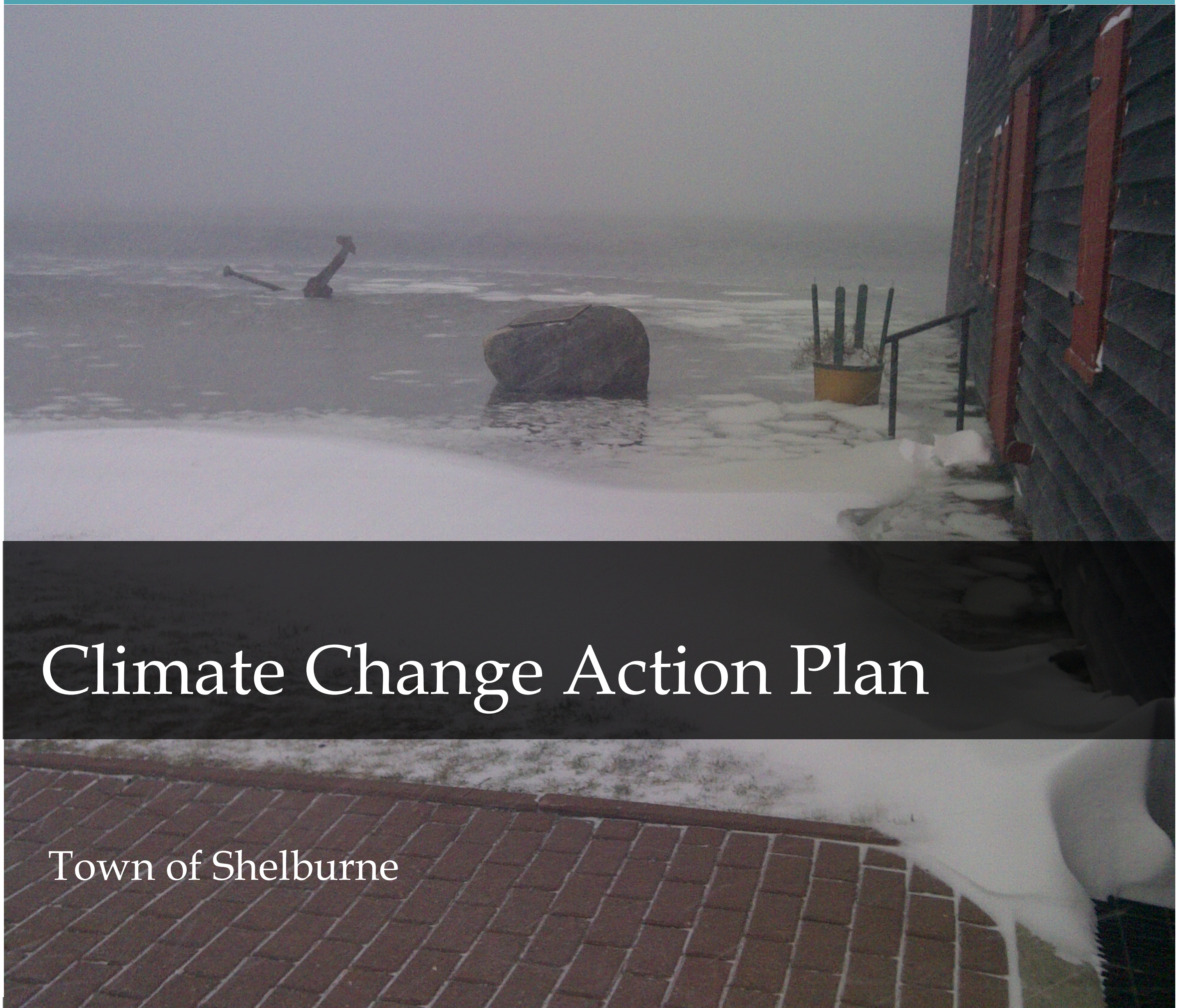

Climate Change Action Plan

Town of Shelburne

2014

Acknowledgments

- Municipal staff, members of the Shelburne Town Council and members of the public who served on the Climate Change Committee
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- Garth DeMont, Geologist, Nova Scotia Department of Natural Resources
- Réal Daigle, Climatologist and Director, R.J. Daigle Enviro®
- Gavin Kennedy, Project Hydrogeologist, Nova Scotia Department of Natural Resources
- Kevin Keys, Site Productivity Forester, Nova Scotia Department of Natural Resources

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Statement from Mayor

This report serves as the Municipal Climate Change Action Plan in fulfillment of the 2010-2014 Canada-Nova Scotia Municipal Funding Agreement. It functions as an amendment to the Integrated Community Sustainability Plan for the Town of Shelburne.

The process of developing the Municipal Climate Change Action Plan has been very interesting, informative and sobering in terms of understanding the potential risks that will be presented to the Town of Shelburne via climate change over the next several years.

Our task was to develop a plan that identifies existing and potential risks that are associated with eight natural hazards and then with the help of experts in the field, identify known areas of concern while thinking about how the severity or frequency may affect various locations. The hazards include coastal erosion, flooding from storm surges, inland flooding, wildland fire, winter storms, extreme heat and hurricane force winds.

As a result, this plan was developed to ensure people, property, infrastructure and essential services are protected from natural hazards associated with changing climate conditions.

Thanks to all those who helped us through the process, with special thanks to Anne Warburton and Heather Mackenzie-Carey

Karen Mattatall

Mayor, Town of Shelburne

Council Resolution

This document was adopted by Town Council for the Town of Shelburne on February 19, 2014 through the following resolution:

THAT Council adopt the Municipal Climate Change Adaptation Plan as presented, as amendment to the Integrated Community Sustainability Plan of the Town and be submitted to Service Nova Municipal Relations Division.

Executive Summary

The Town of Shelburne can plan and design development and infrastructure with information that the forefathers could only dream of having: information about how the environment is *changing*. While such information inherently includes uncertainty, there is now enough evidence-based information about climate *trends* that the Town can evaluate risks and spot opportunities through the lens these trends provide. In essence, the Town can learn from the future. These lessons offer an opportunity to strengthen adaptive capacity: the ability to prepare for, respond to and recover from sudden and gradual challenges. By focusing on improving adaptive capacity, benefit is derived regardless of how future climate unfolds.

A Climate Change Action Plan Committee consisting of Town Councilors, administrators, the Emergency Measures Organization Coordinator and a member of the public undertook a collaborative learning process that analyzed how projected changes in climate could exacerbate natural hazards. They then considered what the potential impacts of the hazards would be given existing land uses, emergency response plans and the condition of infrastructure. The Climate Change Action Plan Committee also considered the municipality's capability to reduce related threats. This information was synthesized and specific actions were identified that would help to protect people, property, special places and Town assets from gradual changes in climate, as well as severe weather events.

