other monitored BoMont tributaries.

However, sample point BMG1 recorded 37.2µg/L on September 19, 2012 which exceeding the 30µg/L threshold. Considering this was a one-time event that was inconsistent with readings at other times at this site, and that it is a site along the Shubenacadie River located under a #2 Highway bridge, it is difficult to define the point source which led to this reading.

Deep Lake Sampling

The Bathymetry of each of the five major headwater lakes (see section 2.2.6: Natural Water Bodies on page 30 and Map E: Watersheds, Hydrology, Elevation and Sampling Points on page 43) in the BoMont watershed area, are illustrated in *Appendix 1: Bathymetry of Headwater Lakes in BoMont Watershed Area* on page 162. The known deepest points of Charles, William, Thomas, Fletcher and Grand lakes are 30m, 28m, 14m, 11m and 40m, respectively.

The deep lake information collected from Lake Fletcher for the Colin's Park SWPP is used as supplemental data to further assess water quality in the headwaters of the BoMont watershed.

Halifax Water will continue to conduct deep lake sampling in Lake Fletcher to monitor for changes in water quality in that part of the BoMont watershed area system and in association with the Collin's Park WSP.

5.4.2 Risk-Based Sampling

Risk-based sampling is scheduled and linked to probable risk(s). Results of the sampling may lead to changes in management, protection efforts, regulations and/or restriction of certain activities.

Petroleum Hydrocarbons

Petroleum hydrocarbon samples are collected in March and September of each year during high water-flow periods at all BoMont sample sites to monitor for potential hydrocarbon spills. Contamination sources include vehicular traffic along Highways 102 and 118, Highway 2, and the Old Trunk Road, the railroad and other sources such oil-based heating systems and industrial-based activities.

5.4.3 Activity-Based Sampling

Activity-based sampling is scheduled based on known events that take place in the watershed, including forestry, road de-icing, quarrying, agriculture, residential development and other known activities. Activity-based sampling helps determine cause-effect relationships and short- and long-term effects of their impacts on the watershed area, which help determine how best to manage land-use activities and the frequency with which physical patrols and water quality monitoring are conducted. The parameters tested for are determined by the activity and the impact it may present to the water supply source, as described in the subheadings below.

The most recent implementation of an activity-based sampling initiative was in association with an oil spill from an oil delivery truck in the Fall River area. On January 14, 2015 a home delivery oil truck was involved in an accident at 78 Arthur Joseph Drive resulting in approximately 40 litres of home heating oil being spilled into a nearby tributary which eventually made its way into Lake Thomas. At the time, Lake Thomas was covered with ice, which made clean-up efforts difficult. Samples were collected daily, downstream of the point source, including the Collin's Park Water Supply Plant (WSP). A small concentration of the spill was detected 4 days later at the Fall River Bridge to the outlet of Lake Thomas, but none observed at the WSP. The concentration was considered very small and risk to the plant was very low. Sampling returned to the regular monthly sample schedule and levels above the detection limit were never observed again.

E. coli

Activity-based *E. coli* sampling is conducted to measure impacts of activities such as removing beaver dams, or wastewater replacement programs within the watershed. When there is a clear and direct pathway to the lake during an activity, *E. coli* sampling is performed daily and continued for one week after the event is over.

Total Phosphorus and Nitrate-Nitrogen

Phosphorus and nitrate-nitrogen sampling is a result of scheduled forestry, or other development activities such as wastewater replacement programs. Nitrate-nitrogen sampling is conducted weekly during the activity and continued for one week after the activity has been completed. Samples will be taken at any lake, stream or running tributary inside the watershed area within 200m of the operation where access is available.

Total Suspended Solids

Total suspended solids (TSS) are typically elevated in stream systems during and immediately following forestry activities, road construction and maintenance, and any other activity that disturbs a stream crossing or nearby land. Increased suspended sediments (solids) change a stream's environment by clogging interstitial spaces between rocks, altering the stream bottom and affecting light penetration in the water column. Each impact has a cascading effect (e.g., decreased dissolved oxygen, stressed aquatic biota, and increased TSS-associated substances). Sampling is conducted daily during stream-crossing activities where there is a clear and direct pathway to the lake.

Petroleum Hydrocarbons

Activity-based petroleum sampling is conducted in response to events or spills occurring within the watershed area. In response to such an event, sampling is conducted daily and continues for one week after operations have been completed. Samples are collected from watercourses within 200m of the event site, as well as from affected dominant feeder streams downstream from the spill where they flow into the closest lake where access is available.

