

PROFILING REGIONAL WATERSHED MANAGEMENT ON THE NORTHEAST AVALON:

INTEGRATING PRACTICES FOR
DRINKING WATER QUALITY

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Assessing drinking water management in NEA

Profiling Regional Watershed Management on the Northeast Avalon: Integrating Practices for Drinking Water Quality

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Action Program



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Executive Summary and Recommendations

This study investigated watershed management in the Northeast Avalon (NEA) region and six targeted municipalities by 1) mapping watershed boundaries and intactness to inform water and wetland management; and 2) understanding the issues around drinking water in each municipality. Residents, planners, developers and municipal staff were interviewed. Many of the watersheds have experienced significant development resulting in a loss of watershed health; few areas have large intact areas remaining. As larger watersheds are shared among municipalities, it is imperative that a planning platform be developed to engage and promote regional planning to ensure watershed health and sustainable drinking water into the future. Mechanisms that encourage as well as discourage regional collaboration around issues of watershed management are outlined.

Below are the main recommendations found in this study:

- Regional watershed management is key method to deal with the increasing water demands associated with development on the Northeast Avalon. Regional watershed management would be highly relevant: when development in one municipality negatively affects the quality and quantity of drinking water in the neighboring municipality; when one municipality reaches its maximum water capacity and might need to look for alternative water sources from other municipalities; in cases when the costs of developing new water supply systems or improving existing ones are too high for a single municipality. Regional watershed management would require a strong municipal collaboration and a direct, more active involvement of the provincial government. For this large-scale management system to work properly, ownership and responsibility would need to be defined well in advance to avoid tensions and conflicts.
- Planning is a crucial element of land development. However, most municipal staff and developers are not environmentally schooled and may fail to preserve natural landscape within rural communities.
- While larger wetlands can be identified on the 1: 50 000 maps, small wetland cannot, resulting in a considerable underestimate of wetland cover. These smaller wetlands also need to be protected, but are not considered when development permits applications are submitted. The Province should not limit their assessment criteria solely on “mapped” wetlands. There is an urgent need for a regional assessment of wetland status in the Northeast Avalon, to determine rates of loss or degradation, and to identify key wetlands to be preserved for watershed integrity and drinking water security.

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- Many of the areas have low watershed intactness values; therefore the remaining large tracts of land with high watershed intactness within each municipality should be zoned for conservation and watershed protection, in order to safeguard long-term drinking water sustainability
- Regional collaboration requires detailed planning that is part of a municipal long-term vision. However, many municipalities cannot afford to have a permanent planner. A way around this problem might be a regional planner who would work with the smaller communities to advance regional approach.
- We heard many instances in which, even though residents expressed their concerns about the impact of new developments on the drinking water supply, the municipal government dismissed their complaints and approved the new development. This further supports the belief among many residents that the municipal councils are strongly under the influence of developers. More effort and time needs to put into making sure that the voices and opinions of those affected by the decision-making process are heard and taken into account.
- Clear cuts are not necessary for installment of a storm water management system. A storm water management system can be installed within a vegetated lot, but costs of such installment maybe higher compared to a clear cut development.
- Septic tanks, although widely used in rural and peri-urban areas and commonly regarded as an efficient approach for onsite treatment of domestic wastewater, can be a potential source of water pollution. The fact that they are not monitored results in an underestimation of the negative aspects of these systems. We need to improve the design, installation, maintenance, and monitoring of septic tanks to minimize the risk to the water quality, especially in the environmentally sensitive areas. In addition, more efforts should be put towards implementing alternative ways for waste water management.
- Residents should test their well water more regularly.
- Non-governmental organizations (for example, Northeast Avalon ACAP) play an important role in encouraging and influencing regional collaboration. These groups can help create an inclusive style atmosphere where environment and conservation leaders, regional government representatives, residents and development practitioners can network and share ideas for strengthening water management policy. We suggest that NAACAP be approached to hold a public workshop where relevant water management best practices are presented and discussed with key management and development individuals in attendance. Information shared via the workshop would guide current and future sustainable development decisions.

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Acknowledgements

We would like to thank all those who volunteered their time to contribute to this report and gave freely of the ideas and expertise. These include residents, planners, developers and municipal staff of the target municipalities and experts. We would especially like to thank Dr. Kathleen Parewick, and NAACAP staff and board members (especially Phoebe Metcalfe and Jen Daniels), who guided the development of this project, David Mercer (MUN Map Library), and Wei Ren.

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General Introduction and report structure

Drinking water is a basic necessity which most of us take for granted, until it runs out, becomes contaminated, or otherwise becomes inaccessible. Most people in North American cities think little about drinking water – it comes out of a tap, and someone else takes responsibility for ensuring that it is there, and is drinkable. Most people living in rural settings in Newfoundland rely on wells, or small surface water supplies, and are more keenly aware of the potential threats to their water supply (Minnes and Vodden, 2014). As St. John's, and to a lesser extent, the entire Northeast Avalon region undergo rapid urbanization, drinking water access and availability are changing for many of the residents of our region. Actions that one jurisdiction takes regarding water or another aspect of development can easily have downstream impacts on watersheds, drinking water quantity or quality. Such trans-boundary impacts are common where municipal boundaries cut across watershed boundaries, as is common in most parts of Newfoundland. Watershed management often requires regional-scale planning that cuts across several jurisdictions. However, the mechanism to move regional planning ahead is lacking. Regional planning in the Northeast Avalon region of Newfoundland has a long, but not very successful, history (<http://www.cbc.ca/news/canada/newfoundland-labrador/mayors-province-reviving-northeast-avalon-regional-plan-1.2445680>). Within the Northeast Avalon region, several community groups have addressed water issues; for example, watershed management has been a key focus for the Northeast Avalon Atlantic Canada Action Program (NAACAP), for the past 5+ years.

This report presents the results of a community-university study on watershed management and drinking water carried out by the University researchers and students, NAACAP staff, and geographic professionals in 2012 - 2014. The study was funded by the Leslie Harris Centre of Regional Policy and Development, through the Harris Centre RBC Drinking water research and outreach fund.

Project Goals

This study examines watersheds and drinking water in the Northeast Avalon region from both physical and human geographic perspectives:

- 1) A physical geographical component examines watersheds, land cover, land cover change, and intactness of the landscape throughout the northeast Avalon region. A key aim of the physical geographic analyses is to identify the most intact areas, which are most likely to be able to provide water, and other ecosystem services, and therefore require highest priority for preservation from rapid development.
- 2) A parallel human geographic component of the study examines the views of area residents and municipal authorities about watersheds and drinking water in several of the smaller municipalities of the Northeast Avalon region. We also sought the

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opinions of water resource professionals and professional planners who are familiar with the Northeast Avalon region, but who are not employed by local or provincial agencies. The social science aspects of the study used maps of each of the municipalities studied to identify areas of critical concern, either due to rapid development, or areas that were identified as highly important to set aside from development. We also examine provincial and local policies regarding watershed management and drinking water, to identify key potential gaps in ensuring secure access to high quality drinking water to all residents of the Northeast Avalon region. Although the Northeast Avalon region comprises 15 municipalities, this report focuses on six municipalities found north of St. Johns: Bauline, Flatrock, Logy Bay – Middle Cove – Outer Cove, Portugal Cove – St Philips, Pouch Cove, and Torbay. These six communities have varying characteristics with regards to degree of urbanization, and varying approaches to delivery of drinking water to their residents.

Report structure

This report is divided into two sections:

Section 1 – Watershed mapping: documents the GIS and Remote Sensing methods used to map watersheds and land cover throughout the Northeast Avalon region;

Section 2 - Presents the views of area residents, municipal officials, and water resource and planning professionals about watershed management, development, and drinking water issues in the Northeast Avalon region, as gathered through a series of in-depth interviews. Interviews were conducted under ICEHR permit 20130367-AR.

Conclusions and Recommendations are presented on pages 68 - 70.

In addition to this report, the HC project supported the Masters of Environmental Science research of Mr. Wei Ren. His study analyzed watersheds in the Torbay and Logy Bay – Middle Cove – Outer Cove municipalities, emphasizing land use changes in one target area in the watershed of each municipality, based on sequential air photograph analysis. Mr. Ren's MES project report is available upon request, and is archived at the MUN QE II library.

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Section 1: Watershed mapping for the Northeast Avalon region.

**Randal Greene and Rafael Fernandez, Feavers Lane, Inc.,
St. John's**

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Introduction

The overall objective of the GIS work was to improve on existing freely- and publicly-available data by compiling, cleaning and analyzing relatively inexpensive or free imagery, elevation and hydrology data to derive watershed boundaries, land cover and landscape intactness at the highest possible resolution (i.e. best possible scale). **The compiled data and analysis outputs can be used to inform water and wetland management, environmental assessment, and other land-use planning activities at regional and municipal scales.**

Key Datasets used in this study

Dataset	Description	Source
Study Area	vector polygon indicating extent of data	This project
Provincial Aerial Imagery	50cm raster; flown 2008	Crown Lands Division
Provincial Vector Data	water lines, break lines, spot heights	Crown Lands Division
Provincial Protected Water Supply Boundaries	obtained from NAACAP	Water Resources Division
Provincial Protected Water Supply Intakes	obtained from NAACAP	Water Resources Division
Provincial Municipal Boundaries	obtained from NAACAP	Municipal and Intergovernmental Affairs (Crown Lands)
Wetland Delineations	based on fieldwork	NAACAP
Various not used directly	pipelines, wellheads, culverts, ditches, coarse watersheds, water quality studies, various Glencrest project layers;	MUN Map Library, NAACAP
Roads	vector lines;	NAACAP
Water	vector lines and polygons, different than Canvec and National Hydro Network;	NAACAP
Canvec	1:50,000 building points, building polygons, residential areas, transmission lines, watercourses, waterbodies; not updated to reflect recent changes	Natural Resources Canada (Geogratis)

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National Road Network	roads of various classes; not updated to reflect recent changes	Natural Resources Canada (Geobase)
National Hydro Network	hydrology, including stream flow and direction	Natural Resources Canada (Geobase)
Spot Satellite Imagery	10/20m 4-band raster; flown 2007; scene 4731 (excludes small strips at top and bottom of study area)	Natural Resources Canada (Geobase)
Waterbodies	vector polygons; derived from provincial vector data	This project; see description below
Watercourses	vector lines; derived from provincial vector data	This project; see description below
Digital Elevation Model	10m raster; derived from provincial vector data	This project; see description below
Catchments, Watersheds, East-West Drainage	vector lines; derived primarily from provincial vector data	This project; see description below
Land Cover	10m raster; derived primarily from Spot satellite imagery, but informed by other datasets	This project; see description below
Intactness	10m raster; derived from land cover	This project; see description below

Geoprocessing and Analyses

Study Area

An area that includes all the municipalities of the Northeast Avalon, from Holyrood to Witless Bay and north.

Provincial Imagery

Aerial imagery flown in 2008 procured from Crown Lands Division in 10km x 10km tiles and mosaicked into a single raster that covers the study area.

Provincial Vector Data (included with imagery)

The Provincial Imagery raster data includes additional vector layers for each tile:

- Spot heights indicating the elevation at a series of points on a semi-regular grid with 50m spacing.
- Break lines indicating the elevation along ridges and valleys, useful to inform creation of a digital elevation surface.
- Water lines of the following types:
 - Shore lines of waterbodies, including watercourses that are appropriate to depict as polygons at scales up to approximately 1:5000.

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- Streams are appropriate to depict as lines at scales down to approximately 1:5000.

Waterbodies and Watercourses (from provincial vector data)

Creation of waterbodies from water lines required the following steps:

- Merging of all water lines that represent the edges of waterbodies from all tiles in the study area.
- Line to polygon conversion of all waterbody lines.
- Extensive manual processing of the results of the previous step to identify and close unclosed polygons, and repeat the line to polygon conversion.
- Cutting “donut” holes in waterbodies for islands.
- Manual digitization of missing waterbody polygons based on the underlying imagery.
- Reporting of issues to the data provider, in the hopes that it will be improved for future releases.

Creation of watercourses required merging of all water lines that represent streams from all tiles in the study area.

Digital Elevation Model (from provincial vector data)

Provincial vector data were created using standard photogrammetry processes. Knowing that, the creation of a digital elevation model (DEM) from provincial vector data required the following steps:

- Merging of all tiles in the study area.
- Getting Z coordinates for each vertex in streams.
- Creating a triangulated irregular network (TIN) from spot heights, shore line, streams and break lines.
- Performing quality control, particularly removing peaks and false valleys.
- Creating a raster file (TIF format) from the TIN. The resolution of the DEM raster Grid is 10 m in the X and Y dimensions and 2.5m in the Z dimension, where the pixel value is the Z value (elevation).

Catchments and Watersheds

Watersheds are nested at many scales, from large ocean drainage areas down to catchments for individual stream segments. The basic concept, regardless of scale, is depicted at

http://resources.arcgis.com/en/help/main/10.1/index.html#/Understanding_drainage_systems/009z0000005m000000/

Using the digital elevation model as the primary input, this project derived watersheds at three scales relevant for management on the Northeast Avalon:

- Catchments at the scale of small to medium-sized ponds and their associated streams.
- Aggregation of catchments into watersheds based on ocean pour points, including major rivers and smaller coastal watersheds (such as those that occur in areas of

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steep coastal cliffs).

- Delineation of watersheds into east (flowing toward the open Atlantic Ocean) and west (flowing toward Conception Bay) drainage.

Geoprocessing was based on the ArcGIS Hydrology tools that are a component of Spatial Analyst, and which are overviewed at

<http://resources.arcgis.com/en/help/main/10.1/index.html#//009z0000005z000000>.

The following steps from this document were followed:

- The DEM described above was used as the primary input.
- A Flow Direction raster was generated from the DEM
- Sinks were eliminated to ensure water does not, according to the model, gather in undrained basins.
- A Flow Accumulation raster was generated.
- The Watershed tool was successively tried with various cutoffs to generate catchments at the desired scale, as described above.
- The Catchment output was manually checked and adjusted where necessary, based on available hydrology data from federal, provincial and NAACAP sources, as well as local knowledge.
- Catchments were manually aggregated into Watersheds based on ocean pour points, using a process similar to that described in the previous bullet, and major Watersheds labelled according to its primary river and/or waterbody.
- Watersheds were manually aggregated into East and West Drainage.

Land Cover

The primary input for creating a NAACAP Land Cover dataset was Spot5 scene 4731 (August 13, 2007), downloaded from GeoBase. A number of other potential options, include Provincial aerial imagery and Landsat satellite imagery, were investigated. Spot was chosen because it has a sufficient number of bands (four) to allow a reasonably good supervised classification of a reasonable set of classes, while resulting in 10m resolution output. One downside of the freely available Spot imagery is that adjacent scenes are from different points in time, and therefore cannot be mosaicked to cover the entire study area. Fortunately, a single scene covering all but the extreme southern and northern sections of the study area was freely available. After substantial investigation, trial and error, the following final set of classes was chosen:

- Barrens / Bare Rock – areas with limited, if any, naturally-occurring vegetation.
- Developed – areas with built structures, substantial pavement/asphalt and limited, if any, vegetation.
- Farms and Greenspace – areas of low, generally grassy vegetation, such as farms, sports fields, municipal parks and open green space.
- Forest – areas of medium- to high-density tree cover.
- Other Veg / Heath – areas predominantly covered with shrubs, bushes and other low- to medium-sized flora.

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- Water – areas under water for most of the year.
- Wetlands – land areas that are predominantly saturated with water.

Reliably differentiating among these classes is challenging for a number reasons:

- Ground-truthing (comparing results to known land cover) was limited to existing local knowledge of the project team.
- Datasets used to derive and compare the results are somewhat outdated, and from different seasons and timeframes. For instance, the provincial aerial imagery is from 2008 and the Spot satellite imagery is from 2007.
- A larger number of image than provided by Spot is generally preferable when undertaking remote sensing work, to allow better differentiation of certain classes.
- There was limited time and budget to perform the supervised classification work.

A stepwise procedure was used to derive the final land cover classes, in order to incorporate information from other datasets and to improve overall classification effectiveness. For instance, supervised classification is often more effective when detecting simple differences (e.g. wetland or not). The following (simplified) steps were used:

- Pan Sharpen Spot 20m imagery band using Simple Mean algorithm to create 4-band 10m raster.
- Create Study Area mask from land area of Watersheds (derived primarily from Provincial 50cm imagery).
- Identify Water from:
 - Provincial waterbodies and streams (derived primarily from Provincial 50cm imagery).
 - NAACAP and Canvec waterbodies, waterways, named rivers, streams.
- Identify Developed first Cut from:
 - NAACAP and NRN Major Roads with 50m buffer.
 - NAACAP and NRN Other Roads with 25m buffer.
 - Canvec Transmission Lines with 25m buffer.
 - Canvec Building Points with 10m buffer.
 - Canvec Building Polygons with 10m buffer.
- Create mask of Study Area without Water.
- Perform maximum likelihood supervised classification of Spot imagery using mask of Study Area without Water and the following classes:
 - Forest
 - Farms and Greenspace
 - Other Veg / Heath OR Wetlands
 - Exposed (Developed OR Barrens / Bare Rock)
- Create mask of Study Area with Other Veg / Heath OR Wetlands only.
- Perform maximum likelihood supervised classification of Spot imagery using mask of Study Area with Other Veg / Heath OR Wetlands only and the following classes:

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- Other Veg / Heath
- Wetlands
- Use Provincial 50cm imagery to visually differentiate Exposed outside of Developed 1st Cut into the following classes:
 - Barrens / Bare Rock
 - Developed

Intactness

Given time, data and budget constraints, it was decided to not pursue a Human Footprint analysis with a detailed 10-level scoring scheme, but instead use a three-level High/Medium/Low measure of Intactness. These help capture areas of highest conservation value and the basis for recommending valuable watershed areas to be shielded from development to ensure high quality, sustainable drinking water. Using Land Cover as the input, Developed and Farms/Greenspace were assigned a Low rating. Then Developed Areas and Farms/Greenspace were buffered by 100m, and those buffered areas assigned a Medium rating. The remaining areas all have a High rating. The table below summarizes the Land Cover classes. In addition to showing the Intactness, it also shows ratings of Carbon Storage and Storm Water Retention, as determined in discussion with the project team and NAACAP staff and board members. These additional categories are useful for various planning and environmental impact assessment purposes.