Eight natural hazards were analyzed: inland flooding, coastal flooding from storm surge, drought, wildland fire, winter ice events, hurricane force winds, extreme heat and coastal erosion. Of these, inland flooding, coastal flooding from storm surge and drought posed the most significant concerns that not only could result in unwanted impacts, but also are able to be addressed through Town policy, procedures, infrastructure decisions, and education and increased awareness.

For inland flooding, actions primarily deal with ensuring water moves either within natural drainage patterns, or where that is no longer possible due to development, is handled in a manner that does not endanger people, property, or damage Town infrastructure.

Sea level in the Atlantic Basin has been rising faster than global estimates. For the coastal flood analysis, the Climate Change Action Plan Committee used water level scenarios provided by the federal-provincial climate adaptation research initiative called the Atlantic Climate Adaptation Solutions Program. These scenarios were derived from historical climate data from a climate station in

Liverpool Milton, and the Liverpool station of the Canadian Hydrographic Service. Historical data was then used to fine tune global climate models and provide locally relevant, downscaled climate projections.

Three scenarios for total water volume were considered in the hazard impact analysis: one representing an elevation where minor flooding is already being observed. The second combines the surge of a 100-year storm with a high tide, and a sea level as projected for the last quarter of the century. The third scenario is a worst-case scenario. It applies the same formula as the second scenario but uses a higher number for storm surge: a surge height recorded during a historical storm that exceeded what was statistically expected of a 100-year storm.

Actions related to coastal flooding seek the balance between the responsibility to protect the Town and low event probabilities. A dynamic aspect of municipal climate adaptation planning is that it must embrace the long-term implications of land use decisions, the near-term implications of infrastructure investments (i.e., the life-span of infrastructure), and the immediate interests of emergency mitigation and response. Therefore, coastal flooding actions focus on providing homeowners with information on what is currently understood about coastal flooding so they can manage their own risk, mitigating flood risk of new developments or redevelopments through land use planning, repairing and maintaining revetments and seawalls in a manner that can be heightened over time, and protecting existing infrastructure.

The Climate Change Action Plan Committee's analysis of drought shed light on the increasing importance of securing a secondary supply of source water. Drought will exacerbate issues of water quality, and introduce issues of water quantity. The impact to the Town would be primarily financial as water treatment costs could increase. Drought could also have implications to public health and the local economy.

The Municipal Climate Change Action Plan also summarizes existing information about the Town's greenhouse gas emissions and presents strategies to reduce or avoid future emissions. The Town's corporate emissions result mainly from heating buildings. Action ideas focus on reducing these emissions in those building which the Town owns and has direct control over operations. As well, the Town continues to be interested in renewable energy opportunities.

The development of this Municipal Climate Change Action Plain fulfills a requirement of the 2010-2014 Gas Tax Agreement and Municipal Funding Agreement, and furthers Town goals stated in the Integrated Community Sustainability Plan.

Section I

MCCAP Development Process

Background

In 2013, Shelburne formed a Climate Change Action Plan Committee (Committee) tasked with overseeing and contributing to the development of a Municipal Climate Change Action Plan (MCCAP). The continued receipt of gas tax revenue was contingent on the submission of the MCCAP to Service Nova Scotia Municipal Relations by end of the fiscal year. Shelburne received approximately $130,000 in gas tax revenue in 2012-2013. The MCCAP, as set out in the terms and conditions of the Municipal Funding Agreement, is considered an amendment to the Integrated Community Sustainability Plan submitted to the Province in 2010.

The need for gas tax revenue catalyzed the MCCAP project, although the Town was already keenly aware of and beginning to adapt to climate and weather challenges. These efforts, however, had not been evaluated as part of **a grander plan to manage the Town in a manner that is climate-wise and weather prepared**. The MCCAP development *process* was a means to begin a conversation about individual and organizational adaptive capacity. It was an opportunity to re-evaluate the state of the municipal planning strategy, existing infrastructure and infrastructure plans from a slightly new perspective and with the benefit of multiple disciplines and local knowledge. It was the synthesis of new and old: new contextual thinking about an old/inherited built environment and long-standing community values.

The bulk of the MCCAP effort focused on learning about climate trends and projections and applying this knowledge to decisions about land use and infrastructure planning to protect public safety and opportunities for prosperity. The process used by the Town to complete the MCCAP is explained in Section I of this report. A review of the hazard impact analysis comprises Section II. Section III describes additional information that was considered when identifying impacts and potential adaptation actions, including: the Town's current level of emergency preparedness; risk vulnerabilities of corporate facilities and infrastructure; social, economic and environmental considerations; and what is known about corporate greenhouse gas (GHG) emissions and efforts to reduce energy consumption. Section IV presents climate adaptation actions that emerged from the overall natural hazard risk vulnerability analysis and recommendations for the Province.

In partnership with external consultants and subject experts, the Town developed the MCCAP through a series of facilitated and collaborative work sessions, fieldwork, and individual interviews with municipal staff. Findings and decisions have been organized within this report in accordance with the mandatory content outlined in Appendix A of the MCCAP Guidebook, as prepared by the Municipal Services Division of Service Nova Scotia and Municipal Relations.

The Municipal Climate Change Action Plan Committee

The Town of Shelburne (Town) formed a Climate Change Action Plan Committee (the Committee) as a project-based working group assembled for the purpose of contributing to and advising on the development of the MCCAP.

The five-member Climate Change Committee (Table 1) worked with external consultants and subject experts (Table 2) to learn about climate trends and projections, and then used that context to evaluate how municipal operations and services would fare given these changes in climate.

The Committee's working sessions included, but were not limited to, the following topics:

- climate trends and projections, and projected water level scenarios,
- natural hazard and extreme weather event impacts,
- the Town's susceptibility to coastal erosion,
- economic opportunities and vulnerabilities in the context of regional climate trends, and
- MCCAP action ideas for climate adaptation and GHG mitigation.