Total Chloride

Activity based chloride sampling occurs within the watershed area following activities such as cold-weather road maintenance on major roadways such as Highways 102, 118, 2 and the Old Trunk Road occurring in close proximity to the BoMont intake, or following any other human related chloride activity.

Samples are collected monthly at all active BoMont watershed sampling sites, from November to April of each year, to measure the effects of cold-weather road maintenance activities in the watershed area. Results showed elevated chloride levels during the months that road salt was applied, however samples collected did not exceed the CCME CWQG. Halifax Water will continue to monitor all sites for chloride to use in conversations with NSTIR regarding ways to improve road de-icing applications with respect to water quality in the water supply area.

In the event that any of the above activity-based parameters and their associated activities shows a high risk to the water supply plant, consideration will be given to shut down the plant until the situation has passed or deemed to have no impact. The *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed in regards to plant shut-down procedures and customer notification. Copies of the ERP can be found at Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

Pesticides

Pesticide sampling may occur following scheduled activities such as forestry-related pesticide application and/or golf course maintenance. Due to the complexity and size of the BoMont watershed samples are collected yearly at the intake through the compliance monitoring program. To date this program has also turned up negative results.

5.4.4 Targeted-Based Sampling

Target-based sampling is done as a response to incidents or unplanned events such as a fuel or other chemical spill, significant weather events, vandalism or malicious intent. Such sampling protects customers by providing a warning system through monitoring events with the potential to shut down the pumping station.

All target-based sampling is conducted at watercourses within 200m of the scene and in all dominant feeder streams downstream of the event at 500m intervals daily, until it reaches the main river (Shubenacadie River) channel, then daily at 500 m intervals along the main river (Shubenacadie River) channel to track its progress. Sampling intensity could be increased and/or reduced depending on whether detection limits persist and whether the contaminant is progressing along the travel path. The water pumping station will be shut down, if in operation, when an event occurs and high-levels of a contaminant persist within 500m of the water pumping station. Sampling will continue until it has been determined that there is no longer a threat to water quality and the plant can be restarted.

The following parameters present the highest probable threat to water quality in the event of an accident or unplanned event within the BoMont source water supply area and are monitored as described under the following headings:

Petroleum Hydrocarbons

Petroleum-hydrocarbon sampling is conducted in response to incidents or unplanned events along Highways 102, 118 and 2, on the Old Trunk Road and along the railroad track. Normal watershed area activities that could include, but are not limited to, forestry activities, traffic accidents, boating, and construction, which may release petroleum hydrocarbons, are not typically monitored for any purpose other than for the risk-based sampling program as described above in section *5.4.2: Petroleum Hydrocarbons* on page 157.

E. coli

E. coli sampling may be conducted in response to unplanned events such as failure and/or overflows from on-site septic-tanks and public wastewater systems (see section *2.3.3: Municipal* Wastewater on page 54 regarding wastewater systems and the risks they present in section *3.1.6: Wastewater Infrastructure* on page 89).

Total Phosphorus and Nitrate-Nitrogen

Total phosphorus and nitrate-nitrogen sampling is conducted in response to unplanned events such as chemical spills, accidents, deforestation, and failure of any of the wastewater systems.

Turbidity

Turbidity sampling is conducted in response to unplanned events such as a storm or fire in the BoMont source water area. Sampling will continue daily until two weeks after the event has subsided. Samples will be obtained from the dominant feeder streams to the Shubenacadie River-inlet points upstream of the BoMont source water supply area.

Chemical Spill or Release

Chemical sampling will be conducted in response to incidents or unplanned events along Highways 102, 118 and 2, on the Old Trunk Road and along the railroad track.

5.4.5 Operational/ Compliance Raw Water Sampling

Operational raw water sampling, which is performed daily at the WSP in order to operate the facility, is the responsibility of the WSP operator. Raw water compliance monitoring is also conducted at the intake and reported back to NSE. Water quality data gathered for one water quality monitoring program (e.g., operational or compliance) may be used to compliment the source water quality program data, and vice versa, when necessary.