Land Cover Class	Carbon Storage	Storm Water Retention	Intactness
Barrens / Bare Rock	L	L	M-H
Developed	L	L	L
Farms and Greenspace	L-M	M	L
Forest	H	H	M-H
Other Veg / Heath	M-H	M-H	M-H
Water	M	H	M-H
Wetlands	H	H	M-H

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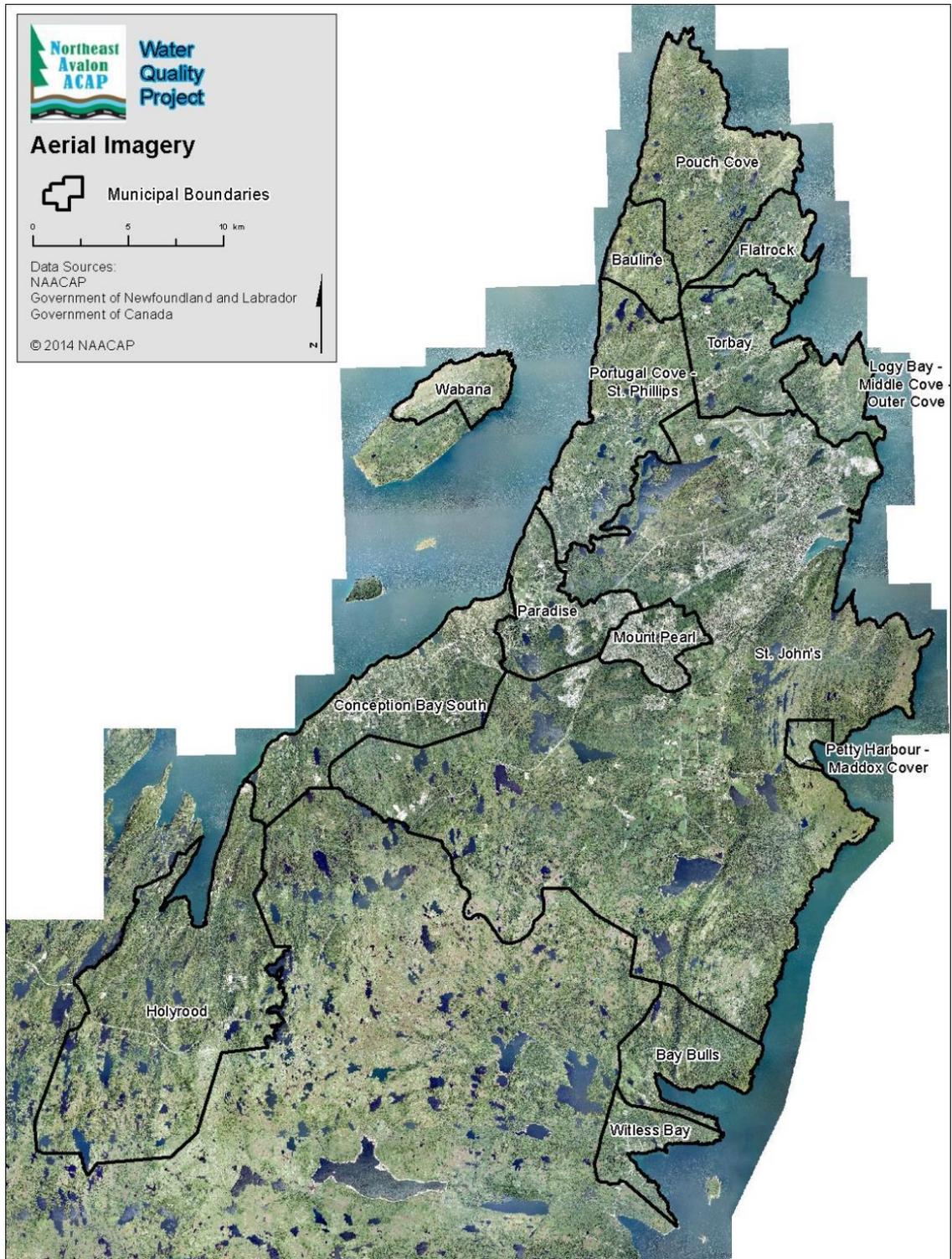
Mapping

The following maps (pages 15 - 37) were generated from the datasets described using ArcMap 10.1 software. Note that high-resolution versions of these maps are available to support high-quality printing.

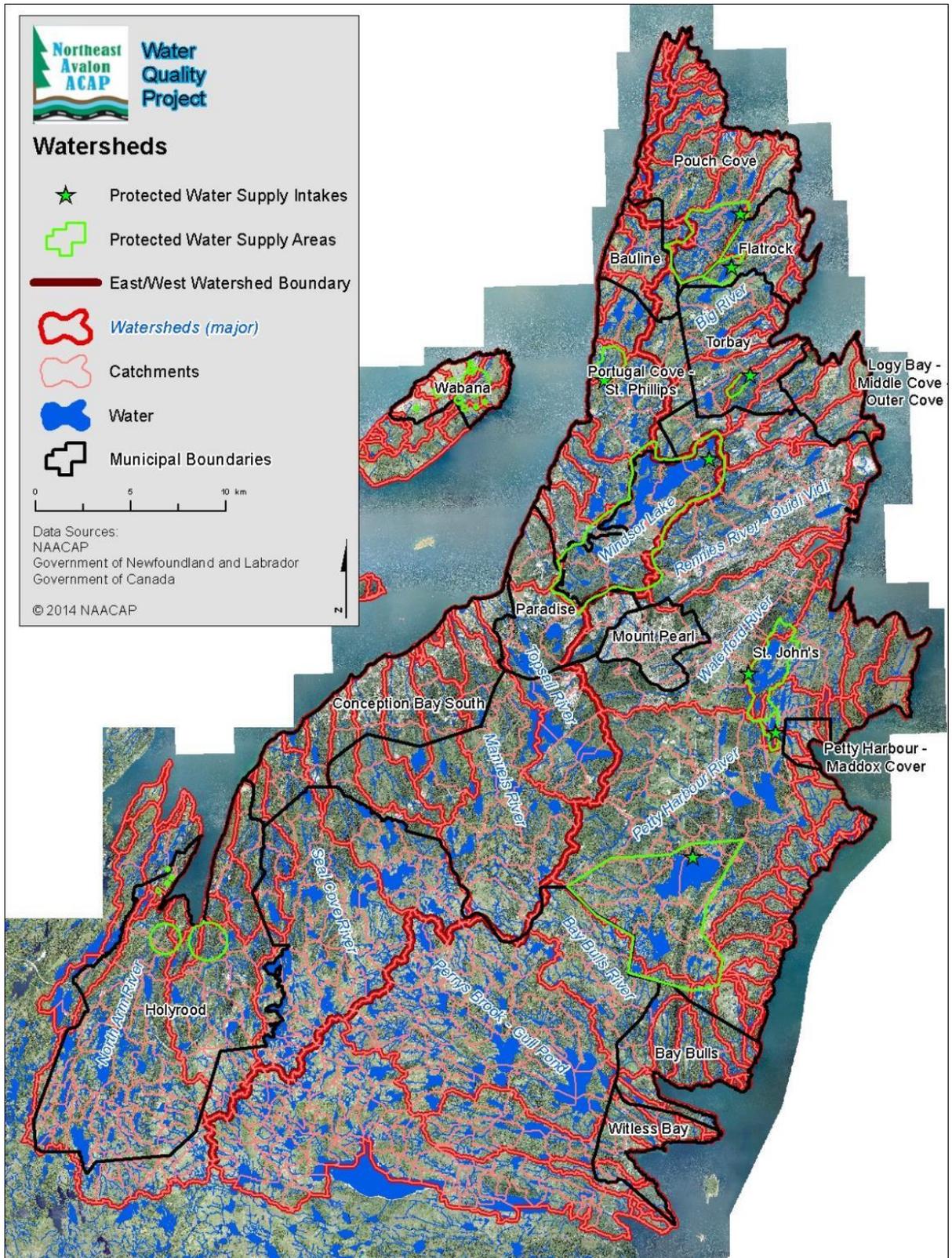
List of maps:

1. Aerial Imagery mosaic
2. Elevation
3. Northeast Avalon catchments and watersheds
 - Logy Bay – Middle Cove – Outer Cove
 - Torbay
 - Flatrock
 - Pouch Cove
 - Bauline
 - Portugal Cove – St. Philips
4. Northeast Avalon Land cover classifications
 - Logy Bay – Middle Cove – Outer Cove
 - Torbay
 - Flatrock
 - Pouch Cove
 - Bauline
 - Portugal Cove – St. Philips
5. Northeast Avalon Landscape and watershed intactness
 - Logy Bay– Middle Cove – Outer Cove
 - Torbay
 - Flatrock
 - Pouch Cove
 - Bauline
 - Portugal Cove – St. Philips