Table 1 Climate Change Committee Members

Town of Shelburne MCCAP Committee	
Karen Mattatall	Mayor
Dylan Heide	Chief Administrative Officer
Roy O'Donnell	Councilor
Don Bower	Emergency Measures Organization Coordinator
Louise Lindsay	Public Member

Table 2 Consulting Team Hired to Assist with the Town's MCCAP Development

Name and Role	Title	Education
Anne Warburton Project Lead	Director, Elemental Sustainability Consulting Ltd.	MA Urban and Rural Planning BSc. Natural Resource Management BSc. Speech Communications LEED Professional
Heather MacKenzie-Carey EMO Lead	REMO Coordinator and Emergency Planning and Management Consultant	MSc Study of Risk, Crisis & Disaster Management Certificate of Study in General Social Work Emergency Medical Technician-Paramedic BSc. Health Education
Philip Finck Science advisor on erosion and flood mitigation	Coastal Geologist	B.Sc, Professional Geoscientist
Dr. Timothy Webster Technical advisor on mapping and water level scenarios	Research Scientist for coastal mapping and risk assessment	PhD in Earth Science from Dalhousie, MSc in Geology from Acadia, Post Graduate Advanced Diploma in Remote Sensing from the Centre of Geographic Sciences, BSc. double major Geology and Physics from the University of New Brunswick
Stacy Muise Engineer for the completion of the Preliminary Risk Assessment for infrastructure and facilities	Senior Civil Engineer	BSc. Math, B.Eng, Dip.Eng. Civil, Dalhousie University and the Technical University of NS

Additional Subject Experts

- Professional Geoscientists, Geologists, Hydrogeologists and a Forester within the Nova Scotia Department of Natural Resources: Garth DeMont, Gavin Kennedy and Kevin Keys.
- Réal Daigle, Climatologist, Director R.J. Daigle Enviro®, co-author of the ACAS report, Scenarios and Guidance for Adaptation to Climate Change and Sea Level.
- Dr. Blair Greenan, Head, Oceanography and Climate Section, Ocean and Ecosystem Sciences Division, Fisheries and Oceans Canada at the Bedford Institute of Oceanography.
- Dr. Li Zhai, Research Scientist specializing in sea level rise, Bedford Institute of Oceanography.
- Dr. Bob Robichaud of Environmental Canada's Meteorological Services Centre, Atlantic Storm Prediction Centre.

Municipal Climate Change Action Plan Committee

Terms of Reference

Background

When the Gas Tax commitment was renewed for the time frame from 2010 to 2014, it was provided to enable municipalities to continue to invest in environmentally sustainable infrastructure projects that contribute to reduced greenhouse gas emissions, cleaner water or cleaner air. Along with the commitment to the funding, there was a requirement for municipalities to prepare a Municipal Climate Change Action Plan to be submitted to Service Nova Scotia and Municipal Relations (SNSMR) by December 31, 2013.

Committee Objective

The Council of the Town of Shelburne has established the Municipal Climate Change Action Plan Committee to develop the required report while ensuring that they are incorporating and expanding on related issue contained within the Integrated Community Sustainability Plan (ICSP). The MCCAP will be amending or become an addendum to the ICSP. This committee is established for the sole purpose of developing the MCCAP and will be disbanded when Council has deemed this mandate complete.

Committee Format

Structure:

The MCCAP Committee shall be comprised of up to six members including the following:

- Chief Administrative Officer
- SCEEMO Coordinator
- Mayor Mattatall
- Deputy Mayor O'Donnell
- Two members of the public with preference to one having a scientific background.

All members of the committee must be appointed by Council and the Town will advertise for members of the public to become committee members.

Remuneration:
The members of the Committee shall serve without remuneration but may be paid such expenses as are necessarily incurred by members in the discharge of duties approved by the Committee.

Role of Members:
Each committee member is expected to attend meetings, provide feedback and input relative to the plan to be developed and advocate relative to the final plan when complete.

Secretary:
The Chief Administrative Officer will act as the Secretary of the Committee and will not be considered as having a vote.

The Secretary will have the following responsibilities to be executed in accordance with the Council and Committees of Council Procedures:

- Collect agenda items
- Develop and circulate agenda packages
- Prepare minutes
- Maintain, update and publicize the Committee's Action Plan as modifications are approved by Council
- Ensure that Council is presented with regular updates and motions requiring Council approval
- Be responsible for coordination of activities directed by the Committee including communications, document provision, etc.

Meetings:
Meetings will be arranged as required in accordance with the Action Plan ensuring that the mandate of the Committee is being met in a timely fashion in accordance with the final plan deadline for submission.

Stakeholder Involvement

At the beginning of the MCCAP process, the Committee posted a press release in the Town's local newspaper. The release explained that a Climate Change Committee was formed, their task at hand, and the provincial gas tax requirement that initiated the undertaking. Within that press release, citizens were given contact information if they wanted to learn more about the process. A second press release was issued when the Draft MCCAP Report was complete to highlight the Committee's findings and note that a copy of the MCCAP is available on the Town's website.

The Committee did not host public engagement events at the advice of the consulting team for a few practical and logistical reasons. First, the Town is geographically small and local knowledge of the area was well represented within the Committee to the extent needed for MCCAP completion. As well, the Committee included one volunteer citizen representative. Secondly, the Committee was working within a tight timeline, so the consultants advised that it would be best to use available time to review relevant research and build organizational capacity around the concepts of climate change and adaptation. As well, it was rightly predicted that public education and outreach would emerge as a Town priority in the MCCAP action items. Third, the Town is amidst a 'perfect storm' of unfortunate circumstances creating a contentious need to significantly raise water rates. Instead of hosting climate change meetings that would likely end up centering on the water rate issue, the Committee sought to identify opportunities to help mitigate these issues in the future (and at present) while simultaneously improving infrastructure decisions. As well, the Town is aware that the Municipal Planning Strategy (MPS) and by-law need formal review and update: a process that will entail significant public consultation. What was learned during the MCCAP process about changing climate conditions and natural hazards will shape what land use and infrastructure ideas are brought forward during that review process. In other words, findings and discussions emerging from the MCCAP will intelligently inform the Town's interests in managing assets in an increasingly sustainable manner.

Climate Change Action Planning Tenets

Four core beliefs underpinned the Town's approach to MCCAP development. First, assessing geological hazards with the best information available and incorporating this information into decision making is fundamentally good land use planning, and benefit can be derived from assessing natural hazards regardless of how future climate unfolds. Case and point for the Town of Shelburne is the propensity of flooding, both storm surge and inland. Though the impacts have been relatively minor to-date and the Town has taken initiative to mitigate flooding issues (particularly inland), it is well understood that flood risk vulnerability will likely increase and vulnerable (i.e., exposed) areas should take this risk into consideration when making planning and development decisions.

Second, actions that arise from assessing natural hazards should be designed for implementation, resulting in prudent actions that are precautionary in nature and financially and effectually realistic. Although many residents believe the Town is on an 'upswing,' and interest in the area's quality of life is growing, the Town is challenged by financial consequences of previous poor long-term infrastructure planning at all levels of government.

Third, climate change planning is most effective if designed to improve adaptive capacity (Figure 1). This requires taking into consideration the culture of the municipality and its governing organization. It substantiates the importance of collaborative working relationships, networks of support and informed decision-making. As well, focusing on municipal adaptive capacity provides an opportunity to assess the culture of governance: the processes, procedures and paradigm through which situations are evaluated and decisions are made. Currently, the Town is in a multi-year period of significant staff and leadership transition. This presents exciting opportunities for beneficial change. It also brings to light the role and importance of professional experience, mentoring, flexibility, and redundancy within the system.