5.4.6 Source Water Quality Monitoring Program Summary

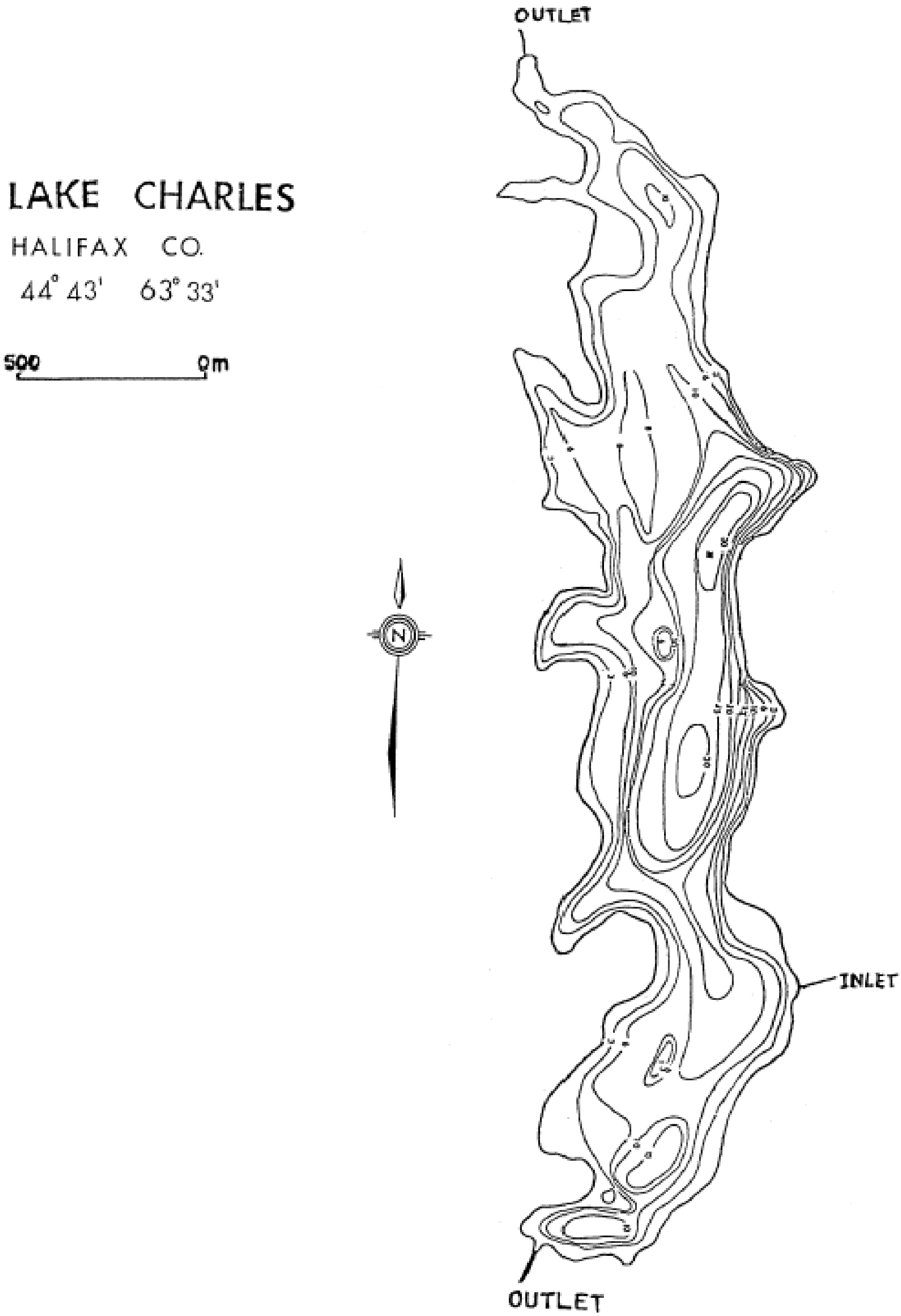
The SWQMP indicates, under baseline conditions, that the water quality in the BoMont watershed area does not always meet the CCME CWQG (see section *5.4.1: Baseline Sampling* beginning on page 139); however, with minimal treatment it meets GCDWQ and therefore provides safe water to BoMont customers. It is strongly recommended that Halifax Water continue to monitor BMG1 through BMG8 as well as CPG1 through CPG6 to provide data that will guide watershed and/or pumping station decision-making; and to continually assess and evaluate the program to ensure water quality needs are being met.