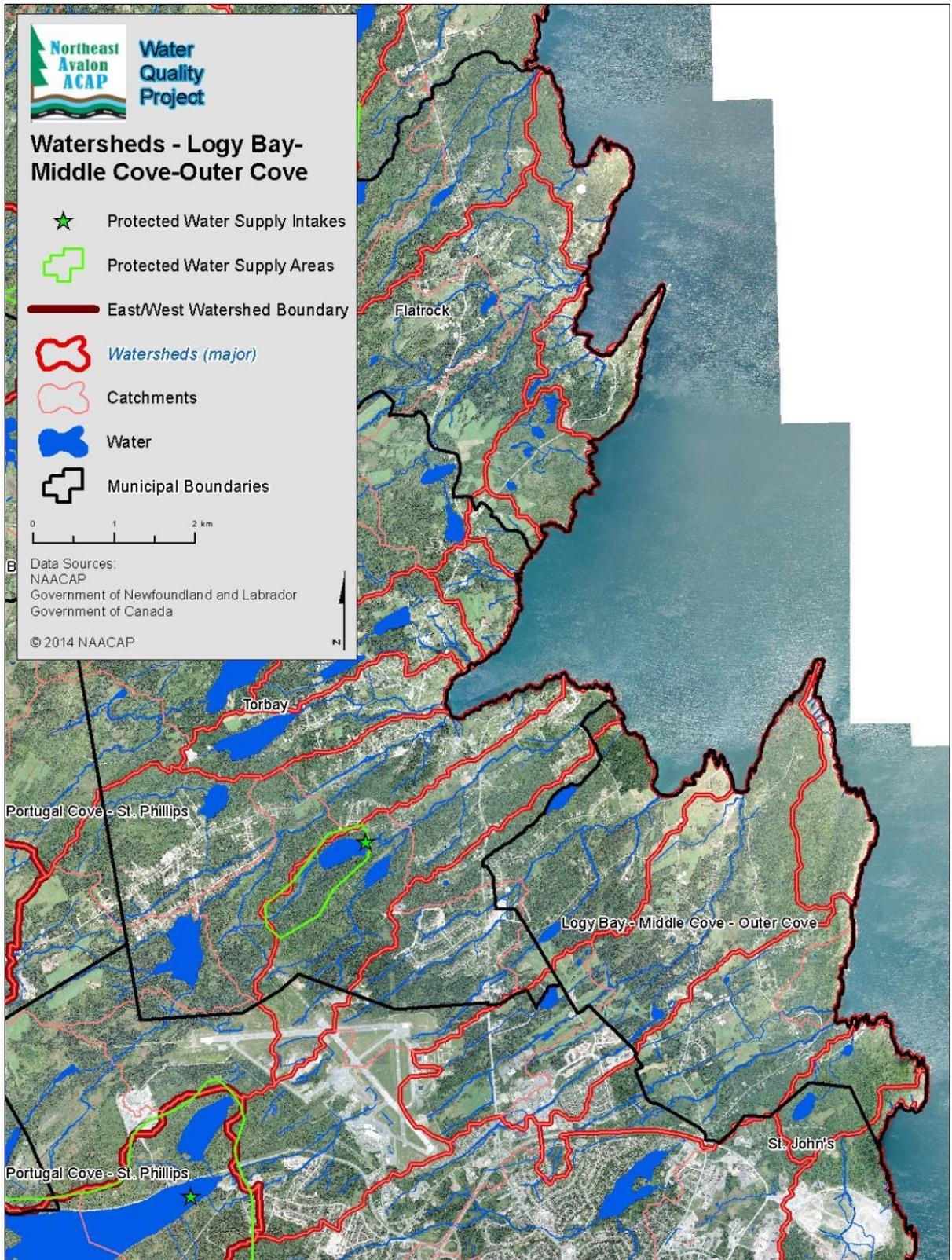
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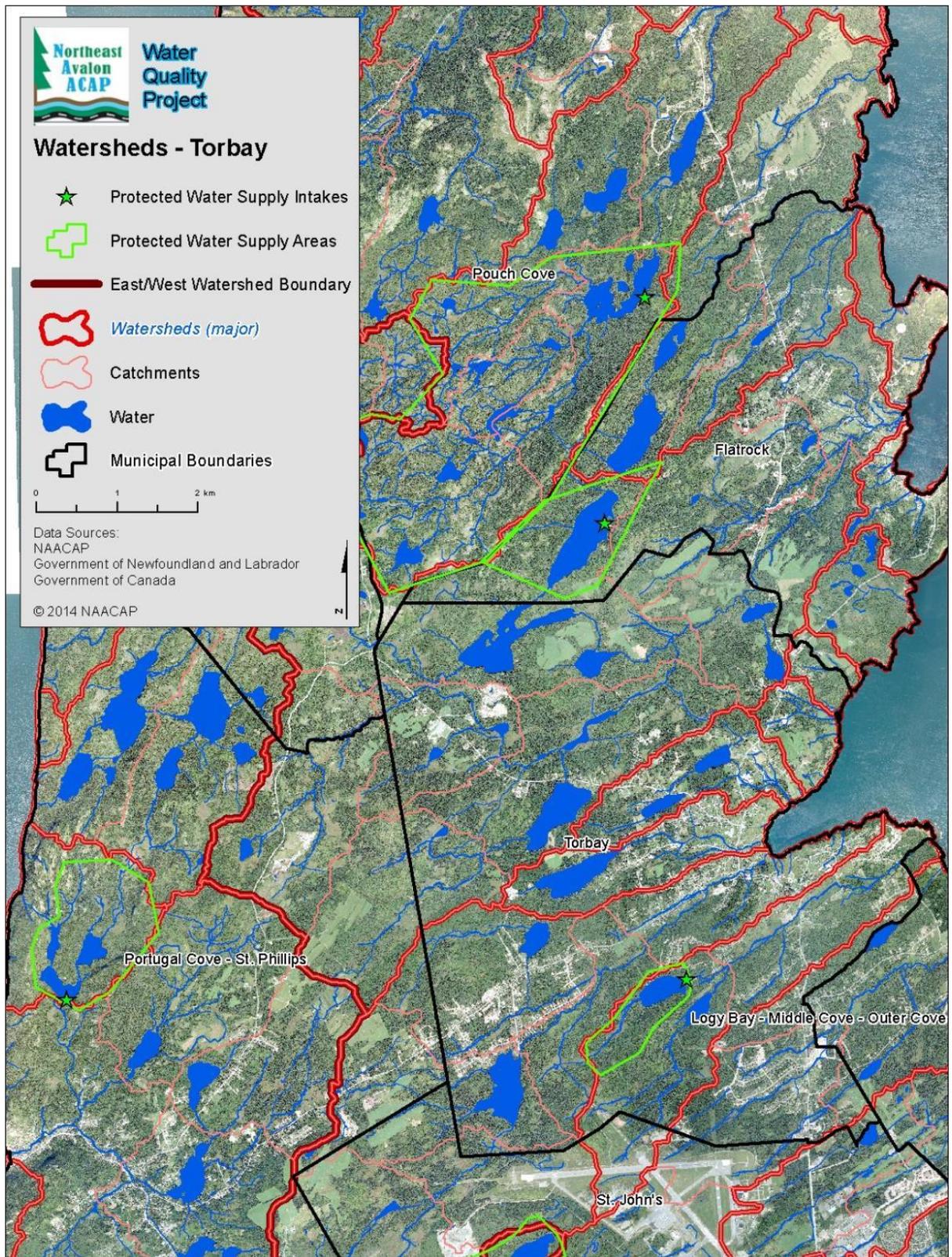
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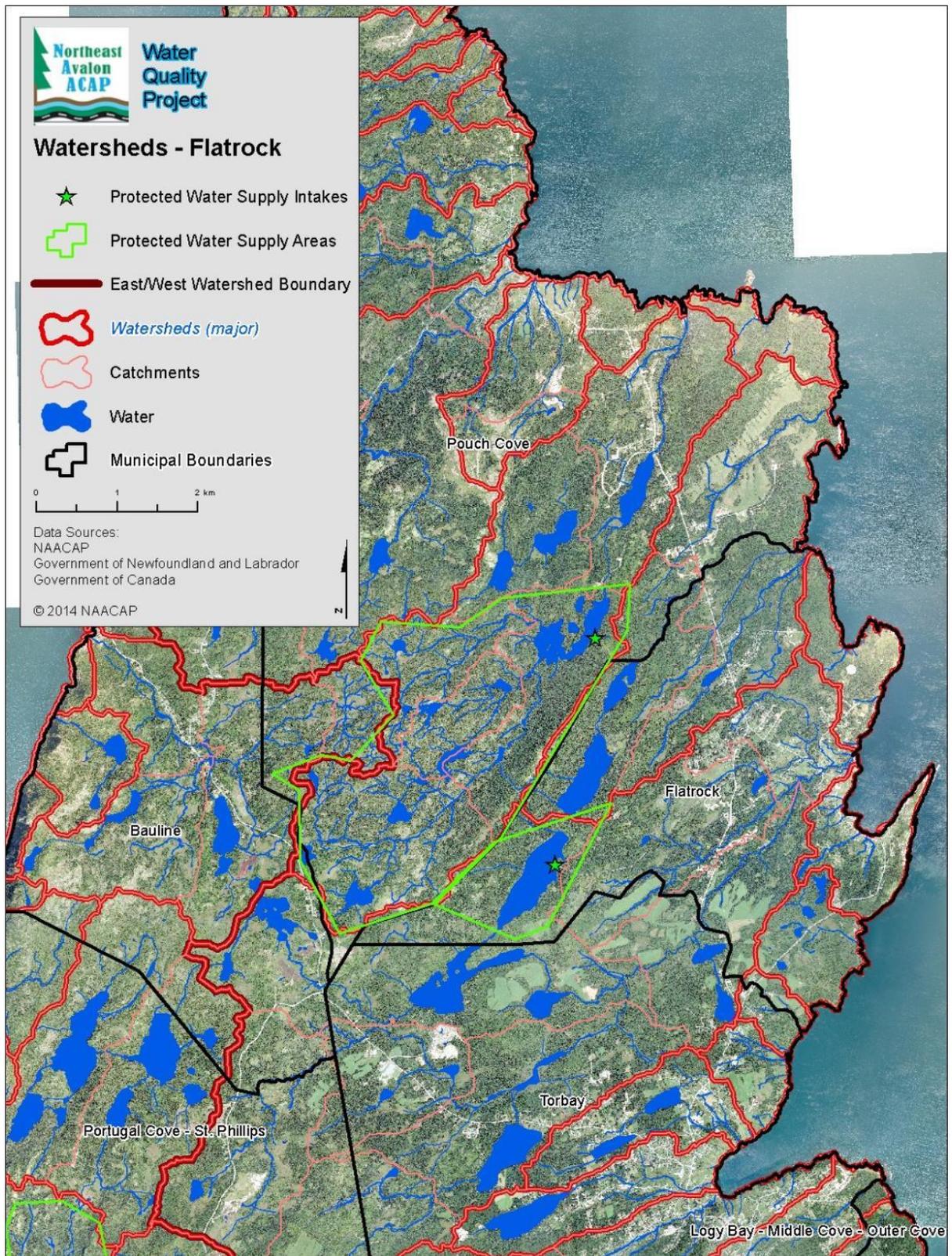
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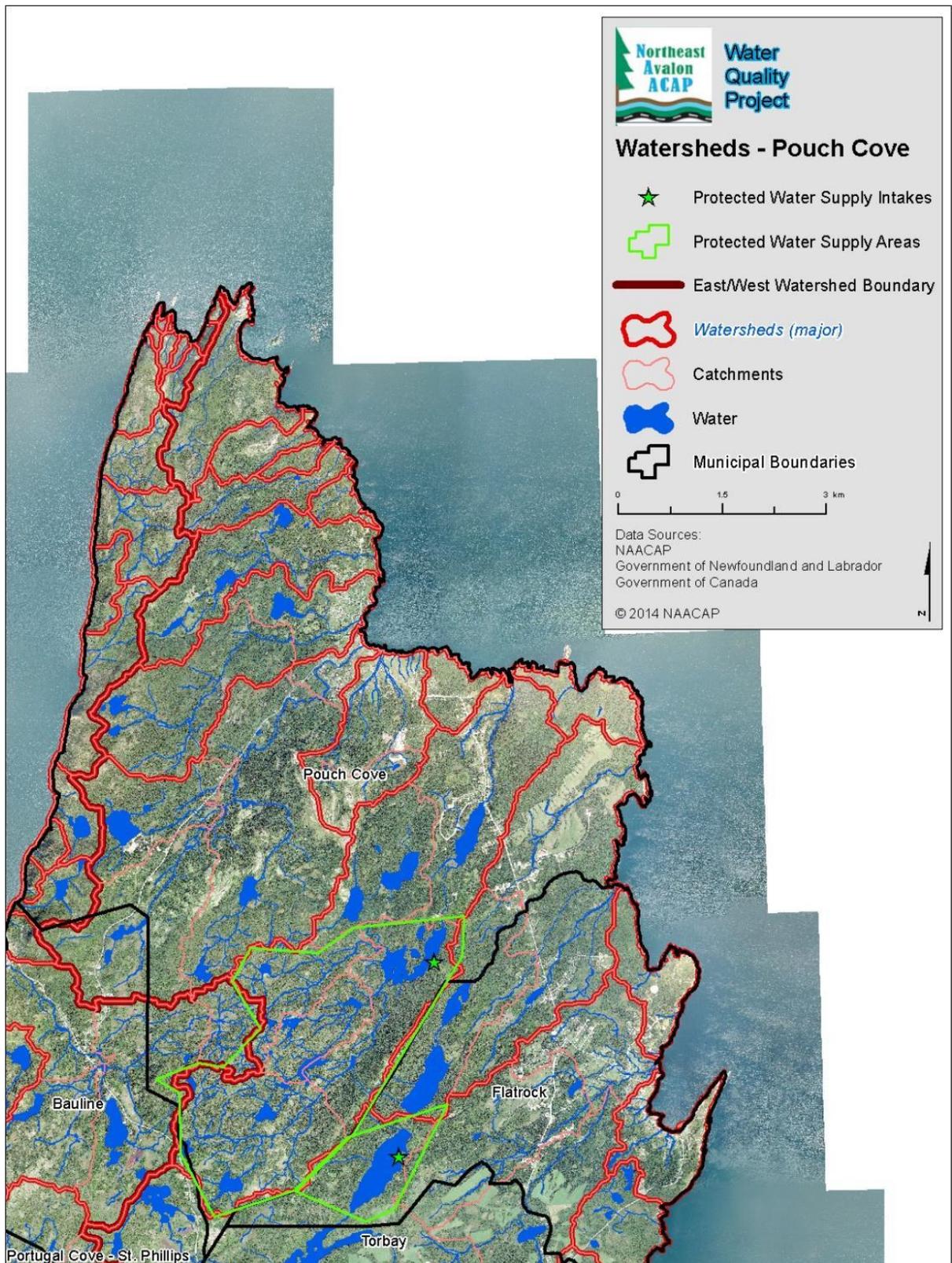
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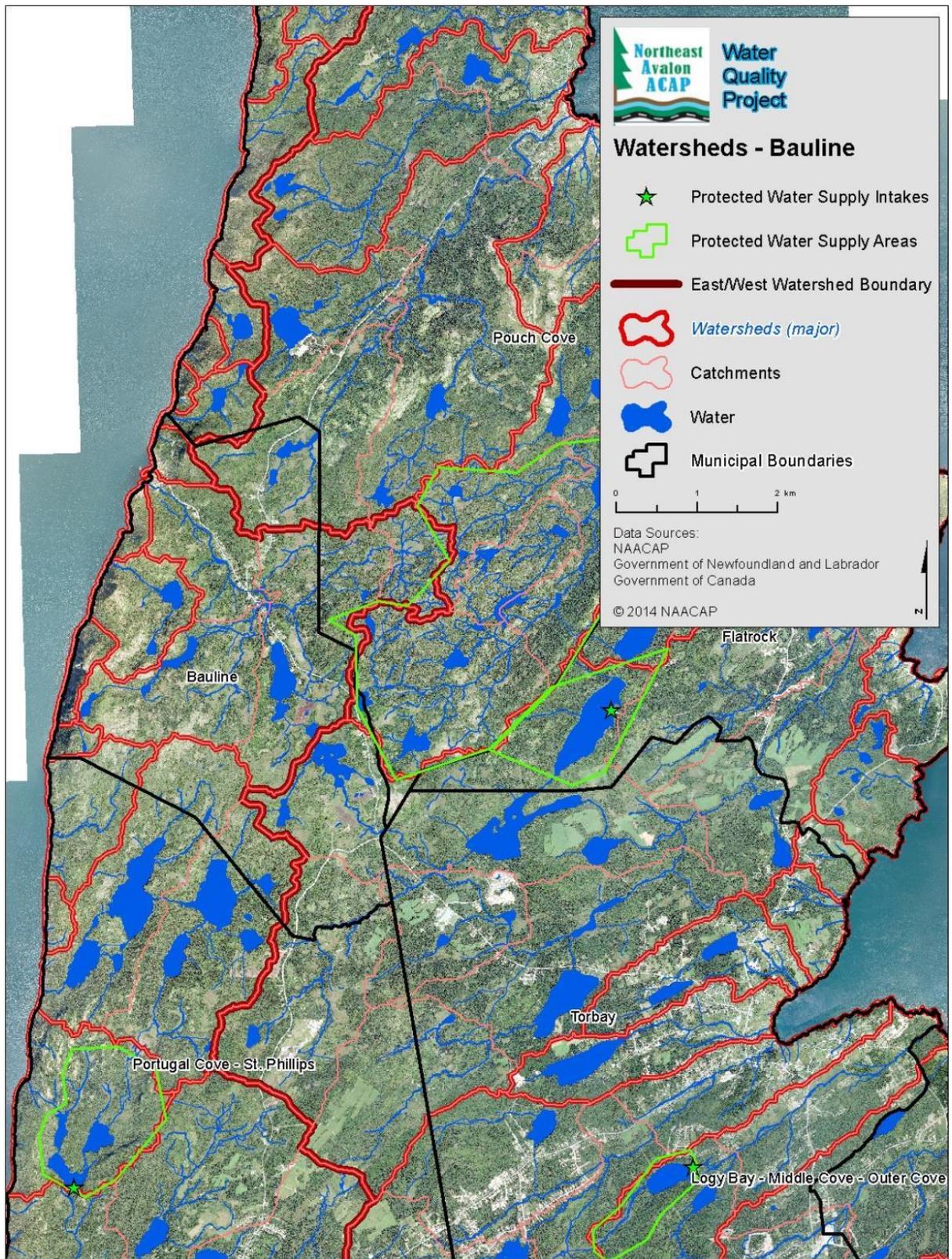
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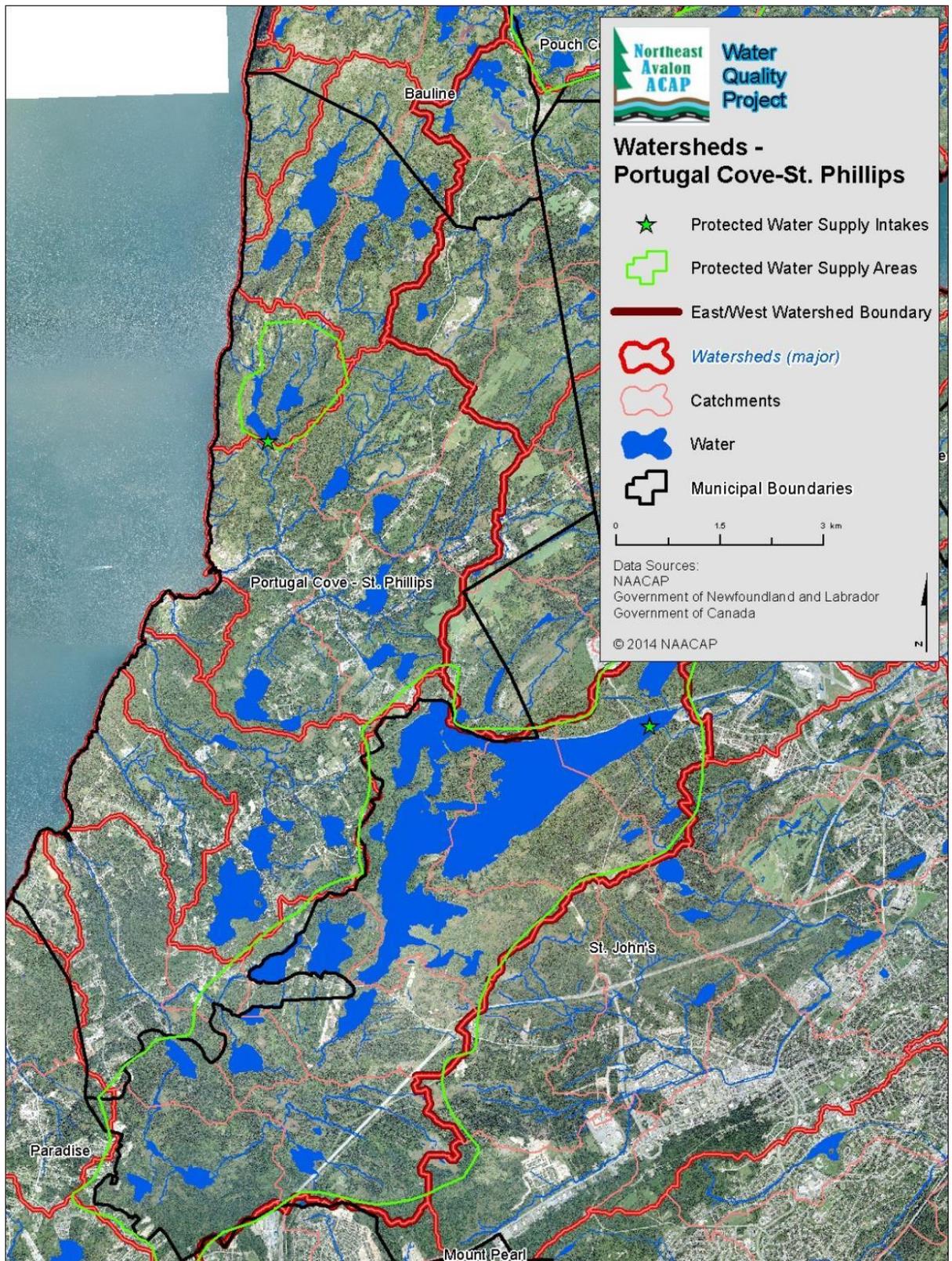
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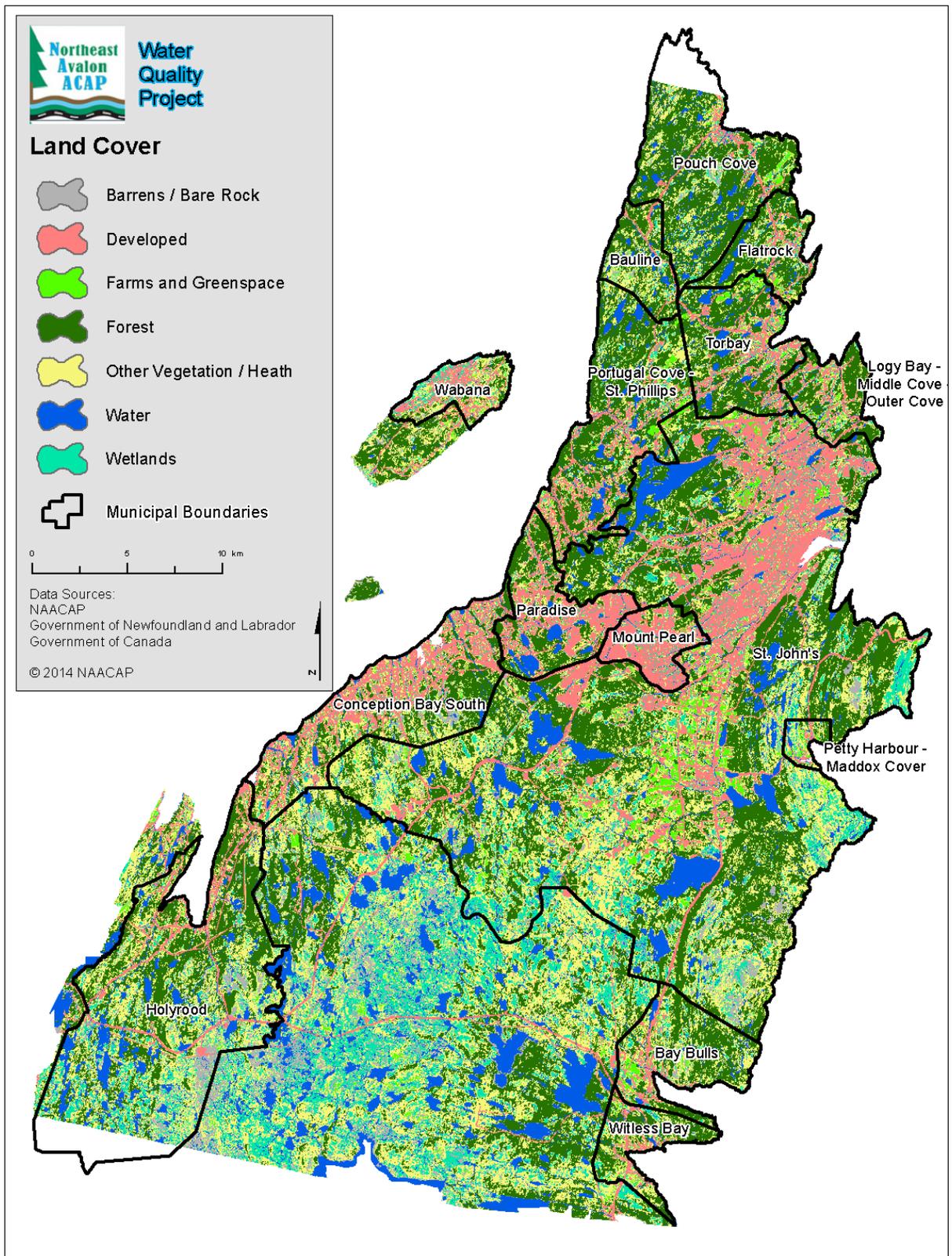