Fourth, there is a direct relationship between land use/development control and disaster mitigation and response. Although land use planning takes a long-term perspective and emergency management planning tends to focus on the most probable event in the near term, cooperative and seamless processes for sharing information and decision-making are a core competence of a municipal organization in today's world. The MCCAP development process proved to be an opportunity to recognize and strengthen the mutually beneficial relationship between land use and emergency management skill sets. Case in point, one of the Town's MCCAP Action Items is to create a process where the Emergency Measures Organization Coordinator has input to land use decisions. With this process in place, the Town is better enabled to navigate the tension between the need for development and the interest and responsibility of public safety.

Adaptive capacity is the action component: the dynamic ability to respond and adapt in the face of change.

Instead of considering deficiencies in infrastructure, risk of illness, or other features that could theoretically place a community at a disadvantage during a crisis, adaptive capacity considers processes and response.

Aspects such as flexibility, redundancy, experience, and networks of support can all be key factors for developing adaptive capacity (Adger et al 2003, 2004, 2005, 2007; Posey 2009, Brown & Westaway 2011).

Social Vulnerability is the propensity of a system (community, individual, ecosystem) to suffer loss from a hazard event, or the degree to which a system is susceptible to hazards. Municipal planners can play a substantial role in reducing disaster impacts through ensuring that communities are developed in a way that limits their vulnerability to natural hazards" (Sandink & Fuller, 2009).

The International Panel on Climate Change defines vulnerability as, "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. (IPCC 2001)

Resilience is the capacity of a system to tolerate disturbance without collapsing into a different state. Resilience incorporates the ability of humans to think, act, anticipate, and plan for future disruptions.

'The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Walker 2004).

Figure 1 Adaptive Capacity, Social Vulnerability, and Resilience

A Method Focused on Impacts and Action

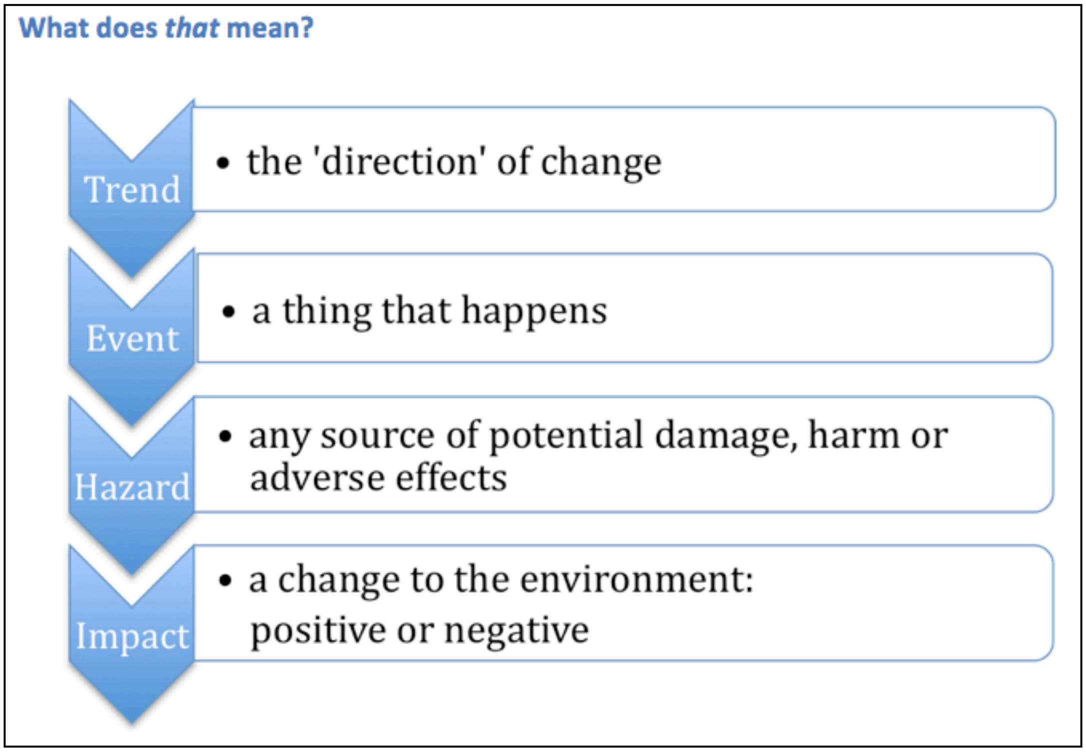


Figure 2 Definition of Hazard and Impact

Eight natural hazards were selected for assessment based on local knowledge and experience. The selection was validated by a thorough review of recent and locally relevant research about climate trends, projections and impacts. The primary sources of research were the Atlantic Climate Adaptation Solutions (ACAS) program, the Bedford Institute of Oceanography, the Nova Scotia Department of Natural Resources, Nova Scotia Environment, Climate Change Unit, and the National Atmospheric and Oceanic Administration of the United States Department of Commerce. The eight assessed natural hazards are:

- Inland Flooding
- Coastal Flooding / Storm Surge
- Winter Storm / Ice Events
- Hurricane Force Winds
- Coastal Erosion
- Drought
- Wildland Fire
- Extreme Heat Events

A hazard-specific impact matrix was completed for each of the eight hazards. The matrices organize and present the following information:

- hazard-related impacts,

- locations of concern when impacts can be spatially defined,
- rankings for impact severity (consequence),
- rankings for frequency,
- rankings for level of public risk tolerance, and
- an overall risk rating per impact.

The use of a hazard impact matrix aligns with the guidance provided by Service Nova Scotia Municipal Relations in their MCCAP Guidebook explaining submission requirements. While the Guidebook suggests a hazard impact matrix to convey results of assessing key hazards, the Town ranked *impacts*. Therefore, instead of presenting one matrix that synthesizes and ranks hazards, the Town of Shelburne MCCAP presents a matrix *per* hazard with associated and ranked impacts. Evaluating the impacts in terms of their potential consequences, probability and degree to which the community could tolerate such change (i.e., disturbance), sets the stage for identification of actions that are specific enough that municipal staff and Council can easily grasp what needs to be done, why and by whom. Thus the actions are more likely achieved.

Because climate change planning deals not just with gradual shifts in climate conditions, but also climate-influenced extreme weather events (e.g., heat waves, extended drought, more frequent intense precipitation) and rapid onset natural disasters (e.g., sinkholes, landslides, wildfires), it is critical to include an emergency management perspective in the assessment of natural hazards and impacts. In fact, it is a duty of the emergency management office (EMO) to analyze hazards to inform planning for disaster preparedness, mitigation, response and recovery. Therefore, municipal climate change planning is well served to draw from and complement this existing body of experience and knowledge.