6 Acknowledgements

Halifax Water would like to acknowledge the following agencies and consultants for their professional support in creating the BoMont Water Supply Source Water Protection Plan: East Hants Planning and Development Staff, HRM Planning and Development staff, and Nova Scotia Environment.

Halifax Water would like to thank its diverse staff for its professional support in the Source Water Protection Program, particularly Carl Yates, Reid Campbell, Krista Danylkiw, Lucie Kendell, and Jaclyn Chezenko, Barry Geddes and Anna McCarron. Having people involved who believe in a goal and following it through helps to create a positive learning experience for all those involved in the process.

Appendix 1: Bathymetry of Headwater Lakes in BoMont Watershed Area




LAKE WILLIAM
HALIFAX CO.
44° 46' 63° 35'
1000
0m
N
OUTLET
INLET
INLET
INLET
INLET
INLET
INLET
7
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3
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13
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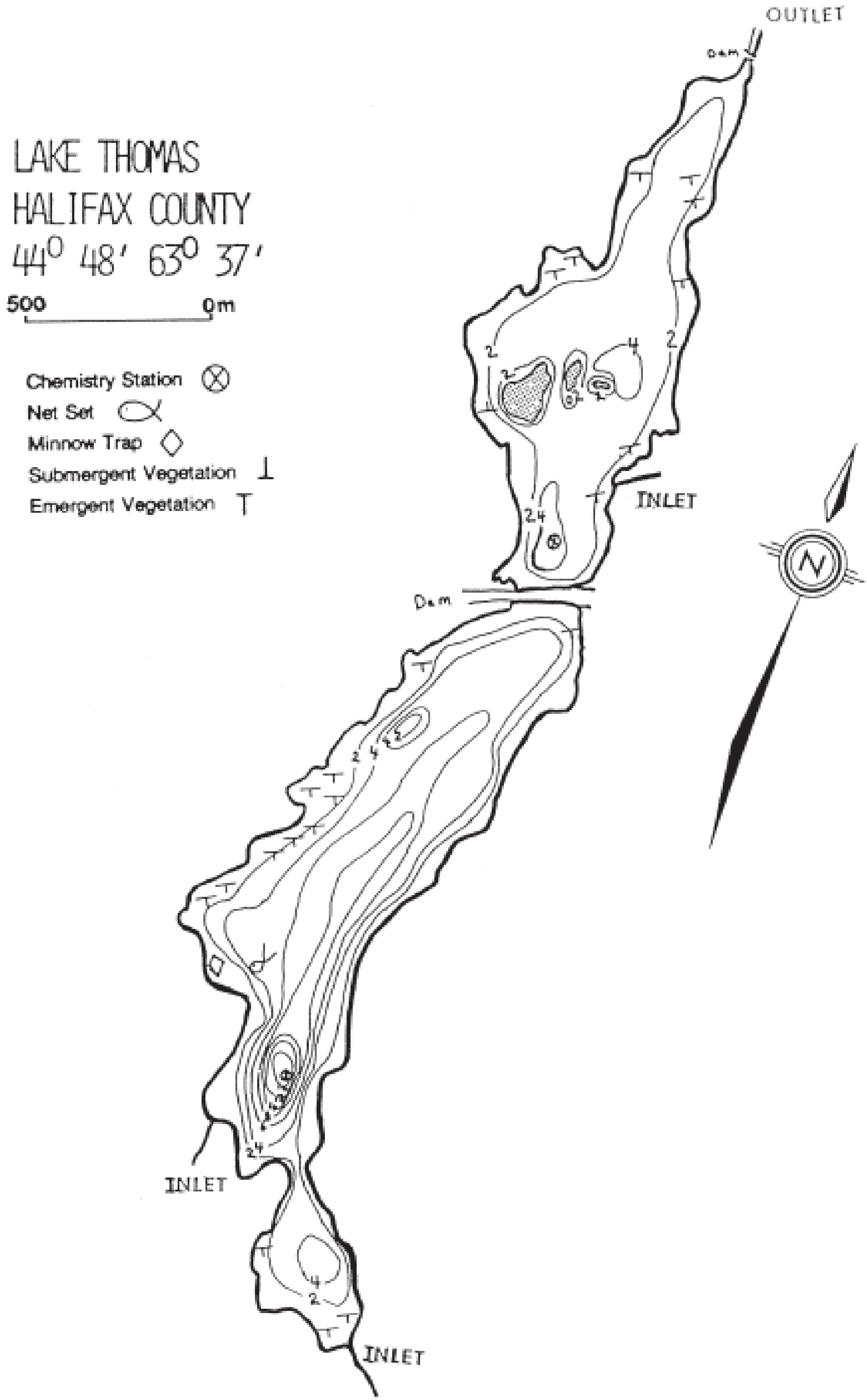