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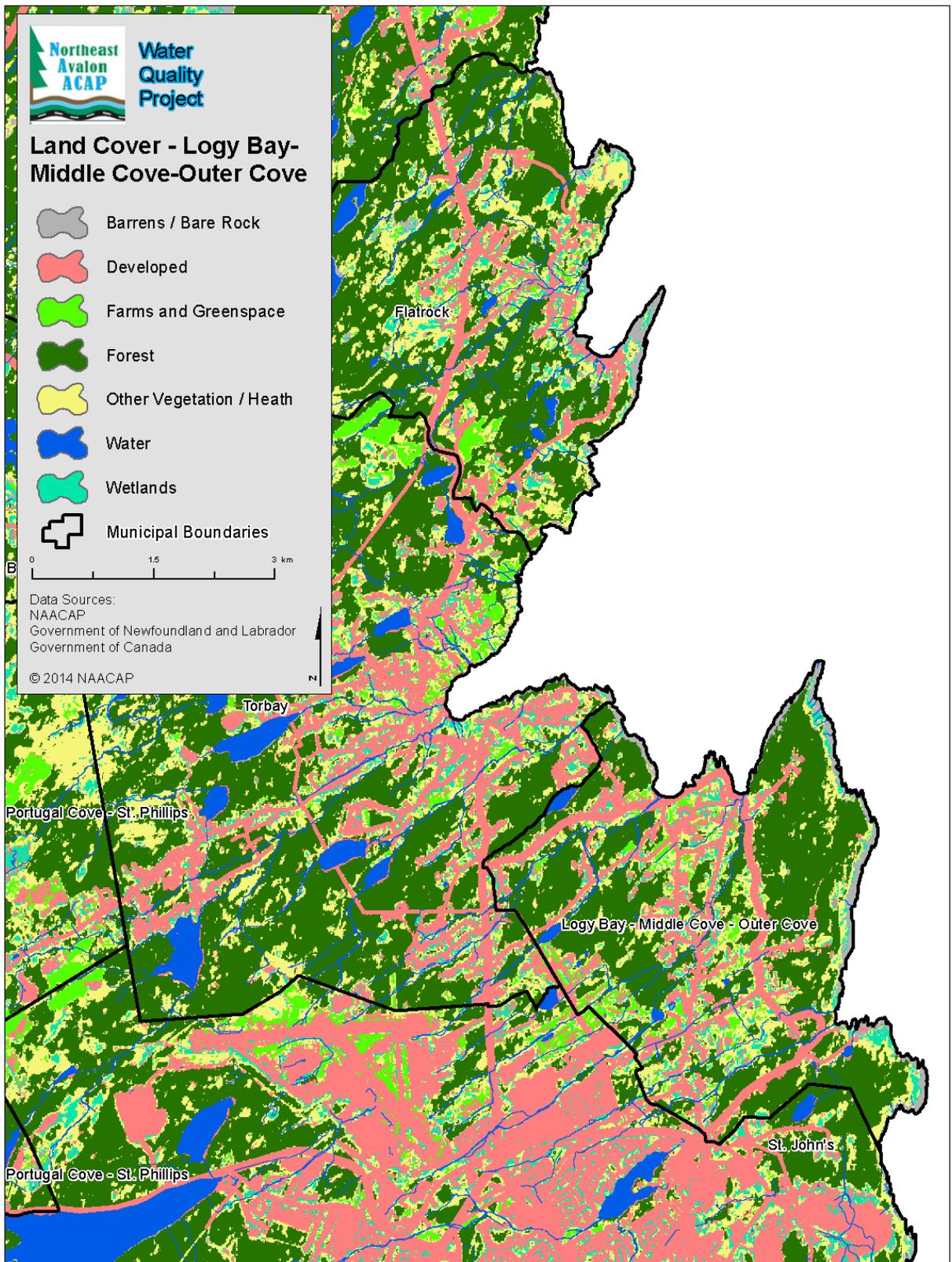
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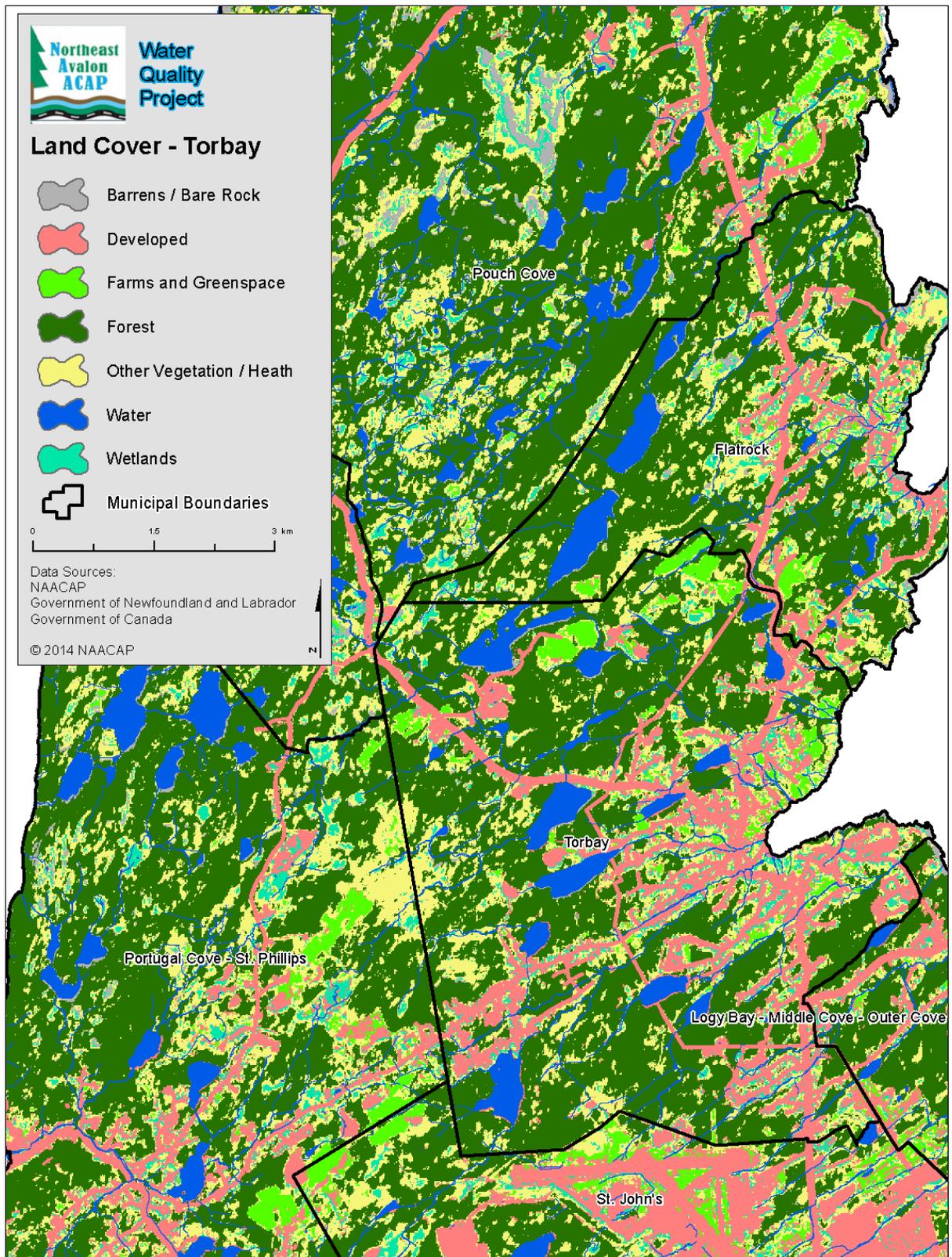
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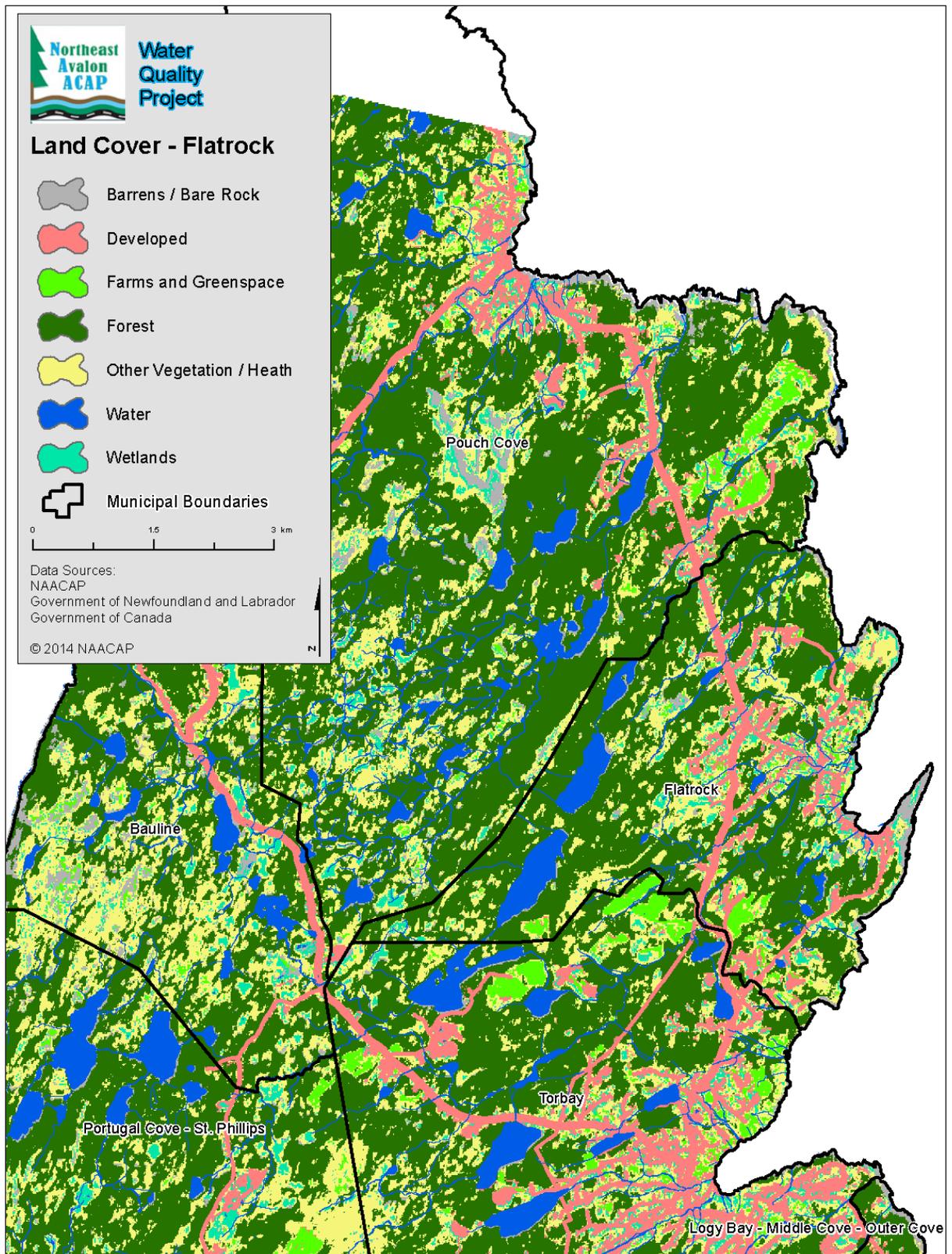
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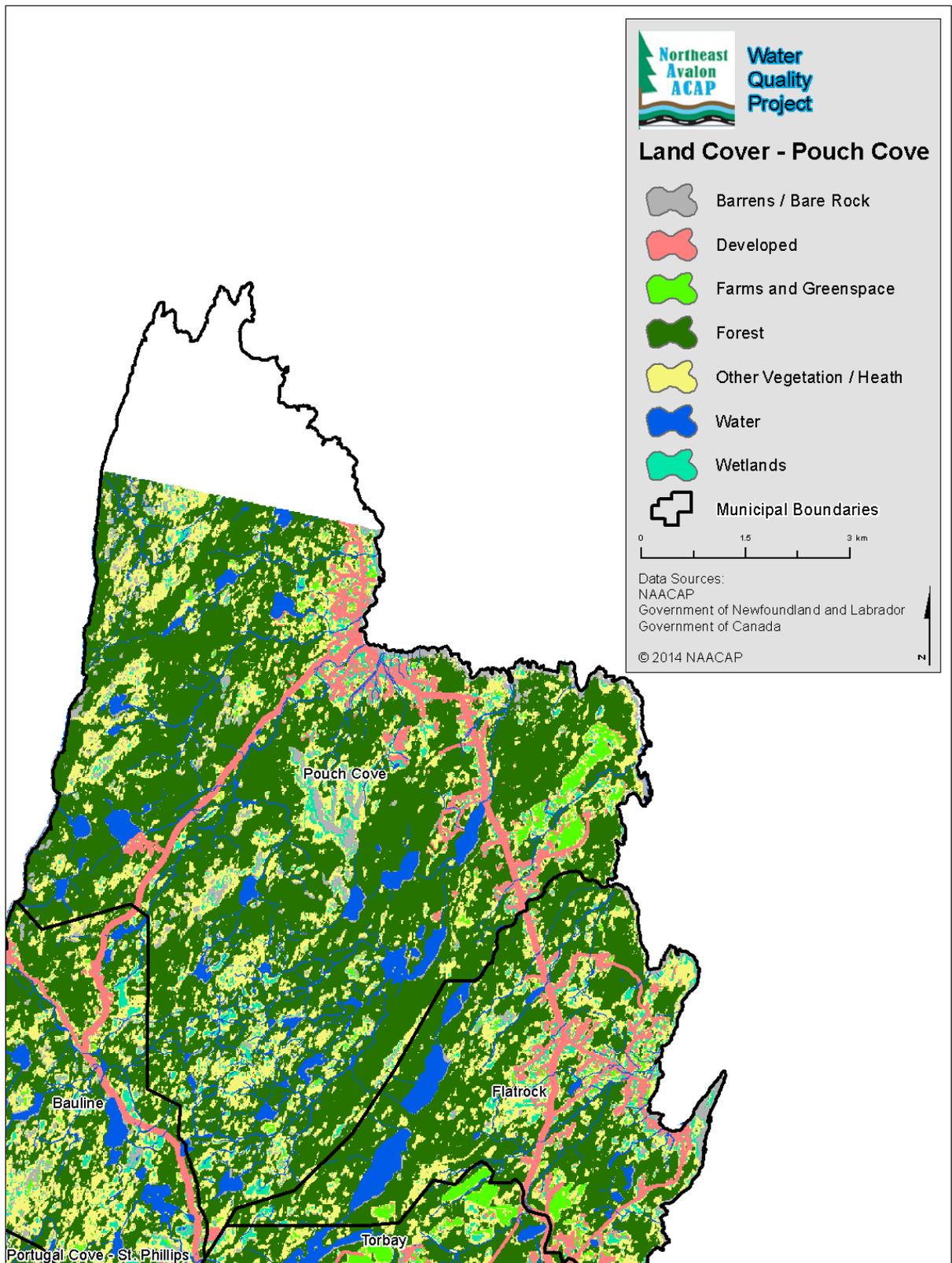
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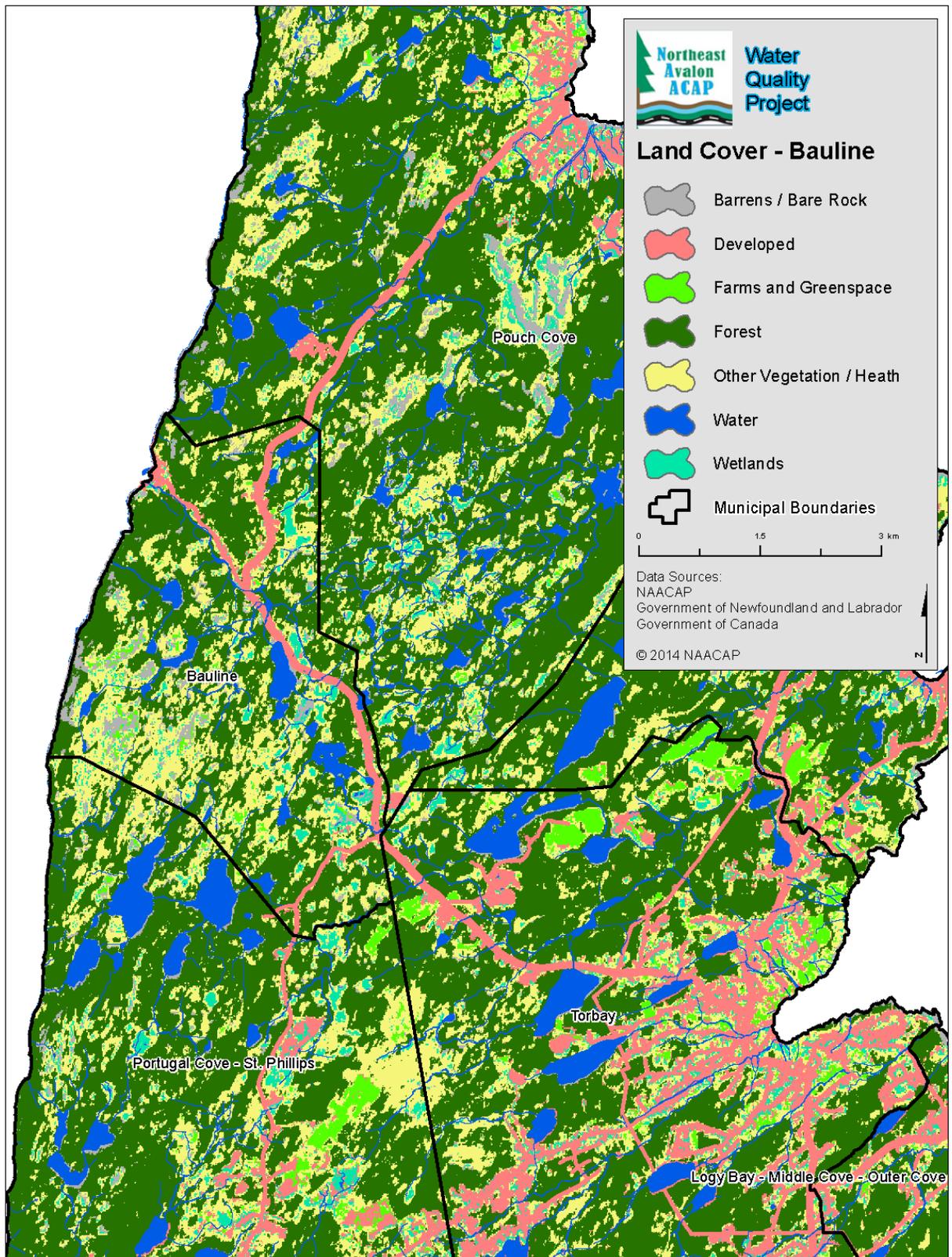
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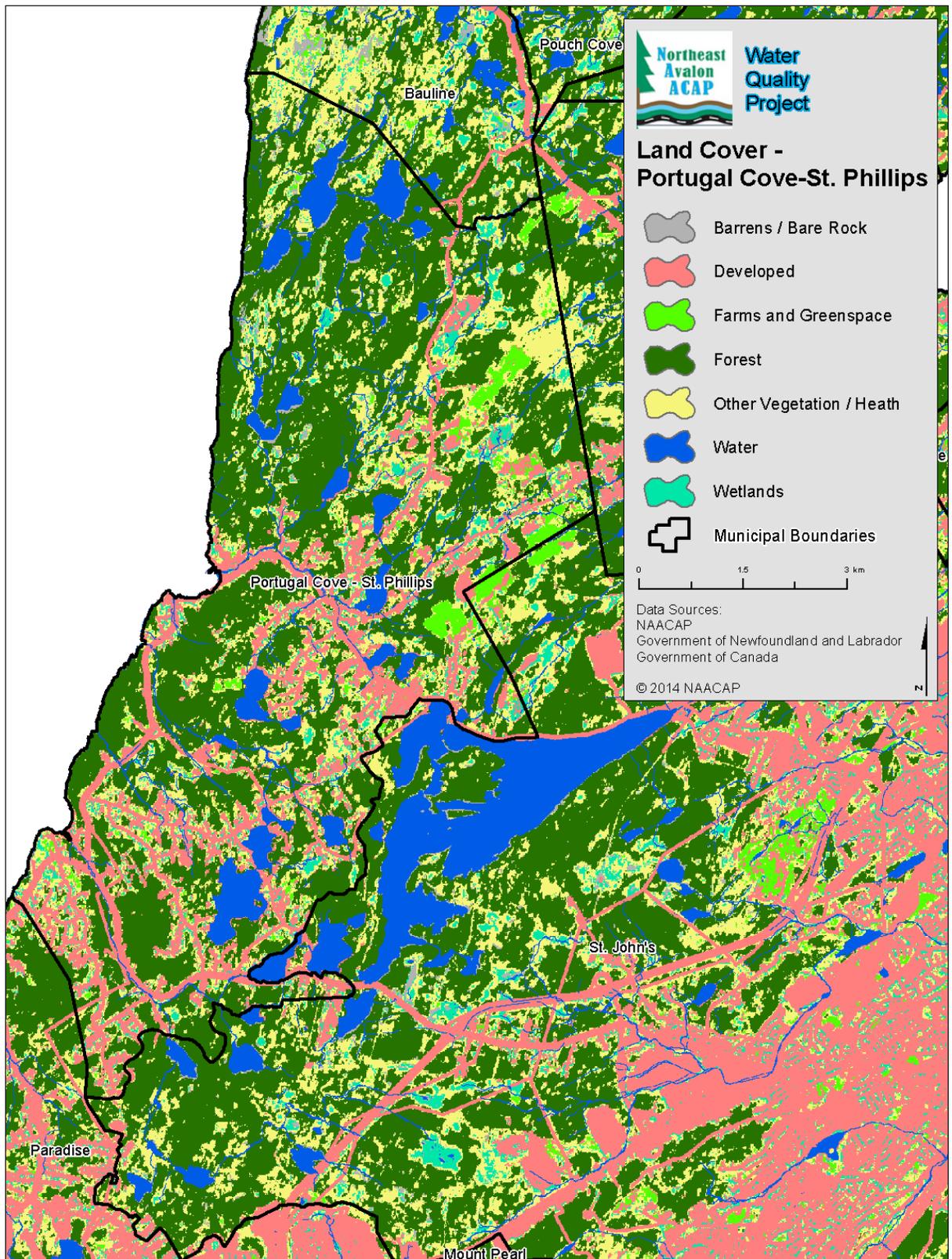
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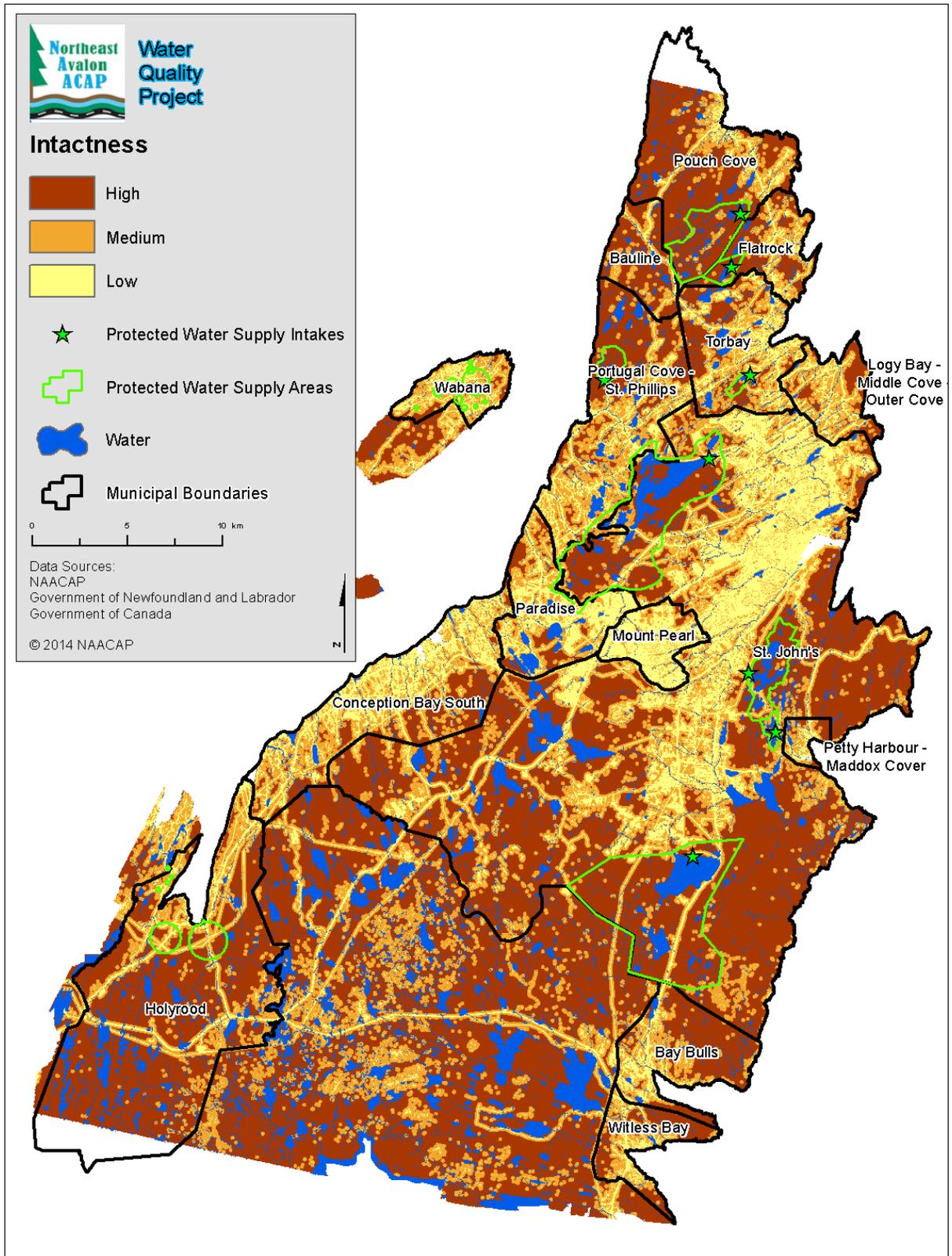