The Town used a ranking methodology from the world of emergency management called the Hazard Risk Vulnerability Assessment (HRVA). This tool uses a 1-5 scale to evaluate impact severity (Table 3). The HRVA also uses a 1-5 scale for ranking probability (Table 4). The consulting team modified the original HRVA probability scale for use in MCCAPs. The modifications made to the scale better reflect climate projection timeframes found in climate research, such as the Williams and Daigle report. As well, the HRVA introduced into the Town's impact assessment process the consideration of public risk tolerance. The degree to which the public is or is not tolerant of a specific impact is of interest to the municipality in that it may influence the manner or speed with which the municipality addresses the issue.

It should be noted that the HRVA narratives that describe impact severity (i.e., the "Overall Impact Score") are written from an EMO perspective only. EMO is concerned with people's lives and safety first and foremost. That concern is immediate in nature, meaning that the EMO perspective is inclined to focus on the most probable event in the near term. Comparatively, municipalities as a whole take a wider view of 'threat'. In addition to public safety, a municipality is concerned with anything that poses a potential interruption of services (e.g., ability to distribute an adequate supply of potable water, ability to manage and treat wastewater, ability to stay financially solvent). Likewise, events or conditions that may result in damage to costly infrastructure are threats to a municipality's bottom line. As well, anything that has the potential to cause local job loss is also a threat, and changes in climate conditions or natural disasters can have major economic ramifications. To a lesser degree, events to which a municipality cannot adequately respond (in the eyes of the public) may be considered threatening because of the potential for diminished trust in, or credibility of, elected officials and municipal staff.

Because of a municipality's inherent need to consider an array of impacts that is wider than the net cast by EMO, the HRVA narratives for Overall Impact Score, like the probability timeframes, were modified slightly before use. The Committee then chose the Overall Impact Score that most accurately reflected the nature of the impact *if it were not mitigated*. For example, if the impact of concern was an interruption in the ability to provide safe drinking water, the Overall Impact Score chosen was the score that best described what the impacts to the community would be if that issue were not addressed.

Table 3 HRVA Probability Scoring Used for MCCAP

Probability Score: Considering historical occurrences and projections, the likelihood of occurrence in years.	
1	Highly probable: once every 5 years or less
2	Likely to occur once every 10 years or less
3	Might occur once every 25 years or less
4	Not expected; could occur once every 50 years
5	Rare chance of occurrence; once every 100 or more years

Table 4 HRVA Impact Severity Scoring Used for MCCAP

HRVA Overall Impact Score Narratives Modified for MCCAP Use	
1	Catastrophic, over 100 people affected; multiple fatalities; injuries, long term health effects; prolonged displacement (over 72 hours); long term effects to environment; destruction of critical infrastructure; loss of socially valued infrastructure; external resources required for immediate response; community unable to function without outside (provincial/federal) support: Municipal Emergency Operations Centre (EOC) activated for 24 hours or longer.
2	Significant; 51-100 people affected; no immediate fatalities; multiple serious injuries; long-term hospitalization required; displacement (24-72 hours); significant impact to environment- medium term effects; critical infrastructure, socially valued & property damage repairable within emergency budgets; external resources required to support/supplement community services/responders; some community services unavailable for less than 72 hours; Municipal EOC activated for less than 24 hours.
3	Moderate; 11-50 people affected; no fatalities, minor injuries; short-term hospitalization and treatment required; displacement (6-24 hours); no long term environmental, infrastructure or property damage; localized damage rectified by routine arrangements and mutual aid agreement resources; minor localized disruption to community services (non-critical) for less than 6 hours, EOC activated less than 8 hours.
4	Minor; less than 10 people affected; no fatalities, minor injuries requiring first aid/ out-patient treatment only; displacement (less than 6 hours); no sustained damage to infrastructure or property; normal community functioning with some inconvenience; no external resources required; Municipal emergency officials notified but no EOC activation.
5	Insignificant; less than 10 people affected; no fatalities, injuries or impact on health and property beyond first responder "everyday" capacity; no displacement; no damage to properties or environment; no disruption to community services or infrastructure; no resources gaps; No Municipal emergency official notification or activation required.

For each impact, the scores for impact severity (i.e., Overall Impact Scoring in the HRVA tool) and probability were multiplied (Figure 3). This provided a number on a scale of 1-25 that served as a measure with which to compare impacts (Table 5). However, a qualitative discussion about the public's risk tolerance of an impact could serve as persuasion to increase or decrease the final risk ranking.

(Probability x Severity of impact) + level of risk tolerance

Figure 3 HRVA Formula for Hazard Prioritization

Table 5 HRVA Risk Prioritization Scoring

Score	Risk Ranking	
1-5	High	The score used to rank risk is derived from multiplying the overall impact score and the probability score, and then considering if and how the score should shift into another risk category based on public risk tolerance.
6-10	Medium	
12-25	Low	

Action ideas were synthesized during the consulting team's background review, which included a literature review, interviews with municipal staff and a 'tour' of known areas of concern. Action ideas also emerged in conversation as the Committee discussed natural hazards and assessed unwanted climate impacts. All ideas for action were 'set aside' by the consulting team until a final Committee working session where the Committee was presented with a draft list of action items that they then collaboratively edited.

Section II

Natural Hazard Impact Analysis

Natural Hazard Impact Analysis

It is important to **focus on the trends** of climate projections more than specific values/numbers. Planning and infrastructure decisions will be well served to pay heed to the trend while understanding that the climate system is inherently variable. Therefore, any one event, or even series of experiences (e.g., multi-year droughts) does not necessarily denote a long-term pattern. The benefit of the MCCAP exercise is that the Town now has information about climate trends, and this information can be used in synch with land use and infrastructure decisions, which also involve long-term thinking. In essence, it is simply more information. And all good business planning seeks to make informed decisions.

This section describes assessment results of eight natural hazards. First, each hazard is explained. Secondly, a rational for its inclusion is presented. The rationale provides general information about observed and potential impacts in the Town. Lastly, a hazard impact matrix summarizes assessment results. When possible, specific information about each impact is given, such as locations that are risk vulnerable.

Underpinning the rationale for the inclusion of each hazard are the projections of William Richards and Réal Daigle in *Scenarios and Guidance for Adaptation to Climate Change and Sea-Level*. This study was designed to provide Nova Scotia municipalities with the best possible, most recent, and localized climate scenarios possible. Trends and projections were confirmed and built upon with 2012-2013 research conducted by the Department of Fisheries and Oceans at the Bedford Institute of Oceanography.