LAKE THOMAS
HALIFAX COUNTY
44° 48′ 63° 37′
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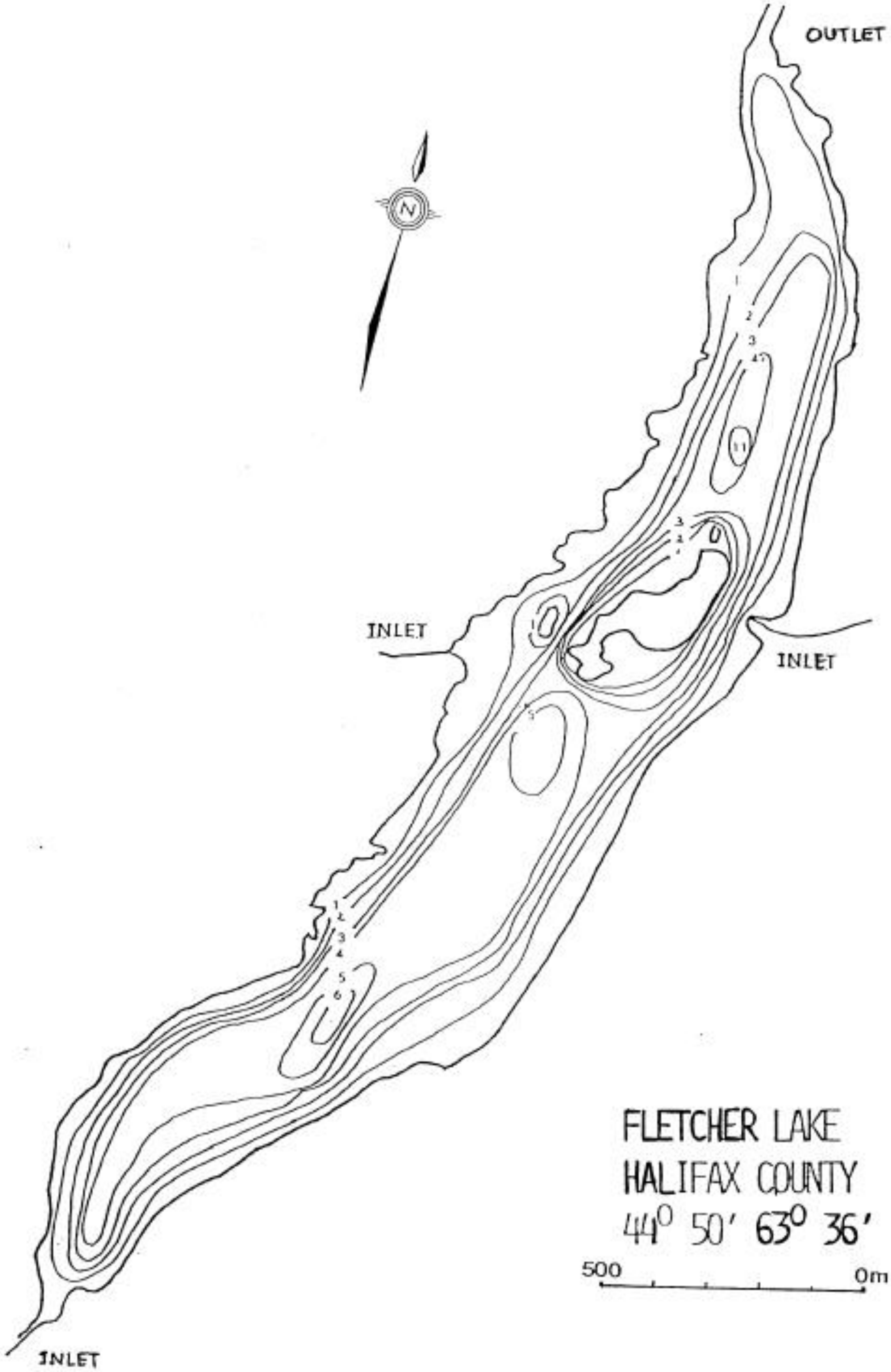
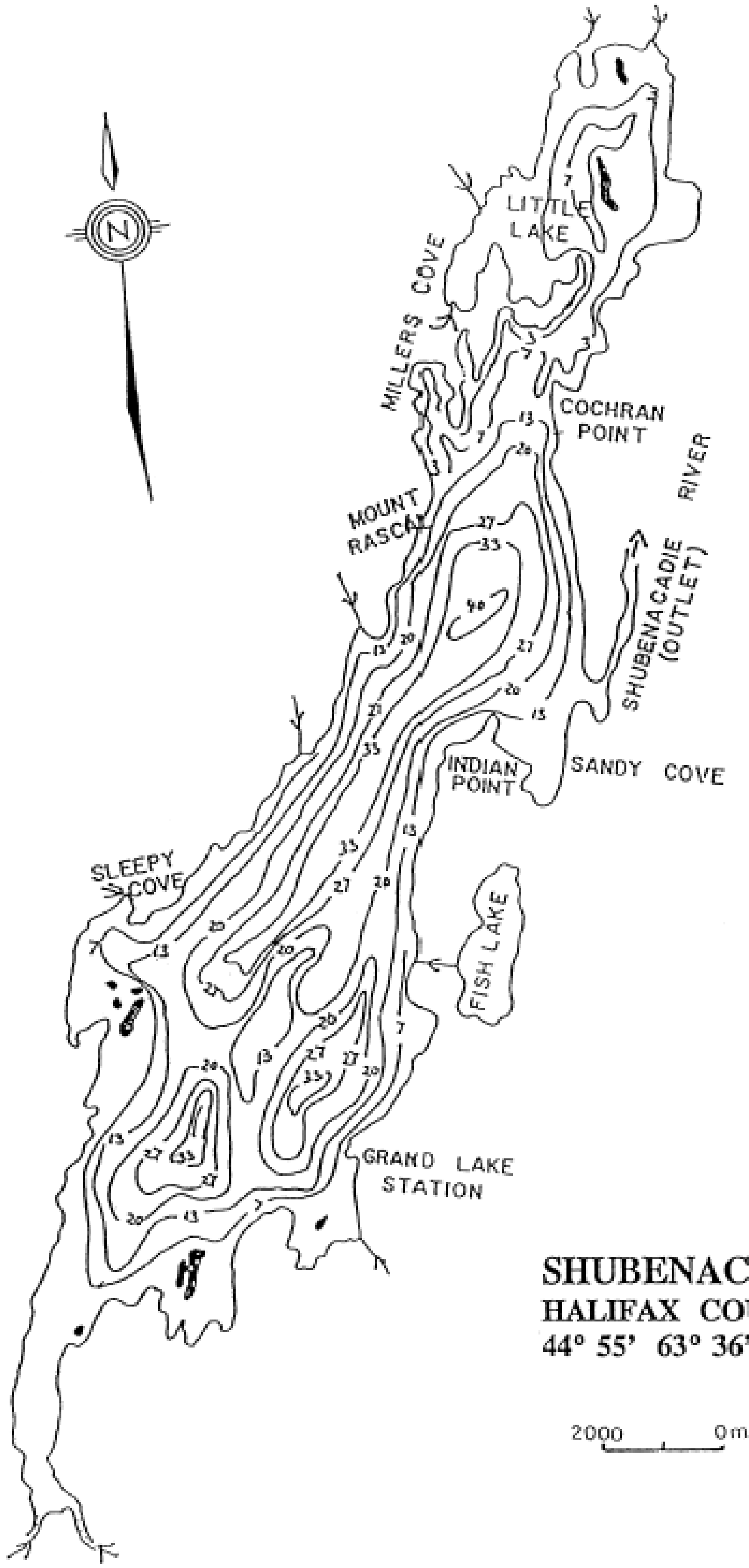
0m
Chemistry Station
Net Set
Minnow Trap
Submergent Vegetation
Emergent Vegetation
OUTLET
Dam
INLET
Dam
INLET
INLET


OUTLET
INLET
INLET
INLET
FLETCHER LAKE
HALIFAX COUNTY
44° 50′ 63° 36′
500
0m



SHUBENACADIE GRAND LAKE
HALIFAX COUNTY
44° 55' 63° 36'

Appendix 2: BoMont Water Sampling Locations, Frequency and Parameters

(See *Map E: Watersheds, Hydrology, Elevation and Sampling Points* on page 43)