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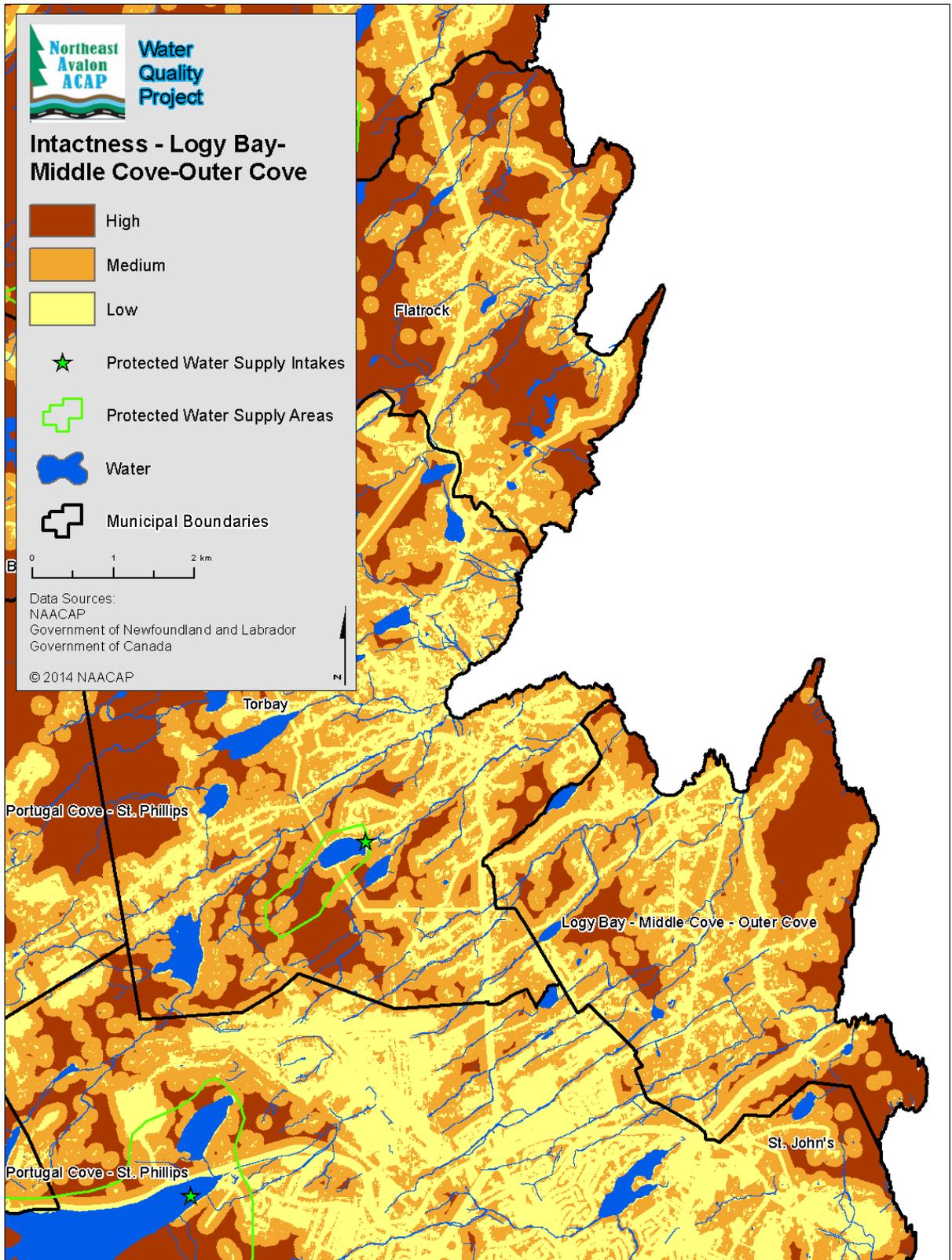
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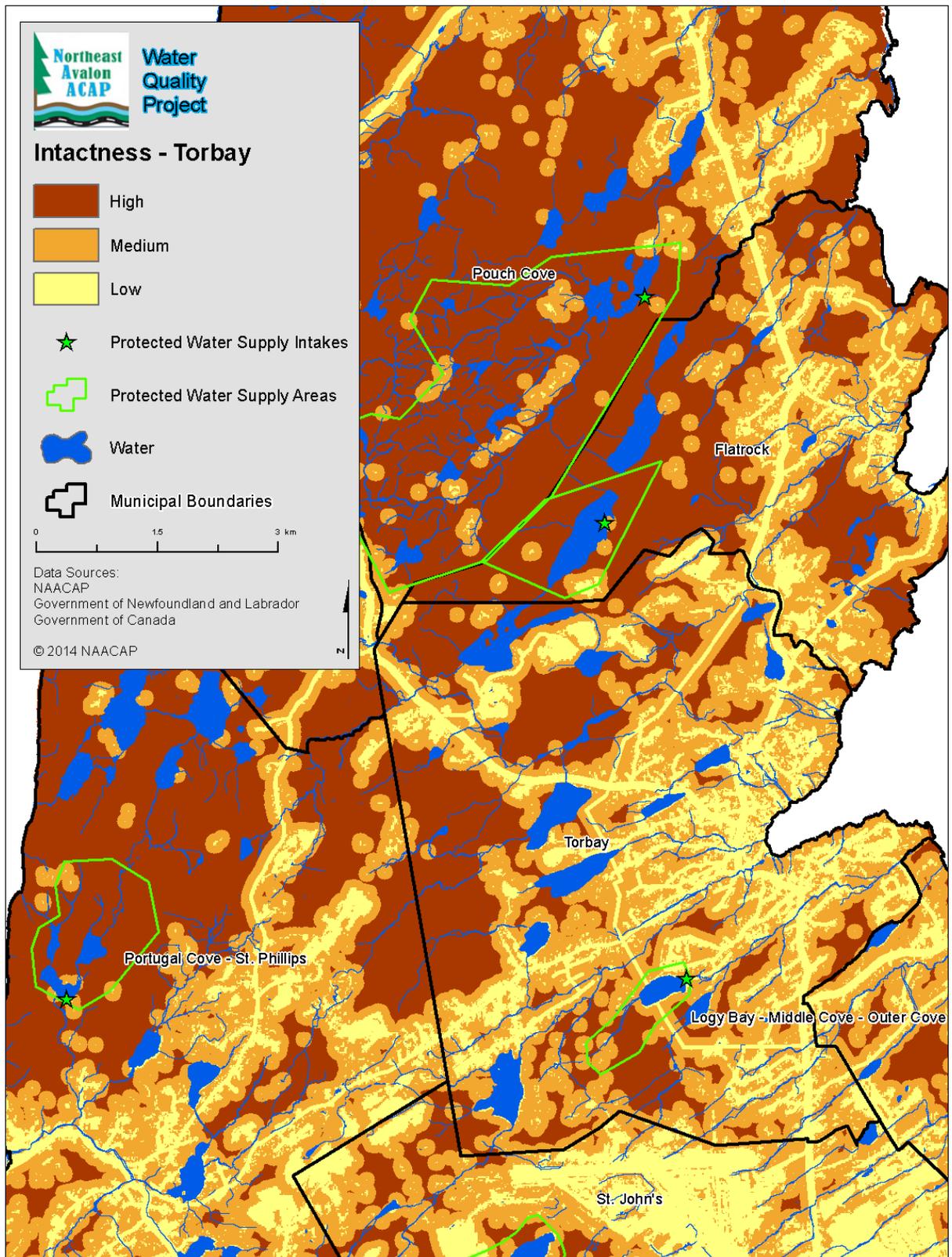
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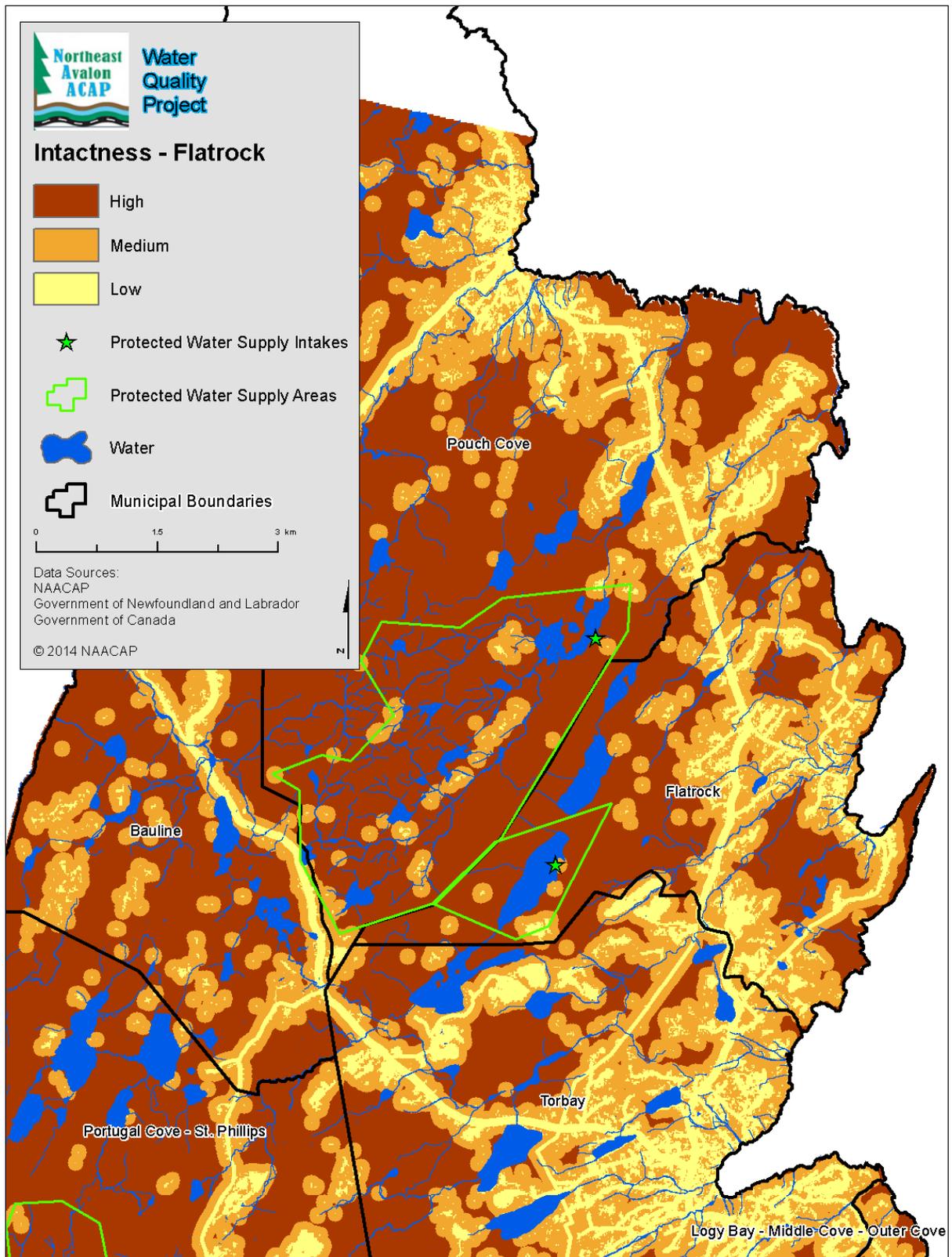
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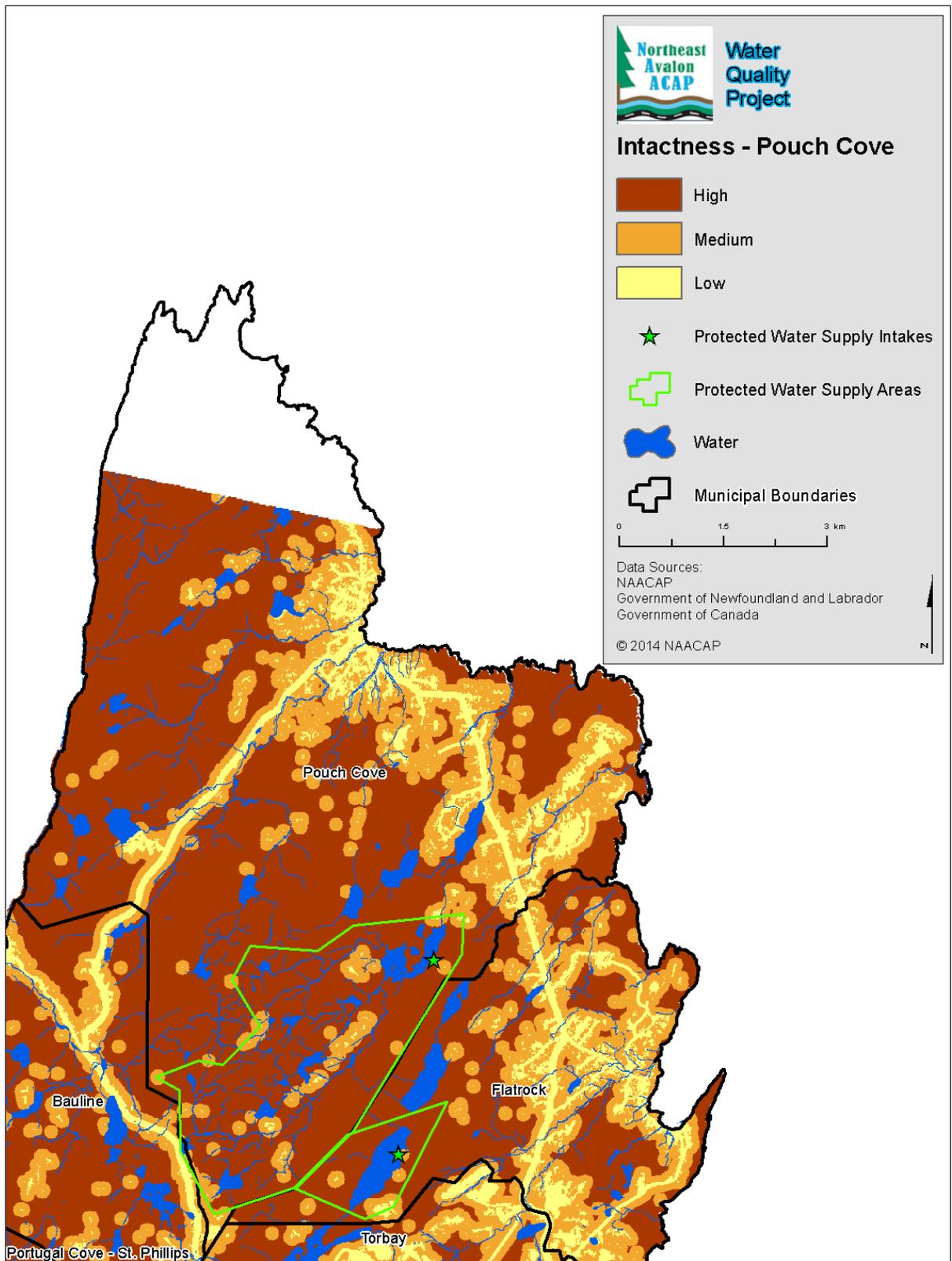
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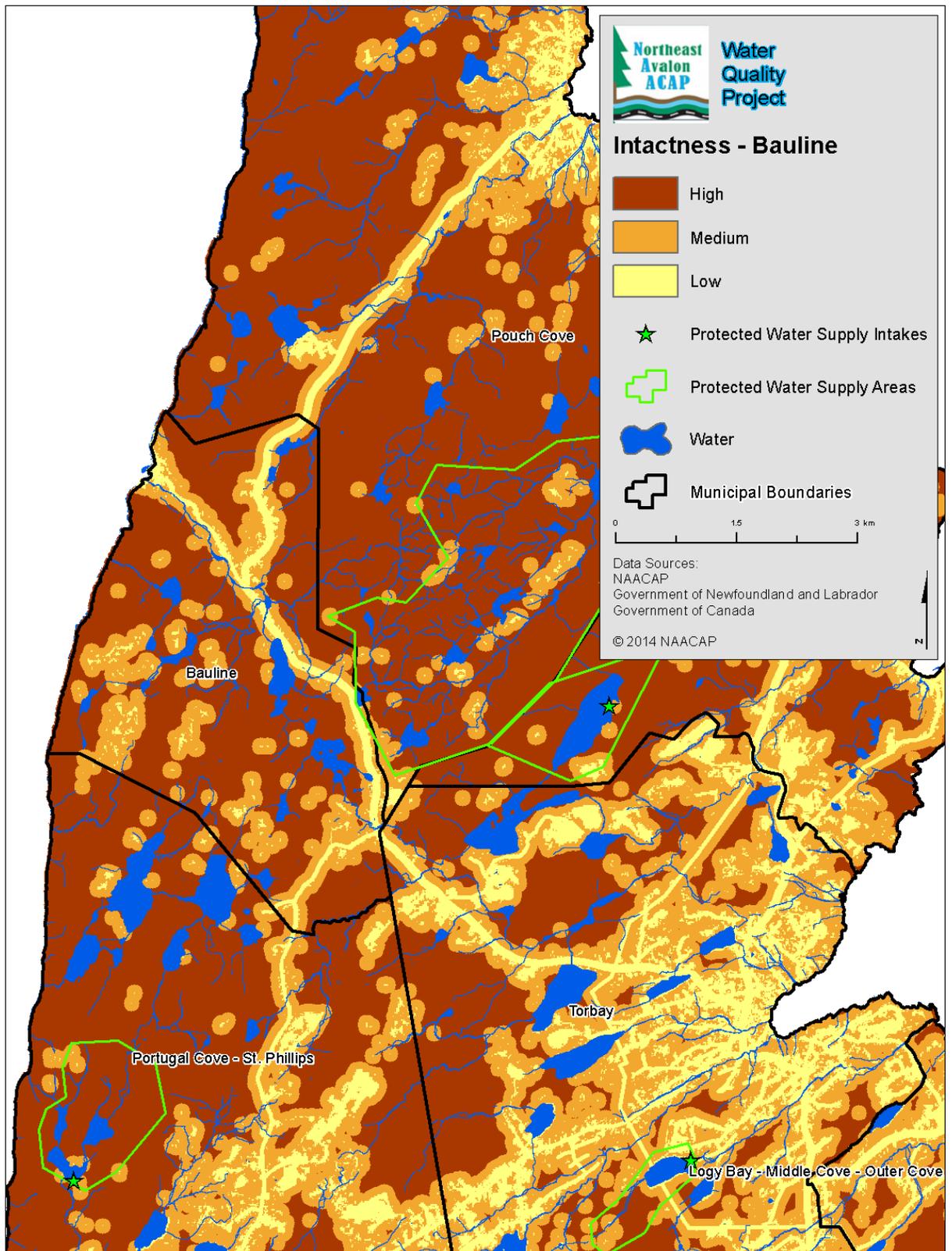
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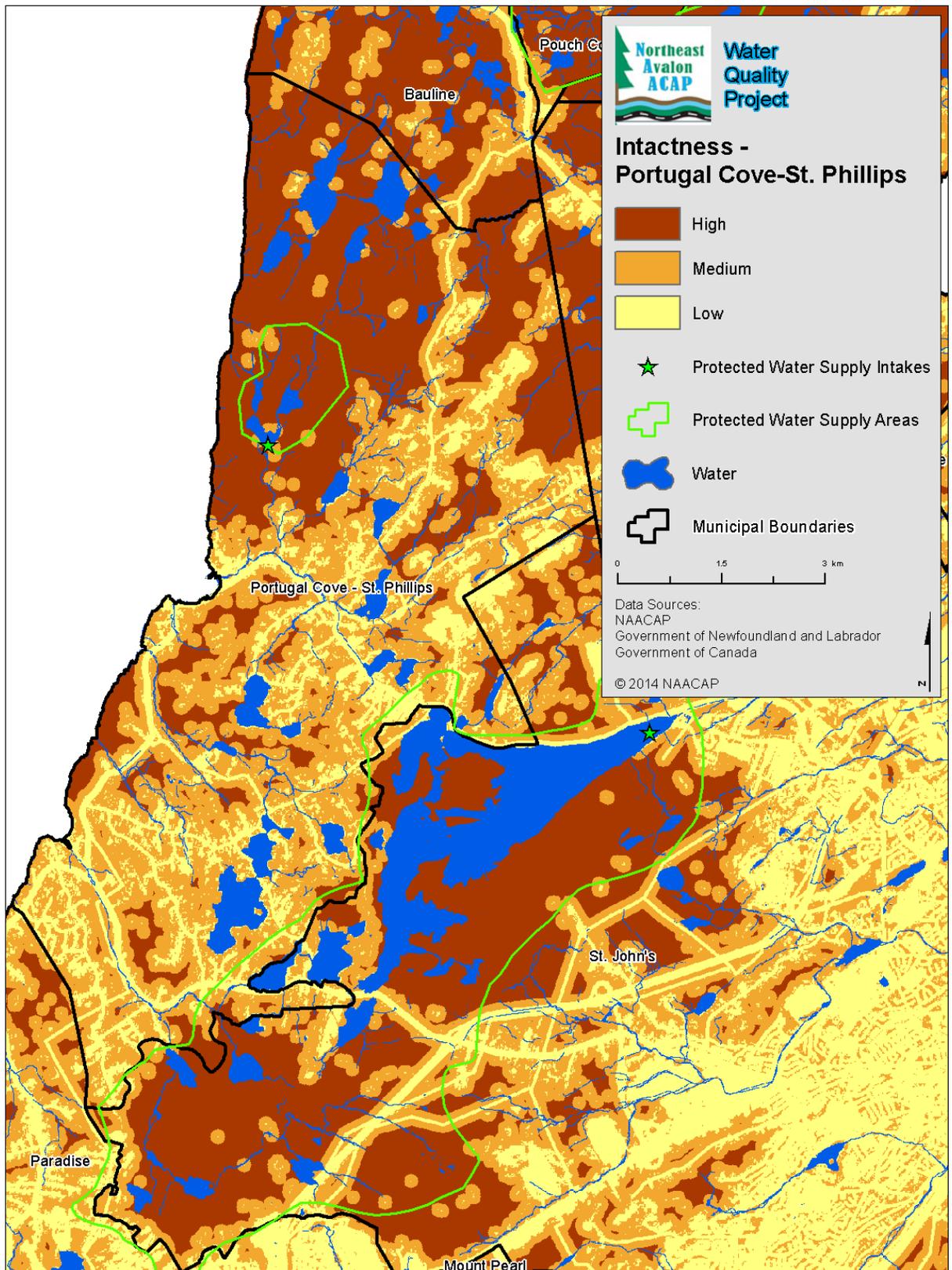
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Discussion