Climate projections are listed for the middle decade of thirty-year periods, reported as the 1980's, 2020s, 2050s, and 2080s. It is an internationally agreed upon meteorological practice to use 30-year time periods when reporting climate normals or averages, or extremes.

For the Town of Shelburne, historical climate data from a climate station in Liverpool Milton (id:8203120 @ 44.08N 64.77W) was used to "bridge between historical and future periods (Richards and Daigle, 2012)". This climate station was chosen because it provided quality historical data.

Sea-level rise parameters were keyed to Canadian Hydrographic Service (CHS) tide prediction sites (Richards and Daigle, 2012). For the Town of Shelburne, the CHS representative site used was Liverpool station 440, with a 2.30m higher high water large tide (highest tide averaged over 19 years) referenced to Chart Datum. Chart Datum is the plane of reference used for nautical charts. In Chart Datum, the lowest normal tide is the 'zero point'.

Inland Flooding

A flood is defined as an overflow or inundation that comes from a river or other body of water and causes or threatens personal harm or damage. This may occur as a result of weather events that deliver more precipitation to a drainage basin than can be readily absorbed or stored within the basin over a given period of time.

A pattern that has emerged from recent climate research is that the amount of precipitation on an annual basis shows little change. However, it is expected that **more intense rains could happen more frequently** (i.e., more rain will fall within a short period of time). In other words, there will be a decrease in the number of rainy days but an increase in the average volume of each rainfall event.

Trends also show a change in seasonal patterns. Annual rainfall is concentrating in the winter season. The Town should expect wetter winters and slightly wetter early springs. Summer and autumn mark a precipitation increase that is less than the standard deviation, so changes in these seasons can be considered negligible at this point.

Richards and Daigle (2012) explained that:

> "information on the impact of climate change on intensity short period rainfall rates is inconclusive at this point in time as there is no standard or accepted research methodology to determine how future sub-daily extreme rainfall could change in intensity and frequency at point locations or over a small area in the future climate. In spite of these caveats, enough evidence, based on theory and studies of trends, has been assembled to make recommendations on how short period rainfalls will increase by a certain magnitude."

The change in the intensity of short period rainfall is expressed as a percentage in the Richards and Daigle report. Specifically, the intense rainfall (expressed as millimeters of rain received within 24 hours) that we now expect from an event with a 20-year return period will increase. The amount of water that will fall in a '20 year return period' rainfall (i.e., an event that has a 5% chance of happening any given year) will be:

- 5% more rain fall by the 2020s,
- 9% more rain will fall by 2050s, and
- 16% more rain fall by the 2080s.

An increase in intensity of short period (≤ 24 hours) rainfall could easily endanger public safety. Inland flash flooding is far and away the greatest threat to people's safety during heavy rainfall from tropical storms, hurricanes, or short intensity rainfall events.

As well, an increase in intensity short period rainfall extends the capacity of water-handling public infrastructure. The Intensity-duration-frequency (IDF) curves used by hydrotechnical engineers to model rainfalls to determine the size and quantity of water handling infrastructure (and bridge heights) are traditionally summarized from historical events. However, the assumption that past rainfall is a good indication of what to expect in the future is no longer valid. It is up to the Town of Shelburne to specify that infrastructure be designed for future climate conditions.

Table 6 Richards and Daigle Projected Precipitation Changes

Parameter	1980s	2020s		2050s		2080s	
	Value	Value	SD	Value	SD	Value	SD
Precipitation-annual	1646.7	1691.9	40.4	1705.9	46.8	1756.5	61.2
Winter	502.3	526.7	20	539.3	25.7	568.7	32.9
Spring	424.1	438.2	18	444.5	24.1	461.9	31.7
Summer	287.2	292.0	17	291.1	22.6	291.5	37.4
Autumn	433	438.3	19.7	437.6	20.8	447.5	32.1
Value shows the change in mm in annual average rainfall							

Inland Flooding Impacts

Inland flooding is *already* an issue in Town. Many of the experienced inland flood impacts have been minor from a municipal perspective. Residents are used to experiencing minor transportation disruptions and property owners have found ways of coping. There is one exception however: there is one property that floods with such frequency and severity that it currently sits empty.

Although inland flooding has caused relatively minor impacts to date, these impacts were becoming increasingly frequent and more severe in recent years. This is a result of how development has changed natural drainage patterns (i.e., there was no hydrogeological information guiding development and large impermeable surfaces with inadequate drainage have been allowed) and exacerbated by the trend of intensifying rainfalls and extended rainy periods. Case in point, the 'mall' was built on a peat bog.

The eastern end of Town (south side of Town, and east of Brewhouse Lane) is particularly vulnerable to flooding from the unnamed brook that runs from the wetland (swamp) behind the Sobey's on King Street toward the Harbour. A Phased Culvert Replacement project in this area is underway, but poses significant financial challenges.

Other areas vulnerable to inland flooding include those properties alongside and within the drainage areas of Black's Brook (which forks within the Town before draining into the Harbour); the vicinity of Ohio Road, particularly along the Roseway River; and the western side of McGillis Point (i.e., what is known as 'the Commons').

In addition to the damage of private property, the Town's Public Works crew and citizens are noticing road washouts with increasing frequency. It is suspected that these washouts are a classic and common example of infrastructure design (in this case a road) built to historically derived IDF curves that are no longer valid, in tandem with a lack of information about and integration of the landscapes drainage patterns.

Another significant concern about inland flooding is that present day heavy rainfalls *already* overload the sewer system. Therefore, a trend of increasingly heavy rainfalls has significant municipal financial implications, could cause significant disruption of services, and poses an increased workload.

Also of concern during inland flooding is the potential for environmental contamination. Rodney Lake, the Town's municipal water supply, sits outside of the Town's boundaries and is subject to the Municipality of the District of Shelburne's Council Policies and By-law. The properties around the Lake are privately owned resource properties (e.g., woodlots), although one is residential. The area surrounding Lake Rodney is considered a "General Development Zone" and **no specific consideration or protections are given to the fact that these lands are adjacent to the Town of Shelburne's drinking water supply**.

Heavy rain falls and strong hydrologic conditions cause runoff and solid material transport, which can affect surface water systems such as Rodney Lake and cost implications for water treatment. For example, research has confirmed that, "especially during heavy rainfall events, mineral leaching could lead to high concentrations in natural waters, having a direct impact on coagulant demand during water treatment . . . and on disinfection by-product formation" (Delpha et al., 2009).