Watershed size and distribution

NEA watersheds are many and complex, with many of the larger watersheds straddling municipal boundaries. As shown in the maps, there are hundreds of catchments and dozens of watersheds and sub-basins within the Northeast Avalon. Most large watersheds cross municipal boundaries, therefore, to ensure integrity of watersheds and security of drinking water supply, watershed management can only be achieved at a regional level. **It is imperative for the Northeast Avalon region to implement a regional planning mechanism to address watershed conservation issues across municipalities.**

Land cover analysis and Intactness

Watershed intactness reflects the ability of the watershed to deliver clean water for drinking either from surface water or well water, minimize flooding and erosion, and provide other ecosystem services. Well water quality is directly connected to landscape intactness because most groundwater on the Northeast Avalon is drawn from shallow, fracture-dominated aquifers. The intactness maps are intended to help municipalities identify areas of their land base that should be set aside from development in order to ensure long-term sustainability of watersheds, and hence of drinking water.

Most natural land cover has been degraded or lost in the areas immediately surrounding St. John's (except for the protected watersheds around Bay Bulls Big Pond and Windsor Lake). Similarly, most natural land cover has been lost, fragmented, or degraded in the majority of other municipalities with the exception of Bauline, Pouch Cove, and the northern part of Portugal Cove – St Philips. **As a result, many areas have low watershed intactness values; therefore the remaining large tracts of land with high watershed intactness within each municipality should be zoned for conservation and watershed protection, in order to safeguard long-term drinking water sustainability.**

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Wetlands

There is a direct link between wetland health and drinking water sustainability. Wetland areas are as a key component of ensuring watershed integrity, and are identified in the land cover analysis with a greater degree of precision than is available from other map data sources. Currently, federal mapping data at the 1:50,000 scale only identify large wetlands, yet the land cover analysis identified a large number of small wetlands throughout the Northeast Avalon area. The Northeast Avalon region has experienced considerable loss of wetland cover and functionality, along with loss of agricultural land (Ren 2014, Slaney 2006). **There is an urgent need for a regional assessment of wetland status in the Northeast Avalon, to determine rates of loss or degradation, and to identify key wetlands that must be preserved for watershed integrity and drinking water security.** This assessment should include additional mapping based on visible wavelength and infrared aerial photography to identify wetlands, and field assessment of wetland condition. The initial priorities for this wetland assessment should focus on the areas of highest development pressure. Such wetland assessment should precede development in order to identify key watershed and wetland areas for the delivery of clean water and other ecosystem services such as flood control.

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Section 2: The human component: professional, resident, and municipality staff perceptions of drinking water resource management on the Northeast Avalon.

Vesna Kerezi, Myron King, Evan Edinger, Luise Hermanutz

Executive Summary

This report summarizes the findings from the qualitative component of the study focused on profiling regional watershed management on the Northeast Avalon (NEA) region. We investigated the practices and attitudes towards drinking water use and water management by exploring perceptions of local residents, municipal government representatives, contractors of the NEA municipalities and others with a knowledge of and/or interest in local water resources from six rapidly expanding municipalities (Bauline, Flatrock, Logy Bay – Middle Cove – Outer Cove, Portugal Cove – St. Philips; Pouch Cove, and Torbay) within the NEA region. Specifically, the study explored attitudes toward water management and perceptions regarding current land development and its impact on watersheds and water supply. Participants were also asked to provide insights about drinking water delivery modes and water supply challenges. In addition, they were asked to share their opinions on governance, in particular within the context of regional water management.

The study helped to identify the main challenges for drinking water management on the Northeast Avalon region, which include rapid growth, lack of integrated planning, especially within the regional context, and lack of proper policy enforcement. The study also indicated the potential strategies that could be useful in ensuring high-quality drinking water on the Northeast Avalon region. In particular, our findings indicate that proper planning and balanced land development, implementation of municipal and provincial legislation, improved research and monitoring, and creation of a regional water system were all identified as key elements of sustainable water management. The report also provides detailed recommendations from the participants regarding development and its impact on watersheds and water supply, planning and land management, and implementation of policies. Special attention is given to approaches that encourage and/or discourage regional collaboration.

Assessing drinking water management in NEA

Introduction

Watersheds are integrated systems that encompass both the biophysical and socio-economic domains: biological and hydrological entities and natural processes on one hand and human values, science, policy, legislative controls and built structures on the other. These connect across varied geographic areas, such as rural and urban environments. Exploring integrated watershed management is crucial for implementing best practice techniques for managing drinking water quality in Newfoundland and Labrador, especially on the Northeast Avalon, where development has seen an exponential increase.

Roughly half of the population of Newfoundland and Labrador reside on the Avalon Peninsula and, therein, the most densely populated region is the Northeast Avalon. The region encompasses the major urban municipalities of St. John's and Mount Pearl, along with the rapidly growing, peri-urban municipalities of Conception Bay South and Paradise. The remaining communities (11) in the greater urban region have more rural characteristics (i.e. less infrastructure, smaller populations, larger proportion of households on well and septic systems) but are all experiencing spill-over effects from the capital city. These peri-urban municipalities are experiencing two distinct shifts in regard to drinking water supply. Firstly, with the expansion of municipal water systems more residents than ever before have access to serviced water supply. Secondly, there are fewer people on surface wells and more people on drilled wells largely because surface wells are more prone to contamination as well as to periodically running dry.

Smaller peri-urban communities are also experiencing densification primarily associated with new residential development. Those communities located adjacent to the most intensively developed areas are observing increasing impacts from runoff no longer retained by upstream land uses. In addition, while increased development in one municipality may negatively impact water supply in adjacent municipality, there is currently not much evidence that there is a strong cooperation amongst these municipalities that would help resolve this issue. A lack of mechanisms, such as specific policies or legislation that would encourage and guide a cross-municipal cooperation is also a problem.

This project interprets 'watershed' as including both surface waters, such as wetlands, lakes and streams, and ground water in the form of underground aquifers; it also includes adjacent land that collects and drains water into those water bodies. Given that watershed systems are interconnected, integrated units, efforts made to manage, conserve, protect and plan around these systems as well as the policy structures that have directed these efforts is of critical importance. Creating a profile of community and regional water policy and practice - be these mechanisms directly related to municipal water supplies or broader efforts that protect, conserve and/or rehabilitate water resources - is of key concern for future integrated approaches and

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is of immediate relevance to drinking water management in this part of the province.

The aim of this study was to identify current and future water-related issues in six municipalities (Bauline, Flatrock, Logy Bay – Middle Cove – Outer Cove, Portugal Cove – St. Philips, Pouch Cove, and Torbay) situated within the Northeast Avalon region and the ways in which water resources in general and drinking water supplies in particular are – or are not – being managed. The findings presented below provide a comprehensive understanding of potential risks and opportunities that should facilitate improved watershed stewardship and guide sustainable development on the Northeast Avalon region.

The project's overall aim is to create a regional profile of contemporary drinking water supplies, delivery systems, protection and usage policies, as well as watershed management, to further our understanding of how to best manage drinking water resources on the Northeast Avalon under conditions of rapid ongoing development. In order to achieve this, we have examined the following questions through this research:

- *How are drinking water delivery modes (piped services versus well-water supplied areas) distributed across the region?*
- *What conflicting uses and other challenges are present that (a) have already affected water quantity/quality, or (b) have the potential to cause future problems?*
- *What are the mechanisms conditioning (encouraging or dissuading) regional collaboration?*
- *What role do urban, peri-urban and rural community differences, interactions and tensions have on integrated watershed and drinking water management?*
- *What experience is there with solving prior drinking water issues in the region that might inform and guide efforts to better integrate future watershed and water supplies management practices?*

Study Area and Methodology

The Study Area for this project includes the following six municipalities: Bauline, Flatrock, Logy Bay – Middle Cove – Outer Cove (LB-MC-OC), Portugal Cove – St. Philips (PC-SP), Pouch Cove, and Torbay (See Map of municipal boundaries on Page 13). The reasons we choose these six municipalities is that they all have experienced a sharp increase in land development in the recent years, enabling us to investigate the impact this development is having on the drinking water supply and

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watershed management. Secondly, these six municipalities differ in their size, drinking water delivery systems, and land development practices, which allowed us to explore the role and importance of these factors for sustainable drinking water supply and watershed management. Lastly, by focusing on these six neighbouring municipalities, we were able to explore the presence or lack of collaboration between municipal governments within the context of watershed management, in the hopes that these municipalities will work together to best manage the watersheds in the future. The province may need to develop new administrative structures and/or policies to foster such a regional approach.

Table 1. Population increase in each municipality. LB-MC-OC – Logy Bay - Middle Cove - Outer Cove; PC-SP – Portugal Cove – St. Philips; (Community Accounts, n.d.). Note Bauline is the only community that has decreased in population.

Municipality	2006	2011	% change
Bauline	395	335	-17.9
Flatrock	1,195	1,455	+21.8
LB-MC-OC	1,820	2,100	+15.4
PC-SP	6,565	7,365	+12.2
Pouch Cove	1,745	1,865	+6.9
Torbay	6,280	7,395	+17.8

Table 2. Municipal personnel. LB-MC-OC – Logy Bay - Middle Cove - Outer Cove; PC-SP – Portugal Cove – St. Philips; (Community Accounts, n.d.)

Municipality	Town manager	Town planner	Notes
Bauline	yes	no	
Flatrock	no	no	Town Clerk
LB-MC-OC	yes	no	
PC- SP	yes	no	
Pouch Cove	yes	no	
Torbay	*yes	**yes	*Chief Administrative Officer **Director of planning

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Qualitative data for this study were obtained through the process of interviewing, which enabled open-ended, in-depth investigation of particular aspects of a participants' life in which they have extensive experience and insight (Charmaz, 2003). We used semi-structured interviews because of their flexibility that allowed us to ask follow up questions and investigate topics that were maybe not initially anticipated (Mabry, 2008). All questions from the interview schedule were open-ended, allowing participants to freely express their thoughts and opinions in response to questions without the harness of expectations. A list of questions from the interview schedule is provided in Appendix 1. Each participant was also given a map of their municipality and asked to mark the spots and areas that he or she was talking about during the interview. These marks include areas of development, rivers, wetlands, watersheds and others. These maps are archived at NAACAP office for future reference, and are not included to protect the privacy of the participants.

The participants included local residents, municipal council members (current and former), town staff, contractors of the NEA municipalities (e.g. planners), individuals active in environmental organizations, and university researchers. Aside from local residents and individuals active in environmental organizations, our respondents spoke in their capacity as either an employee (i.e. public works managers, town clerk/manager) or contractor of the Northeast Avalon municipalities with some relationship to drinking water-related matters.

We interviewed 25 participants from six municipalities, which include: Bauline ($n=1$), Flatrock ($n=4$), LB-MC-OC ($n=2$), PC-SP ($n=9$), Pouch Cove ($n=3$), and Torbay ($n=7$). These participants include local residents, municipal council members (current and former), and town staff. We also interviewed a researcher, two contractors of the NEA municipalities, and a groundwater specialist who is familiar with local groundwater issues. Overall, we interviewed a total of 30 participants during the period from June 28, 2013 to February 25, 2014. The interviews lasted between an hour and two hours and were conducted at the convenience of the participant.

Table 3. Number of participants interviewed in each municipality. LB-MC-OC – Logy Bay - Middle Cove - Outer Cove; PC-SP – Portugal Cove – St. Philips.

Municipality	Local residents	Municipal council members	Town staff	Total
Bauline	1	-	-	1
Flatrock	3	1	-	4
LB-MC-OC	1	-	1	2
PC- SP	7	-	2	9
Pouch Cove	2	-	1	3
Torbay	4	2	1	7

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The difference in the number of participants from one municipality to another was not intentional but rather a result of a varied response rate within these municipalities. In the initial phase of data gathering in July 2013, we contacted an equal number of individuals in each of the six municipalities, using gatekeepers and the snowball approach to reach the potential participants. [Gatekeepers are individuals from particular settings such as organizations “who have the power to grant or withhold access to people or situations for the purpose of the research” (Burgess, 1984, as cited in Valentine, 2005; pp. 116). The snowballing process is where the researcher through one contact recruits another contact, which in turn helps recruit the next one (Valentine, 2005)]. In the later phase of data gathering from August 2013 until February 2014, we again contacted those that have not responded during the initial phase and continued recruiting new participants whose contacts were given to us by those that have already participated in our study. Since the findings from qualitative research were not meant to be representative nor used for generalization (Valentine, 2005), the difference in participants from one municipality to another is not considered an issue

The qualitative data in this study were analyzed using a method known as thematic analysis. This method of analysis is based on segmentation, categorization and (re)linking smaller sets of data before the final interpretation (Grbich, 2007). It consists of identification, analysis, and reporting of patterns (i.e., themes) within the data (Braun and Clarke, 2006). Whether or not a theme is relevant does not depend on its frequency but on consistency of themes “across and within study participants” (Floersch et al., 2010; pp. 408). More importantly, the relevant themes are those that correspond well to the overall research questions and deepen our knowledge of the topic of study (Braun and Clarke, 2006; Floersch et al., 2010).

Drinking Water Supply and Water Management on the Northeast Avalon Region

Current Water Supply and Water Management

How are drinking water delivery modes (piped services versus well-water supplied areas) distributed across the region?

Drinking water is supplied through both private wells and municipal water system in the majority of municipalities profiled in this study. This is true for Bauline, PC-SP, Pouch Cove and Torbay. The two exceptions are Flatrock and LB-MC-OC, which draw water exclusively from private wells. The wells in all six municipalities are either surface or drilled wells, the latter of which are often referred to as artesian wells.

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Municipal water systems can service a single municipality, as is the case in Bauline, Pouch Cove, and Torbay, or be part of a larger regional water system. PC-SP water system is part of a larger Regional Water System that services not only that town, but St. John's, Mount Pearl, Conception Bay South and Paradise. While PC-SP manages its local water system, the Town also pays a fee for the shared services and infrastructure used through the Regional Water System. The sources of service water are: Bay Bulls Big Pond (PC-SP), Three Island Pond (Pouch Cove) and North Pond (Torbay). The source of municipal water in Bauline is Brook Path Well.

When it comes to a secondary back-up supply of water among those four municipalities that have municipal water, Bauline is the only municipality that has a designated secondary source of water that can be used in a case of emergency (i.e. Bauline River). In Pouch Cove the residents have access to the "Lion's Club well" but this is not a designated secondary water source nor does the Town manage it. As for the residents from all six municipalities that are on private wells, in most cases they do not have a secondary source of water.

The percentage of residents on a municipal water supply versus those on private wells varies across the municipalities (Table 4). For example, in PC-SP 30% of households are serviced by the municipal water supply. At the same time, less than 50% of households in Torbay and less than 80% of households in Pouch Cove are connected to the municipal water supply.

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Table 4. Percentage of residents on well versus municipal water supply in each municipality.

Municipality	% of residents on Private well water supply	% of residents on municipal water supply
Bauline	100	0
Flatrock	100	0
LB-MC-OC	100	0
PC-SP	70	30
Pouch Cove	80	20
Torbay	50	50

There are several reasons why there are still a large number of un-serviced households in these six municipalities. Firstly, developing a municipal water supply can be cost-prohibitive. There are high costs associated with both installing and maintaining municipal water systems, especially if the population density is low. Geographically for some municipalities, the amount of bedrock layer to displace for service infrastructure is high, adding to the cost. It can be also cost-prohibitive to connect the houses on higher elevation to the existing municipal water system.

Another good example of cost-prohibitive factors can be seen in Flatrock and LB-MC-OC. In the 1980s there were plans to develop a municipal water system in Flatrock. Middle Pond (also known as Medalsis Pond), was designated as a water source and external funding was secured through a provincial grant. Soon, a pumping station and several pipes were put in place. However, it quickly became evident that not only were the construction costs too high but the number of residents was too small to sustain the overall cost of running a municipal water system service fees. Consequently, Flatrock's municipal water system was abandoned, and all residents are on private wells.

An additional reason that communities such as Flatrock are not interested in the municipal water supply is related to the sewage issue. The installation of a municipal water supply is usually accompanied by an installation of a municipal sewage system. In places like Flatrock in which there are no sewage treatment facilities, this means that the raw sewage would be flushed directly into the ocean. As one of our participants from Flatrock emphasized, pumping untreated sewage into the ocean is not an appropriate alternative to their current system of septic tanks. We were also told that the existing private wells in both Flatrock and LB-MC-OC can sustain the Towns' current rate of development, especially since they do not have any industry that would require a large uptake of water. It is for these reasons Flatrock participants indicated they preferred private wells rather than municipal water supply.

The situation in LB-MC-OC is quite similar to the one in Flatrock as LB-MC-OC also relies exclusively on well water. Instead of spending its tax payer's money on maintenance of municipal water and sewage systems, LB-MC-OC can allocate this

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money for other purposes. For instance, LB-MC-OC was recently able to finance a flood risk study that investigated the robustness of their infrastructure (e.g. bridge, culverts etc.) when challenged by intense flooding. LB-MC-OC's decision to stay on well water is also justified by the Council's strategy to maintain the Town's rural character. As a result, there are no commercial buildings in LB-MC-OC and all new residential dwellings are built on a minimum of 2 acre size lots.

Lastly, the reason the percentage of un-serviced households is still relatively high is that some municipalities may have reached the maximum number of households that can be connected to the municipal water. Torbay for instance, is one such municipality. Even though the town would like to connect more houses and commercial buildings to the municipal water supply, it is unable to do this as the water supply has reached its maximum water capacity.

Specific Drinking Water Management Issues

Quality and Quantity of Water Resources and their Supply Systems

Quality and quantity of well water

In general, participants on private wells reported being more satisfied with both the quality and quantity of their water than the participants who were on the municipal water system. For example, participants with wells would often emphasize the quality of their well water by saying how nice and clean it is, or that it has no taste and no odour, or that it tastes much better than the municipal water. Participants listed high concentrations of iron, manganese and sulfur, and the presence of coliform bacteria as the main problems regarding well water quality. In relation to the well water quantity, some participants said that they never had any issues with water quantity, while others mentioned occasional problems. In general, none of them experienced ongoing or long-term issues regarding water quantity. Overall, it was very clear that participants with well water were glad that they control and manage their own water supply. Their sense of ownership and independence was very strong and they disliked the idea of losing this control by connecting to a municipal water system.

Quality and quantity of municipal water supply

Some participants reported being very satisfied with the quality of their municipal water; however those who were not satisfied mentioned some of the following issues: high levels of chlorine, presence and/or high levels of Trihalomethanes (THM), occasional boiling orders, mouldy smell, unpleasant taste, and discolouration (e.g. brown, murky water). Since THMs raised a lot of concerns and were mentioned among participants from more than one municipality in this study, we will briefly explore the issues with THMs below.

Before Portugal Cove-St. Philips became a part of the Regional Water System, the

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Town's source of water was Blast Hole Pond. Portugal Cove-St. Philips switched to the Regional Water System in 2004 because of the poor water-quality and inadequate volume of water from Blast Hole Pond. The poor water quality was caused by high concentration of chlorine and THMs. THMs are by-products of disinfection and are formed during chemical reaction between chlorine and the organic, humic matter present in the water (Government of Newfoundland and Labrador, n.d. (a)). Blast Hole Pond is a soft bottom pond that contains elevated levels of organic compounds and is therefore prone to having higher levels of THMs, which may, over prolonged period of time, increase the risk of cancer (Health Canada, 2006). Since 2004, there have not been any issues related to THMs in Portugal Cove-St. Philips.

In Pouch Cove, on the other hand, THMs continue to be a matter of dispute between the municipality, province and the local residents. Pouch Cove's source of water, Three Island Pond, is a soft bottom pond and residents face identical problems to those experienced in Portugal Cove-St. Philips before 2004 (e.g. presence of THMs in the water, brown, murky water etc.) In the last year, there has been an increase in the number of complaints from the local residents regarding water quality, and some of these have been discussed in the local media. Even though we talked to a small number of Pouch Cove's residents, it was apparent that the water quality is of great concern for the people of Pouch Cove. More specifically, residents believe that the existing levels of THM pose a serious health risk and are worried that the municipal and provincial governments are downplaying these risks. They feel that they have been misguided and lied to about the impacts of THMs, and that a serious problem like this should not be dismissed but should be immediately dealt with.

With respect to quantity, participants were for the most part satisfied with their water supply. The two most common problems were watering bans in the summer (i.e. water shortage) and occasional drops in water pressure. A drop in water pressure was commonly experienced by those living at higher elevations but was also a result of breaks and leakages in the water system. Problems with water shortage were also reported in Bauline with the exception that this was not caused by low water levels in the Town's water system but was a result of power outages, which compromises the pump. Participants from Portugal Cove-St. Philips also talked about the infrastructure of the Regional Water System and pointed out its vulnerability. Namely, there is only one trunk pipe in this system, which means that a leakage or some other problem in one municipality can affect the other municipalities. The only municipality in which water quantity was rated as *the* most important water related issue was Torbay. Participants from Torbay discussed at length the issue of water quantity which we include in the section on Torbay below (see pages 66-67).

Challenges that Affect the Quality and Quantity of Drinking Water

What conflicting uses and other challenges are present that (a) have already affected water quantity/quality, or (b) have the potential to cause future problems?

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The list of all identified issues that affect the quality and quantity of drinking water can be seen in Table 5. We specified how many participants raised a particular issue, in which group category they belong (i.e. whether they are local residents, members of municipal staff, council members or planners) and in which municipality a particular issue has been observed. Some of these challenges have already been discussed in the previous section on quality and quantity of municipal water supply and private wells. Since this study specifically focuses on exploring the impact of development on the Northeast region on the drinking water quality and quantity, we will discuss this issue in more detail in the following section.

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Table 5. Issues identified by interviewees affecting the quality and quantity of drinking water. B – Bauline; F – Flatrock; LB-MC-OC – Logy Bay - Middle Cove - Outer Cove; PC-SP – Portugal Cove – St. Philips; PC - Pouch Cove; T – Torbay; Δ - local resident; • - municipal staff member OR council member; x – planner.

	B	F	LB- MC-OC	PC- SP	P C	T	Plan ners
Development							
Clear cuts		Δ	Δ	ΔΔΔ ΔΔ••		ΔΔ	x
Destruction of buffer zones				ΔΔ		ΔΔ ΔΔ	x
Roads and houses too close to water bodies (e.g. Windsor Lake)				Δ ΔΔ			
In-fills/backland dev.			•Δ				
Flooding/Runoff		Δ	•Δ	ΔΔΔ		ΔΔ Δ•	x
Discolouration of drinking water (wells)			•				
Drying up of wells			•			Δ•	
Building on wetlands		Δ	•	•ΔΔ		ΔΔ ΔΔ	
Roads (impervious surfaces)				Δ		Δ	
High density (wells)				ΔΔ		ΔΔ ΔΔ	
Uphill development			•	Δ		ΔΔ Δ	
Small lots						Δ	
Inadequate storm water management (e.g. heavy silting)				••Δ		Δ	x
THMs				ΔΔΔ• •	Δ	Δ	

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Boil water orders				Δ••		Δ	
Watering bans				Δ•		Δ	
Algae bloom						ΔΔ	
Discolouration of drinking water (municipal water system)				•	Δ	Δ	
Manganese (wells)			•	Δ			
Sulfur (wells)			•	Δ		Δ	
Iron (wells)		Δ	•	Δ		Δ	
Coliform bacteria (wells)		Δ		ΔΔ		Δ	
Salt				Δ		Δ	
Pesticides and herbicides				Δ•			
Fertilizers						ΔΔ	
Fragile infrastructure – single trunk water main				••			
Water system reached its maximum capacity				•Δ		ΔΔ ••	
Toxic plume						ΔΔ •	
Lack of back-up supply			•	Δ	Δ	Δ	
Small watershed			•	Δ		Δ	
Lack of research/ monitoring		Δ		ΔΔ	Δ	ΔΔ Δ	
Lack of law enforcement		Δ	•	ΔΔ		ΔΔ	
Sod farms	Δ			Δ			
Peat farms	Δ			•			
Rock quarry				ΔΔ•			

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The impact of Development on the Watersheds and Water Supply on the Northeast Avalon

The population on the Northeast Avalon has been steadily increasing since 2001, likely as a result of economic development and a continued trend towards urbanization. While the City of St. John's went through a population decline between 1981 and 2006 due to household aging and out-migration, other municipalities, such as Mount Pearl, Paradise and Torbay have all experienced significant increase in population. A similar trend has also been seen in other suburban municipalities, including Conception Bay South, Flatrock, LB-MC-OC and PC-SP (Government of Newfoundland and Labrador, 2008).

The reason suburban life has become increasingly popular in the last two decades can be explained by several factors. Firstly, residential real estate in suburbia is relatively cheap when compared to the urban core. In addition, major infrastructure developments greatly improved the quality of life in these communities, making them more desirable places to live. Lastly, by-pass roads such as the Outer Ring Road and the Torbay By-pass made these communities much more accessible (Government of Newfoundland and Labrador, 2008).

There is another important factor that helps to explain a population increase in the smaller, more rural communities on the Northeast Avalon. As stressed by our participants, these communities attract people because of their rural landscape and their so called "rural life". At the same time, St. John's is still close enough that they can easily commute and avail of other benefits that come from living in close proximity to an urban center.

When asked about the development in their community, all of our participants have said that they have seen increased development in their communities in the recent years. This, per se, was not a problem as many of them supported development and wanted to see the progress and improved quality of life in their communities. The problem, as we will see, is not so much that there is development, but that this development is done in an *ad hoc* fashion. In the following section we will briefly discuss the impact of development, or more precisely unplanned or, in the words of the participants, "bad" development, on the quality and quantity of drinking water, drinking water management and watershed management.

High Density Development: Increased Pressure on the Existing Water Levels

As more people move into the communities on the Northeast Avalon, the need for water is constantly increasing. When it comes to municipal water supply, municipalities have good estimates as to the number of new developments they can connect to their water system before reaching the maximum capacity. A more

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problematic issue is new, un-serviced development that relies on well water supply. The challenge here is that municipalities rarely have detailed profiles of aquifers, which makes it hard to determine whether the aquifer can sustain new development and if so, how many new residences. The risk of running into problems with water supply is especially high for the un-serviced developments on small lots and so called in-fill developments. These developments, also known as backland or backlot developments, refer to the development of properties behind existing structures (PC-SP Planning & Development Department, n.d.). If water levels in the aquifer are relatively low to start with, this additional pressure on the resource might cause problems with water quantity for both old and new households. In addition, un-serviced developments on smaller lots with surface wells are susceptible to contamination caused by septic tanks from new adjacent developments.

When asked directly about whether the future development on the Northeast Avalon should be serviced or un-serviced, the planners that participated in this study suggested that, due to the rural character of many of these municipalities, we need to have both serviced and un-serviced development in place. Planners as well as the majority of other participants, including local residents, also emphasized that the un-serviced land development should be built only if there was a study done to see if there is enough water to support the existing and new development.

In addition, some of the participants argued that the un-serviced land development on larger lots was not the best use of land. Such development contributed to urban sprawl and was quite expensive to connect onto the municipal water supply. As a result, it was argued, in particular by the planners, that the new land development should, overall, be serviced and “densified” (i.e. built on smaller lots). An alternative way to service new development is to drill a series of wells that would provide water from the aquifer. However, this is not a viable option at the moment, as it requires long-term involvement of municipal governments or developers who would need to own and operate such systems. So far, neither the municipal governments nor the developers have shown interest in this approach.

It should be noted that serviced and densified development, while strongly supported by planners, was not perceived as the most suitable type of development by all of our participants. Actually, the majority of participants, in particular local residents, argued against these serviced, high density developments. They were also concerned about the practice of building un-serviced subdivisions on smaller lots saying that these developments have a high risk of water depletion. In general, local residents argued that the new development should be built on bigger lots (1 acre or more), which were seen as a proper way to ensure sufficient water availability for households (greater recharge area/greater aquifer). At the same time bigger lots were also perceived as a crucial element in maintaining and promoting the rural, traditional character of these communities.

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Clear Cuts, Runoff and Flooding

One of the most extensively discussed issues related to “bad” development was a significant increase in the percentage and density of impervious surfaces associated with new roads and clear cut developments. Impervious surfaces prevent water from seeping into the ground, causing runoff, which means that there is less water available for recharging groundwater. Runoff can also cause flooding, carry sediments and pollutants into streams, and cause erosion of the stream banks. Many participants heard about or witnessed the flooding caused by such runoff first hand. They were of the opinion that developers and municipalities do not plan for runoff and do not consider the ways in which it will affect neighboring areas, water levels, water quality etc. Participants also thought more should be done to prevent these problems by, for instance, using hydrological data to understand and predict the runoff from these new developments. Some participants even thought that the municipalities could come up with a regulation that would make it mandatory for the developers to leave some vegetation within the development. However, not everyone argued against clear cuts. Some participants pointed out that clear cuts are necessary if the developers are to put in the proper storm management system. Another argument was that, if the vegetation is left on the lot, it takes longer to build the development.

Riparian Vegetation and Buffer Zones

Clear cuts were associated with another negative impact of development, which is the loss of riparian vegetation and buffer zones. A buffer zone is the undeveloped area adjacent to a body of water that plays an important role in maintaining good water quality. It slows floodwaters and reduces rainwater runoff, which in turn recharges the groundwater, maintains stable stream banks and downstream properties (Riparian buffers, n.d.). Riparian vegetation is important for the intake of organic debris; it controls erosion and sedimentation, and moderates stream temperature and light. It is crucial for maintaining invertebrate, fish, bird, and mammal communities as well as the near shore vegetation (Lee, Smyth and Boutin, 2004). Buffer zones have also been increasingly used to disperse storm water runoff (Qiu and Dosskeyb, 2012).

Many participants wanted to see wider buffers zones and better protection of already existing buffer zones. The latter was particularly emphasized as there were several occasions in which existing buffer zones were cut during development without any repercussions or attempts to restore the buffer zone. On other occasions buffers zones were destroyed by landowners themselves who would often replace them by lawns. Overall, many of our participants argued that we need to protect both surface water and riparian vegetation through stricter regulations, better monitoring and enforcement.

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Riparian vegetation and buffer zones are currently protected under the *Policy for Land and Water Related Developments in Protected Public Water Supply Areas* and the *Water Resources Act*, SNL 2002 cW-4.01, sections 39 and 64. Among the activities not permitted because of their negative impact on the water quality and quantity is extensive land clearing, clear cutting of forest in sensitive areas, and application of manure and chemicals in specified buffer zones. The policy also specifies the width of the buffer zones, which can be seen in the table below.

Table 6. Width of Buffer Zones depending on water body type (adapted from http://www.env.gov.nl.ca/env/waterres/regulations/policies/water_related.html)

Water Body	Width of Buffer Zones
Intake pond or lake	a minimum of 150 metres
River intake	a minimum of 150 metres for a distance of one km upstream and 100 m downstream
Main river channel	a minimum of 75 metres
Major tributaries, lakes or ponds	a minimum of 50 metres
Other water bodies	a minimum of 30 metres

Developments in the protected public water supply areas must go through the evaluation process during which a detailed development plan accompanied with maps, drawings and specifications must be sent to the Minister for approval. The municipal authority or those responsible for the operation and maintenance of a waterworks need to ensure that all approved development activities are undertaken in accordance with the terms and conditions of the approval. They are also responsible for serving a stopping order after obtaining prior approval from the Minister in cases when an approval or the policy is violated.

Wetland importance and loss

Many participants pointed out the importance of wetlands for water filtration and groundwater recharging. However, participants were aware that not everyone shares their opinion about wetlands. Participants pointed out that many people don't perceive wetlands as an important and fragile ecosystem, but as "waste" areas. Those participants that were concerned about the wetlands also thought that not enough has been done regarding wetland protection, which leaves the wetlands too susceptible to impacts of land development. For example, infilling of wetlands was said to cause increased runoff, flooding, and problems with the sewage. Some of the participants also criticized the attitude among some residents that think of ponds and wetlands as individual properties that can be fenced and destroyed without any repercussion. Once again, the lack of policy enforcement were said to be at the root of this problem.

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The current policy regulating development on wetlands is the *Policy for Development in Wetlands* that is based on the *Water Resources Act*, SNL 2002 cW-4.01, sections 30, 48 and 64.

The policy states the kind of developments that is not permitted in wetland, which includes:

Infilling, drainage, dredging, channelization, removal of vegetation cover or removal of soil or organic cover of wetlands can exacerbate flooding problems or have adverse water quality or water quantity or hydrologic impacts.

Developments of wetlands which are located within the recharge zones of domestic, municipal or private groundwater wells.

Placing, depositing or discharging any raw sewage, refuse, municipal and industrial wastes, fuel or fuel containers, pesticides, herbicides or other chemicals or their containers, or any other material which impairs or has the potential to impair the water quality of wetlands.

Participants' recommendations related to development and its impact on watersheds and water supply

Recommendations from local residents:

- *Runoff management*: One way to deal with surface water runoff is to make new regulations regarding clear cuts and buffer zones, and to ensure that these policies are being enforced. Sustaining rural character of these communities (e.g. bigger lots, more vegetation) is another way to control the runoff and its adverse effects.
- *Slope development*: Building developments on high slopes often leads to runoff and flooding. To prevent these problems, high elevation land should be protected and not assigned to residential zones. If this land is developed, a proper mechanism should be implemented to prevent these issues (e.g. zero runoff policy).
- *Riparian vegetation and buffers zones*: When it comes to watershed management and storm water management, much more attention must be paid to protecting riparian vegetation and buffers zones. We should have more buffers zones and these should be wider than they are at the moment. More specifically, riparian vegetation should be kept as a buffer zone of 10-15 m on each side of the stream, as specified in the provincial legislation (Government of Newfoundland and Labrador, 2010). The width of the buffer zone should be defined based on the slope. In addition, to assure that the buffer zone is marked properly the perimeter should not be made during low water levels. Instead, the mark should be put where the high water level is during the wet season.

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The importance of studies: Developers should be required to conduct hydrological studies before they start developing.

- *New methodologies and technologies:* We should be implementing new, more sustainable methodologies and technologies that have been used in similar geographical contexts, which have shown to be successful.
- *Implementing lessons learned:* We should be learning from other regions and/or municipalities that have already gone through the process of urbanization and urban sprawl. There is no need to make the same mistakes as they did but instead we should be studying and implementing their “lessons learned”.

Recommendations from professional planners:

- *Storm water management:* Storm water management should be part of integrated land management. We should improve existing storm water management and/or use alternative methods of storm water management. Vegetation, including buffer zones around streams, should be preserved to absorb excess runoff and recharge groundwater. Additionally, placing storm water discharge pipes directly into streams should not be allowed [Municipal staff mentioned this as well].
- *Septic systems:* We should be using new, alternative ways for septic systems (e.g. communal septic systems) instead of relying on individual, 500 gallon septic systems. For this to happen, municipal government needs to see the value of this and take ownership of these systems so that they can be properly administered. In addition, the province needs to come up with better regulations regarding ownership.
- *Hydrological studies:* Hydrological studies should include aquifers, as well as rivers, lakes and watersheds.
- *Cooperative watershed management:* We need cooperative watershed management, which should be regulated by adequate provincial and regional legislation.
- *Serviced and densified development:* As noted by several planners, new development should be serviced (i.e. increased density). These developments should also vary in size and type, resulting in a mix of large and small size lots and dwellings that would be connected to municipal water supply and individual wells. In general, however, new developments should be serviced and built on a smaller size lots.

Recommendations from council members and municipal staff members:

Un-serviced development: The 1 acre policy is not the only solution for the current problems related to un-serviced development. Un-serviced development should be built on larger sized lots (i.e. 2 or 3 acre).

Filling in wetlands: We should avoid filling in wetlands. There should be more emphasis placed on mapping and protecting wetlands (especially the bigger wetlands such as those that are visible on the 1: 50 000 map).

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The *right* type of development: making development sustainable for future of our water supply

The importance of planning

Through the course of this study, planning was repeatedly mentioned as a crucial phase of land management. We often heard complaints about how not enough thought has been put into municipal and regional planning. One of the reasons why so little attention has been given to (proper) planning is that not many see the value of planning. Environmentally-friendly, naturally endowed lot planning is oftentimes perceived as an extra service and not as a key element of land management. This was emphasized by one of the professional planning consultant that participated in our study; that ideally, land management should be a process consisting of six phases: planning, programming, designing, building, monitoring and maintaining. At the moment, the first three phases are usually skipped (e.g. planning, programming, and designing) and most of the land management and development planning is done by engineers, most of whom do not have environmental and conservation training.

A second reason why conceptual planning is usually not a part of land management is that the municipalities often underestimate the value of having or creating a vision of what kind of community they wish to become. The majority of time and resources deal with every day operational tasks, but rarely think about the long-term strategy for their community. The small number of staff is another very important limitation. While municipalities might have planners that primarily deal with permits and rezoning, they are rarely able to support additional planners that can specifically focus on land planning, community capacity, and policy. Ideally, municipalities would need to have both types of planners. It was pointed out several times throughout the study that it is hard to prevent bad development if communities have no vision.

While not all of our participants mentioned a six phase land management, they clearly stated that the current way of development on the Northeast Avalon is unsustainable. From an environmental point of view, participants thought that we should be doing a much better job in mapping and protecting land of ecological/environmental significance. They were of the opinion that, at the moment, we simply destroy such land because of inappropriate planning and development.

Some of the participants called for the collective approach and integrated land management. This management approach aims to enhance the land's economic and environmental benefits for current society while maintaining or increasing land's capacity and benefits for the future generations (United Nations Commission on Science and Technology for Development, 1997). In doing this, it applies a multi-stakeholder, trans-disciplinary and cross-jurisdictional approach to policy and the decision making processes. Integrated land management has become institutionalized in Canada and is getting recognized across as the globe as an important approach for

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land use and natural resources management (Bellefontaine, Haley and Cantin, 2010).

Keeping the rural integrity of our communities

Another important element of this sustainable development is that it should not have a negative impact on the “ruralness” of these municipalities. More specifically, some of the participants thought that the rural landscape and rural lifestyle that attract newcomers to these communities was being destroyed by the same newcomers and the new developments. They were fearful that these communities are losing their rural character and that they are turning into bedroom communities. Participants understood that it is unlikely that these communities will ever go back to being a true rural community, one that lives completely off the land and noted that development is inevitable. However, the participants wanted for their communities to strike some kind of balance between so called “rural community” and its “traditional lifestyle” and the increasing development (e.g. subdivisions) that is rapidly turning these communities into suburbia.

Participant recommendations related to *planning and land management*

Recommendations from local residents:

- *Public consultation*: Residents believed that not enough effort and time is put into making sure that the voices and opinions of those affected by the decision-making process are heard and taken into account. For instance, there were occasions in which, even though residents raised their concerns about the impact of new developments on the drinking water supply, the municipal government dismissed their complaints and approved the new development. Residents argued that their opinions on developmental planning and land management, and its impact on the watersheds and drinking water supply, should be taken into consideration during future land management decision making processes. In general, municipal governments and local residents need to open a dialogue about the impacts of the development on their community and whether these changes are desirable or not.
- *Sense of community*: To help achieve a more balanced development, communities should nurture a sense of community and encourage community engagement. In addition, more effort should be done to create connections between residents and their natural environment, encouraging them to take personal pride and interest in their local environment. For instance, municipal government and local NGOs should help familiarize local residents with their natural environment, raising awareness about the environment and, more importantly, creating a sense of stewardship and ownership.
- *Protecting the land*: Land of particular ecological/environmental significance should be identified, mapped and protected. This should be done before the actual planning and building takes place [Mentioned by all three groups (local

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resident, municipal staff member/council member, and planners)]

- *Updated policies:* The new regional plan for the Northeast Avalon should be developed as soon as possible [Local residents and planners held the same opinion.]