The Town is particularly concerned about the transport of contaminants around the area of the previous dump. The full impact of this is largely unknown. As well, the Town (like many other Nova Scotia communities) is concerned about arsenic and radon in well water. **Unstable climatic conditions where rocks and soils alternate between being water saturated and water starved exacerbate the risk of heavy metal transport into groundwater systems.** The most common, naturally occurring arsenic-bearing mineral found in Nova Scotia is arsenopyrite, an iron-arsenic sulphide (Goodwin et al., 2010). In fact, regional soil and till geochemical surveys (i.e. Stea and Fowler, 1979; Woodman, 1994) demonstrated that mean concentrations often exceed the Canadian Soil Quality Guidelines of 12 parts per million arsenic (for residential, parkland, agriculture, commercial and industrial lands) (Goodwin et al., 2010).

“Arsenopyrite is relatively soluble and highly mobile under certain conditions. As a result of its solubility, arsenopyrite will readily break down and liberate arsenic into the surface water or groundwater, regardless of whether or not an area has been subjected to mining activity” (Goodwin et al., 2010). In other words, when water levels are low and arsenopyrite is exposed to oxygen, oxidation occurs. The oxidation process releases arsenic (and iron and sulphur). As water levels come back up, arsenic may be carried by water into our homes and businesses.

Inland flooding can also cause the release of environmental contaminates into Shelburne Harbour. Municipal staff has long known that there are infiltrations to the wastewater system, but the exact location and extent of these infiltrations is *not* known. Because of these infiltrations inland flooding can contribute to the overload of the treatment plant and incidents of overflow. This is a concern to all citizens that enjoy the lifestyle a healthy Harbour ecosystem provides. Indeed, the Harbour is the essence of the Town’s social and cultural assets. Of importance to the local and macro economy is the concern contamination poses to the local fishing industry.

Also of unknown impact is the probability and risk of flooding throughout the province that may impact the Town of Shelburne’s supply chain.

Inland Flooding Hazard Impact Matrix

A flood is an overflow or inundation that comes from a river or other body of water and causes or threatens damage. This may occur as a result of weather phenomena and events that deliver more precipitation to a drainage basin than can be readily absorbed or stored within the basin over time, or as a Flash Flood, the result of heavy amounts of rainfall within a short period of time. Threat of road/bridge washout or evacuation would trigger Municipal planning/response.					
Resulting Impacts	**Susceptible Locations**	**Severity**	**Frequency**	**Level of risk tolerance**	**Overall risk**
Risks to public safety	Causeway; South end East of Brewhouse Lane; along Black’s Brook	4	4	Medium	Moderate
Evacuation	Black’s Brook	5	3	Medium	Low
Private property damage	Dock St.; East of Brewhouse Lane; Black's Brook (Peter's house) and along Unamed Brook	5	1	Medium	Moderate
Drinking water contamination	Population on wells (75%); Town sewer system as below	2	1	Low	High
Transportation disruption	Corner of King St. and Water St.; bridges (2 on Roseway, Black's Brook, on trail, Arthur Street) ; Sandy Point causeway (to hospital)	4	1	High	Moderate
Food & fuel shortages	Unknown past local situation	2	3	Low	Moderate
Financial burden on Town	Cost of waste treatment exaggerated due to infiltration issues; increased road repairs	2	1	Low	High
Economic impacts	Lobster fishing in particular	2	1	Low	Moderate
Environmental contamination	Shelburne Harbour	3	1	Low	Moderate

Coastal / Storm Surge Flooding

Coastal flooding occurs when seawater inundates coastal landforms. This can be influenced by storm surge, sea level rise, wind, waves and tidal variations. Storm surge is a temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions.

Storm surge, sea level and tide level are three factors that combine to create conditions for flooding. A storm surge is the difference between the observed water level and the predicted astronomical tide. The surge can be created by meteorological conditions including low atmospheric pressure, strong winds or swells that can be caused by tropical cyclones (such as hurricanes), by mid-latitude extratropical storms (such as Nor'easters), or by any severe weather conditions (Storm Surge and Coastal Inundation).

At this time, there is inconclusive evidence that Nova Scotia will experience an increase in the frequency of weather that drives up water levels. But despite high levels of uncertainty about storm tracks and frequency, there is strong evidence that the intensity of storms is increasing and will continue to do so. This trend is evident through shifts in storm return periods.

Storm return periods are the average time between occurrences of an event exceeding a given level/magnitude. For example, a 100-year return period storm is defined by storm characteristics that have a 1% chance of occurring in any given year, or a 1% annual exceedance probability (Table 7). The advantage of using the language of annual exceedance probabilities instead of return periods is that people may erroneously assume that an event called a 100-year storm will happen once every 100 years.

Table 7 Storm Return Periods Expressed as Annual Exceedance Probabilities

10 year return period = 10% annual exceedance probability
25 year return period = 4% annual exceedance probability
50 year return period = 2% annual exceedance probability
100 year return period = 1% annual exceedance probability

The observed climate trend is that the amount of time between storms of a given magnitude has decreased. Said another way, the annual exceedance probabilities are increasing. For example, the meteorological conditions that used to be associated with a storm with a 1% annual exceedance probability based on statistics from the 20th century may have a 4% annual exceedance probability by the 2040s. In other words, in the next 30 years or so, our '100-year storms' will be our '25-year storms'.

"Even if storms (both hurricanes and nor'easters) do not grow in severity, coastal flooding will become more frequent as sea levels rise. Thus, a smaller surge would lead to coastal flood levels equivalent to that produced by a major storm today" (Gornitz, 2005). Sea level rise is usually expressed as the average increase in the global mean sea level. Recent research from the Bedford Institute of Oceanography (BIO) suggests that, "mean sea level rise in most of the Atlantic Basin is projected to be higher than global estimates" (Yin et al. 2009, Xu and Perrie, 2011). This is due in part to glacial isostatic adjustment (geological process that cause land uplift or subsidence) and changes in dynamic sea level (changes stemming from ocean circulation patterns). Given these considerations, the potential relative sea level rise in the southern part of the Atlantic basin on the 50-year time scale is 0.4-0.7m, and could be as high as 0.9 meters in some seasons and at some locations (DFO 2012). On the 100-year time scale, relative sea level rise in the Atlantic Basin is projected to range from 0.9-1.6m (DFO 2012).