Recommendations from professional planners:

- *Proper land management:* The proper land management should consist of six phases: planning, programming, designing, building, monitoring and maintaining. Unfortunately, current land management usually starts with the building phase thus skipping the first three phases. Moreover, management practices should be based on integrated land management.
- *Five dimensions of sustainable development:* We should aim to have sustainable development that incorporates the following five dimensions: culture, environment, economy, governance and society.
- *Hydrological studies:* Hydrological studies should be conducted before planning and building start.
- *Watershed borders determine land development:* Ideally, land development should be based on watershed borders and not on municipal borders. This would require more cooperation between municipalities and it would need to be accompanied by a change in policy [Mentioned also by municipal staff member/council member and planners.]

Development and Policies

During this study, many participants expressed their frustration regarding lack of policy. Most of the time, the problem was not that the provincial or municipal regulations and policies were bad or insufficient, but that they were not properly implemented or enforced. Participants often pointed out that nobody monitors whether the regulations have been implemented or how they have been implemented. They also stressed that those who are not abiding the law do not experience any repercussions for their wrongdoing, which often encourages further illegal activities.

Another challenge was that many of the existing regulations and guiding documents were outdated. This caused a lot of frustration for planners, for instance, as it means that they need to integrate new visions into an outdated, archaic document. In addition, the challenge with policies such as *Groundwater assessment guidelines* [Government of Newfoundland and Labrador, Department of Environment and Conservation, Water Resource Management Division. (2009). Groundwater supply assessment and reporting guidelines for subdivisions serviced by individual private wells. Retrieved on September 26, 2013 from

http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC4QFjAA&url=http%3A%2F%2Fwww.env.gov.nl.ca%2Fenv%2Fwaterres%2Fregulation%2Fappforms%2Funserviced_subdivision_gw_assessment_guidelines_dwh_revisions.pdf&ei=NA_HUsTdOIiO2wWqmIDACw&usg=AFQjCNGs7CXfZBrf_GOrPTN

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[Cqq31TlcvTw&sig2=Sa5BFcTkaImTziVKuNCUIQ&bvm=bv.58187178.d.b2l\]](#) is that they are only guidelines, not regulations. Because the guidelines have only limited power this, among other things, allows developers to do only the bare minimum. It has also been said that, because the current guidelines and regulations are not always specific enough, they can be interpreted in many ways.

Recommendations for better policies and proper implementation of polices that were *mentioned by the majority of our participants*:

- Provincial and municipal governments should put more effort into monitoring the implementation of regulations and policies. In general, there is a great need for an improved enforcement of policies.
- Provincial and municipal governments should enforce and increase the fine for illegal activities.
- We need better, updated legislation on land planning, land development and watershed management.
- Legislation regarding development should be more specific in directing developers regarding what they need to do and how exactly they need to achieve this.

Regional Watershed Management: Regional Collaboration as a Viable Solution for the Future?

One of the questions in this study was whether there is a need for a more collaborative watershed management or more specifically, whether regional watershed management was perceived as a viable alternative to individual municipality watershed management. What we found is that many participants said that regional watershed management might be the best way to deal with the increasing water demands and other challenges associated with development on the Northeast Avalon such as preserving wetlands that support water quality and quantity. Regional watershed management was seen as an appropriate approach to deal with some of the following situations: when development in one municipality negatively affects the quality and quantity of drinking water in the neighboring municipality; when one municipality reaches its maximum water capacity and might need to look for alternative water sources from other municipalities; in cases when the costs of developing new water supply systems or improving existing ones are too high for a single municipality etc. Regional watershed management would require a strong municipal collaboration and a direct, more active involvement of the provincial government. For this large-scale management system to work properly, ownership and responsibility would need to be defined well in advance to avoid tensions and conflicts in the future. We will describe below some of the identified mechanisms that encourage and discourage regional collaboration. These mechanisms relate not only to the concept of regional watershed management but to the regional collaboration in general.

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Mechanisms that *encourage* regional collaboration as mentioned by the participants:

- *Improved communication:* Exchange of information and experiences is one of the key elements in encouraging better collaboration between municipalities as well as collaboration between provincial and municipal governments. Municipalities need to foster better communication between each other and dismiss the belief that no communication is needed. This stance is often linked to the historically rooted rivalry and competition among municipalities that hampers collaboration.
- *Municipalities Newfoundland & Labrador:* An important non-governmental organization that encourages regional collaboration is Municipalities Newfoundland & Labrador (MNL). MNL is an umbrella organization mandated to represent municipal government interests; MNL also acts as a bridge between municipal and provincial government. MNL annual convention represents a great opportunity for the municipalities to share information and talk about their experiences, but this platform has not yet been used to its full potential.
- *Other non-governmental organizations:* Other non-governmental organizations, such as the environmental group Northeast Avalon ACAP, also play a role in encouraging and influencing regional collaboration. These groups can help create an inclusive style atmosphere where environment and conservation leaders, regional government representatives, residents and development practitioners can network and share ideas for strengthening water management policy.

Mechanisms that *discourage* regional collaboration as mentioned by the participants as mentioned by the participants

- *Inequality between municipalities:* In comparison to small(er) municipalities that have a very limited budget and a small number of staff, St. John's has a much bigger pool of human and financial resources. Small(er) municipalities perceive this advantage of St. John's as a real barrier for any type of collaboration as it automatically puts them in a subordinate position.
- *Planning is essential:* Regional collaboration requires detailed planning that is part of a municipal long-term vision. However, many municipalities cannot afford to have a permanent planner and are predominantly focused on doing things on a day-by-day basis. Here again, the lack of human and financial resources is preventing or at least significantly slowing down the process of regional collaboration.
- *Inadequate policies:* The ability to cooperate is driven by policies and if these are not working, it is hard to achieve cooperation. The current policies lack

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vision and do not encourage regionalization. Some of them are also quite outdated, including the St. John's Urban Region Regional Plan that regulates the land use planning on the Northeast Avalon. The Plan was developed in 1976 and while there have been amendments to the Plan, it had not been comprehensively reviewed since it was adopted. At the same time, there are fears that the new Plan will create competition within municipalities and further divide the region, splitting it into rural north, urban core and rural south and putting at risk the sustainability and independence of small rural communities in the north and south.

Development, Water Supply and Watersheds Management on the Northeast Avalon: Examples of Lessons Learned

What experience is there with solving prior drinking water issues in the region that might inform and guide efforts to better integrate future watershed and water supplies management practices?

The importance of research

When asked about the research done on their local water supply, the majority of our participants (including municipal staff member, council member, and local residents) could offer very little about such research. Those who were aware would usually mention groundwater assessment procedures associated with un-serviced developments or the water quality monitoring of either municipal water supply or private wells. Other types of hydrological research were rarely mentioned, although many participants believed that the municipalities and province lack hydrological data and that we need to do more hydrological studies. In general, participants argued that proper water management needs to be based on good hydrological data and qualified with sound environmental research.

That being said, we believe that the hydrological surveying done in Logy Bay-Middle Cove-Outer Cove is a nice example of how a large-scale hydrological study can improve municipal water management and ensure its sustainability. The main objective of this study, commissioned by the LB-MC-OC and conducted by the CBCL Limited, was to evaluate the hydraulic structures within LB-MC-OC and create flood risk maps of the four study basins: Kennedy Brook, Outer Cove Brook, Coakers River and Drukens River. The study findings were then used to assist in the management of surface water resources (CBCL Limited, 2012). In the following paragraphs we will describe this particular research and explain why we regard this experience as an important lesson that might inform and guide efforts to better integrate future watershed and water supplies management practices on the Northeast Avalon.

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Case study: Logy Bay-Middle Cove-Outer Cove

The municipality of LB-MC-OC relies solely on the individual well-based water supply that, as mentioned previously, is said to sufficiently sustain the Towns' current rate of development. However, the Town has experienced flooding and runoff that has been attributed to the new development from outside the LB-MC-OC municipal borders. More specifically, the LB-MC-OC council was of the opinion that the development alongside the municipal border with Torbay and St. John's (around Stavanger Drive, Costco area) caused the intense flooding and runoff. The council was concerned about development close to the rivers, and since during the recent intense flooding a Town's bridge was destroyed, the council wanted to know whether the bridge and the existing culverts could sustain future flooding and charge from upstream development. The Town decided to finance a flood risk study for four main river areas in LB-MC-OC. This study identified that the bridge and culverts were indeed under capacity due to the outside pressure. The study's findings were then used to persuade the province and the City of St. John's to assist in financing of the rebuilding of the new bridge.

The flood risk study was done in conjunction with another hydrological study; this one focused on mapping wetland areas within LB-MC-OC. Engineers conducting this study were asked to identify wetlands that can be seen on the 1: 50 000 maps. Once these wetlands were identified, they were then put onto a municipal map. The reasoning behind this study was the Council's opinion that the wetlands, which are visible on 1: 50 000 map, should be protected and not, as was often done in the past, simply removed during the development. The council intends to use this municipal map to persuade developers to make "smart decisions".

In addition, the increase in the commercial development in Torbay and the challenges it poses for the LB-MC-OC's water management might soon bring about another hydrological study. If approved, this regional water study would be jointly conducted by LB-MC-OC, the Department of Environment and the Town of Torbay. The study would investigate the domestic and commercial water demand in a highly developed area adjacent to the LB-MC-OC and Torbay municipal borders. The Town of LB-MC-OC hopes that the findings from this study could be used to further investigate and mitigate the impacts that the development in Torbay has on the LB-MC-OC's watershed and water supply.

While some of the above-mentioned circumstances might be unique for LB-MC-OC, there are several important lessons that other municipalities can draw from. Findings from water studies allow municipalities to make relevant, sound decisions about their water supply and water management. Moreover, findings like these can give the municipality greater control over decisions-making processes, especially if these occur within the context of several municipalities or between a municipality and the

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provincial government. In addition, good hydrological data supported by an effective municipal bylaw might be a good way to help protect wetlands that support a healthy water supply. Lastly, this case demonstrated the permeability of municipal borders and the extent to which development in one municipality can negatively affect the water supply and management in the other. We may expect that with the continued development of the Northeast Avalon, there will be more instances like the one just described. Thus, municipalities will have to learn how to deal with this challenge and how best to mitigate the negative effects associated with continued development. Given the permeability of the municipal boundaries, regional watershed management will be crucial in supporting sustainable water supplies into the future.

Suburban dilemma: To curb development or regionalize services in Torbay?

Torbay is a municipality undergoing significant growth and development. Its population increased by 15% since the last census and there are approximately 100 new homes built each year. Currently, most of Torbay consists of residential areas and the past council wanted to increase the number of industrial areas, and with this, the town's commercial tax base. However, the serious challenge impeding Torbay's development is the fact that the town reached its municipal water system's maximum capacity. An evaluation of water capacity was conducted and showed that Torbay has the maximum capacity of 1500 dwelling units; Torbay is now at 1400 dwelling units. The current serviced development is mostly done on in-fill lots and the town already has had to reject certain developments. In the meantime, the three new developments, known as Forest Landing, Pine Ridge, and Jones Pond are all un-serviced. Even though it is possible to continue building new residential and commercial developments on un-serviced lots, many participants questioned the sustainability of such system, noting that there is a lack of hydrological data regarding groundwater availability in Torbay.

Torbay has been trying to address the issue of water capacity by developing an additional municipal water source. The town has looked into turning Great Pond into a secondary source but found the pond to be too shallow. Another pond, called South Pond, was also found to be unsuitable as a secondary source due to contamination from the St. John's airport. A toxic plume, originating in 1970s, is a product of chemicals used for de-icing airplanes and fire-suppressant chemicals used by firefighters during training on the airport property. The tests showed that the toxic plume, which includes phosphates and glycol, polluted the soil and the groundwater in this area. Besides polluting the South Pond, the toxic plume also restricted the development in the adjacent areas since any additional groundwater draw would exacerbate this pollution. By limiting development, especially industrial development, the toxic plume has had a negative impact on the town's finances. More importantly, the toxic plume poses a health risk and as such, requires regular monitoring.

Torbay has also looked at the possibility of connecting to St. John's municipal water system. There is a dialogue with the City of St. John's but, as noted by our

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participants, this regional approach, although often discussed, is not easy to reach. Bringing water from other places such as St. John's is an issue for some, who questioned the reliability of such a setup and the dependence on another municipality. Participants said that the east end of St. John's might not have that much water and that the current infrastructure might not be capable of such support. Connecting to St. John's for water translates for some as the loss of Torbay's independence. Smaller communities, as stressed by many of our participants, greatly value their independence and are reluctant to give it away.

Some of Torbay's residents mentioned an alternative regional water supply, one that would service Flatrock and Torbay, and possibly even Bauline and Pouch Cove. Potential sources of water for this system are several ponds within Flatrock, including Middle Pond (i.e. Medalsis Pond), Moon Pond, Half Moon Pond, and Middle Three Island Pond. The idea of such regional water supply has been mentioned to the municipal government, but the system is considered too costly and so far there has been little or no interest in it. Historically rooted rivalry between neighboring communities is another factor said to prevent this and other regional cooperation. At the same time, proponents of this idea pointed out that water can be a unifying force among municipalities and that the cost of developing and maintaining this system would be shared between municipalities. In addition, it might be easier to get money from the provincial government if several communities work and apply together.

The complexity of Torbay's situation undoubtedly requires a more involved solution than the one indicated in the section's title. We cannot predict what the final solution will be and what sort of compromises it will require. We can, however, expect similar scenarios and dilemmas to occur in other municipalities. Curbing development, finding other revenues to increase municipality tax base, regionalization of services, need for cooperation, the issue of independency – are some of the issues that other municipalities will be faced with in the near future.

When it comes to watershed management, **it is imperative that we find a way to establish regional management as watersheds transcend political boundaries to ensure we implement ecologically relevant planning to ensure sustainable development.**

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Conclusions

While we observed a wide range of opinions regarding water quality and quantity, we noticed that the majority of our participants were concerned about their water supply and worried about the issues they might face in the near future. Those participants who were concerned about their drinking water were also generally interested in nature conservation and emphasized the need to protect watersheds, wetlands, and coastlines.

However, aside from those who were directly involved in drinking water management such as town staff, municipal council members, and professional planners, the majority of our participants had a somewhat limited knowledge about their local water supply. This is particularly true for the historical development, management and research of the water supply. Those that rely on wells as their water supply usually had a more in-depth knowledge about the development and management of their water supply.

Our participants mentioned that many residents hold a belief that there is an almost endless supply of water in Newfoundland and that there is no need for concern. A few of them stressed that the people in the province do not have a high environmental awareness. Some even speculated that the abundance of natural resources and open spaces in Newfoundland created complacency among people and a sense that the natural environment is robust enough to handle any kinds of anthropogenic pressures. Participants also said that although Newfoundlanders appreciate nature, because we have never experienced such high pressure from developers and development in the past, we weren't concerned about protecting the land. Many thought that we need to do a better job in increasing environmental awareness.

An important message from this study is that the participants were not against development per se but that they want a different development. Some called this development “smart” development, or “smart growth”, and some referred to it as integrated land management. Regardless of the term, what they called for is development and land use management that is based on scientific research data, is controlled by strict regulations, has long-term, multiple benefits, and does not have a devastating impact on the human and natural environment. In other words, participants wanted to see sustainable development and land use management. According to our participants, a key element of a balanced development was envisioning, planning, and building the sense of community.

Recommendations

- Regional watershed management is key method to deal with the increasing water demands associated with development on the Northeast Avalon. Regional watershed management would be highly relevant: when development in one municipality negatively affects the quality and quantity

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of drinking water in the neighboring municipality; when one municipality reaches its maximum water capacity and might need to look for alternative water sources from other municipalities; in cases when the costs of developing new water supply systems or improving existing ones are too high for a single municipality. Regional watershed management would require a strong municipal collaboration and a direct, more active involvement of the provincial government. For this large-scale management system to work properly, ownership and responsibility would need to be defined well in advance to avoid tensions and conflicts.

- Planning is a crucial element of land development. However, most municipal staff and developers are not environmentally schooled and may fail to preserve natural landscape within rural communities.
- While larger wetlands can be identified on the 1: 50 000 maps, small wetland cannot, resulting in a considerable underestimate of wetland cover. These smaller wetlands also need to be protected, but are not considered when development permits applications are submitted. The Province should not limit their assessment criteria solely on “mapped” wetlands. There is an urgent need for a regional assessment of wetland status in the Northeast Avalon, to determine rates of loss or degradation, and to identify key wetlands to be preserved for watershed integrity and drinking water security.
- Many of the areas have low watershed intactness values; therefore the remaining large tracts of land with high watershed intactness within each municipality should be zoned for conservation and watershed protection, in order to safeguard long-term drinking water sustainability
- Regional collaboration requires detailed planning that is part of a municipal long-term vision. However, many municipalities cannot afford to have a permanent planner. A way around this problem might be a regional planner who would work with the smaller communities to advance regional approach.
- We heard many instances in which, even though residents expressed their concerns about the impact of new developments on the drinking water supply, the municipal government dismissed their complaints and approved the new development. This further supports the belief among many residents that the municipal councils are strongly under the influence of developers. More effort and time needs to put into making sure that the voices and opinions of those affected by the decision-making process are heard and taken into account.
- Clear cuts are not necessary for installment of a storm water management system. A storm water management system can be installed within a vegetated lot, but costs of such installment maybe higher compared to a clear cut development.

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- Septic tanks, although widely used in rural and peri-urban areas and commonly regarded as an efficient approach for onsite treatment of domestic wastewater, can be a potential source of water pollution. The fact that they are not monitored results in an underestimation of the negative aspects of these systems. We need to improve the design, installation, maintenance, and monitoring of septic tanks to minimize the risk to the water quality, especially in the environmentally sensitive areas. In addition, more efforts should be put towards implementing alternative ways for waste water management.
- Residents should test their well water more regularly.
- Non-governmental organizations (for example, Northeast Avalon ACAP) play an important role in encouraging and influencing regional collaboration. These groups can help create an inclusive style atmosphere where environment and conservation leaders, regional government representatives, residents and development practitioners can network and share ideas for strengthening water management policy. We suggest that NAACAP be approached to hold a public workshop where relevant water management best practices are presented and discussed with key management and development individuals in attendance. Information shared via the workshop can help guide current and future sustainable development decisions.

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Appendix 1

Community Water System Interview Guide

Name:
Date
Place:
Organization:

Opening questions: the Interviewee's background (esp. in relation to water supply in question)

Where do you live?
How long have you lived here?
What is your profession? (Role)
How long have you been working/associated [*with the subject town/area*]?

The Drinking Water Supply

What is the local source of drinking water? Is it the only one? Is there a back-up supply?
How long ago was this supply developed and/or designated? Can you tell me anything about the historical development of the drinking water suppl(y/ies) locally?
How is drinking water currently delivered in the community? Do all residents have piped services? What proportion of community households rely on well and septic systems?
How is the water supply managed/protected?
How would you describe the quality and quantity of your local drinking water?
Are you aware of any research that has been done on the local water supply? Has there been an evaluation of the sustainability/capacity of the water supply?
Has hydrological surveying been undertaken in the area? (*esp. in case of well-water supplied areas*)
What groups/organizations have you partnered with regarding water-quality management?

Issues for Area Drinking Water Resources

What kinds of development/land use is there in the vicinity of the water suppl(y/ies)?
What kinds of development/land use is there in the vicinity of the greater watershed/catchment? What other threats to surface and shallow subsurface water quality exist in the various watersheds under study?
Have there been past problems with the water supply and/or delivery system(s)?
Have they been addressed/resolved? If so, how? If not, why?

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What would you consider the emerging or more recent challenges you face in managing your community's drinking water supply?

What are the major barriers to collaboration with government/non-government groups around the issues?

Describe your relationship with the provincial and federal government departments/agencies, NGOs or private industry regarding drinking water quality?

Has the relationship changed over time?

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