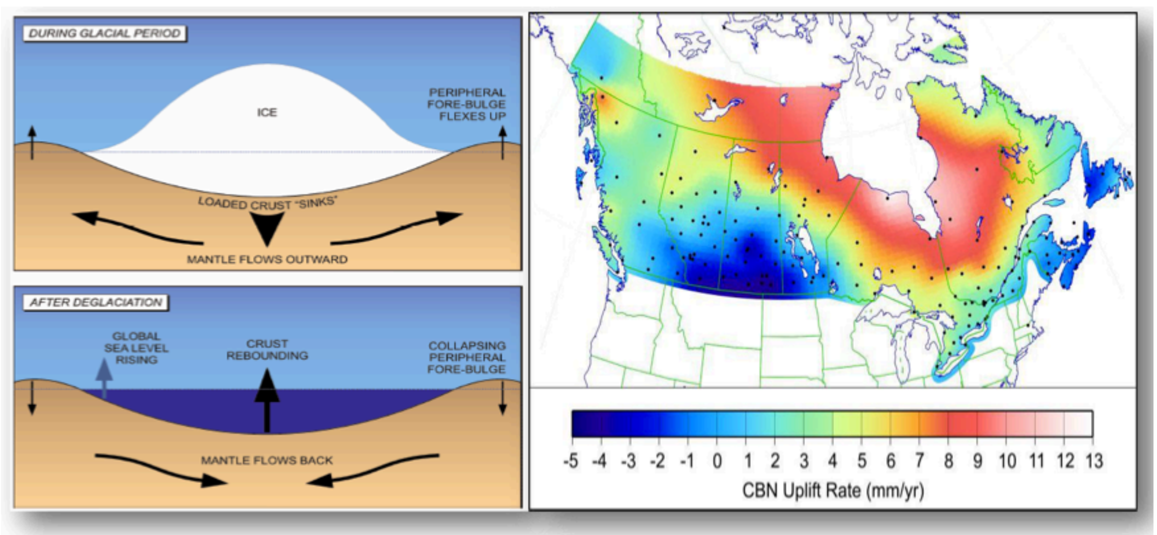


Figure 4 Glacial Isostatic Adjustment (Henton, Craymer, Ferland, Dragert, Mazzotti, & Forbes, 2006)

The geological adjustment (change) that is occurring in Shelburne is one of subsidence/sinking. This is a result of the post-glacial vertical motion of the earth's crust. There is a rebound (maximum in the Hudson Bay area) and a corresponding subsidence (sinking) along coastlines in response to a depression of the earth's crust caused by the immense weight of continental ice sheets during the last Ice Age (Figure 4). The Richards and Daigle report (2012) provided localized sea level rise projections that combined sea level rise and glacial isostatic adjustment and reported this water level projection as Total Sea Level Rise. Richards and Daigle also reported an Extreme Total Sea Level that combines Total Sea Level Rise, high tide, and storm surge levels generated during benchmark storms for four different annual exceedance probabilities (Table 8).

Table 8 Water Level Scenarios for the Town of Shelburne: Richards and Daigle 2012

	2000	2025	2055	2085	2100
Total Sea Level Rise (m)		0.15±0.03	0.43±0.15	0.83±0.36	1.06±0.48
Extreme TSL – 10 Yr Ret Period	3.01±0.20	3.16±0.23	3.44±0.35	3.84±0.56	4.07±0.68
Extreme TSL – 25 Yr Ret Period	3.11±0.20	3.26±0.23	3.54±0.35	3.94±0.56	4.17±0.68
Extreme TSL – 50 Yr Ret Period	3.18±0.20	3.33±0.23	3.61±0.35	4.01±0.56	4.24±0.68
Extreme TSL – 100 Yr Ret Period	3.25±0.20	3.40±0.23	3.68±0.35	4.08±0.56	4.31±0.68

Coastal Flooding Impacts

Coastal flooding already occurs within the Town under certain conditions of high tide, winds and storm surge. This threat is predicted to increase with rising sea levels, increased precipitation and the potential for winds and storm surge under hurricane and blizzard conditions.

For purposes of the hazard assessment, three total water volumes were analyzed. These three scenarios are mapped as critical flood layers. Impact areas were confirmed with mapping. While the scenarios may seem to have a low probability given they are based on projections for storms with 1% annual exceedance probabilities at a time of high tide (on end of century sea levels), any flooding of this magnitude would cause risks to public safety, evacuation of Dock St. and low-lying areas, and an extended power disruption in particular to the marina/dock area.

There is a substantial amount of municipal infrastructure vulnerable to coastal flooding. This infrastructure ranges from revetments and seawalls along the Town's waterfront to the industrial scale Marine Terminal. Impacts to these properties and municipal infrastructure could be financially catastrophic not only to the Town, but also to the fishing and marine transportation sectors in particular. For example, should a surge move the rocks placed along the waterfront as a means of surge protection, the cost of replacing these rocks would be a large burden to the Town's already strained budget. As well, the concrete top of the Marine Terminal is a 'floating top'. While there are practical reasons for this design, it speaks to the ease with which damage can be done. In fact, the elevation of the wharf deck ranges from 2.7 to 3 m, so it would be overtopped by water greater than 3 m. This elevation is least severe of the three critical flood layers examined by the Committee.

There is also a wealth of heritage properties exposed to coastal flooding. Damage to the Heritage District effects distinguishing cultural features that the Town celebrates, actively works to maintain, and markets for destination tourism.

The Sandy Point Causeway links the Town with the Roseway Hospital. Flooding has already been observed on the causeway during storms. While the causeway is not the only access to the Roseway Hospital, it is the most direct and commonly used.

A curious concern of coastal flooding is the degree to which it worsens inland flooding. The brooks that currently cause inland flood issues in Town drain into the Harbour. When high tides coincide with heavy rainfall, inland flooding is obviously compounded. Sea level rise will only exacerbate this situation.

Coastal Flood Risk Map

Three critical flood layers are shown on the Town's Coastal Flood Risk map: 2.5, 3.3 and 4.4 m above the Canadian Geodetic Vertical Datum of 1928 (CGVD28), the typical vertical datum used for contours on topographic maps. The values were extracted from the lidar Digital Elevation Model (DEM) and low lying areas inland of the ocean were only included if a culvert or some other structure allowed free connectivity between the low lying area and the ocean. These values were derived through consultations with the town and on water levels reported in Richards and Daigle (2012).

The **2.5 m** is an observed critical water elevation because of previous flooding experience. The **3.3 m** represents the 100-year return period water level in the year 2100 using recent sea-level rise projections.

Richards and Daigle (2012) present an elevation of 4.31 ± 0.68 m above Chart Datum for Liverpool, NS, the closest community to Shelburne for which historical weather data was available. Chart Datum (CD) represents the vertical datum used to reference the tide tables and nautical charts and typically represents an elevation lower than the low water level during a large tidal range period. In the case of Liverpool, CD is 1.04 m below CGVD28, thus the elevations report by Richards and Daigle (2012) have been converted from CD to CGVD28 so they can be related to the land elevation. Therefore 4.31 m CD becomes 3.27 m CGVD28 and since the lidar DEM is typically accurate to 15 cm in the vertical, the value was rounded to the nearest decimeter making it 3.3 m CGVD28.

The highest flood level represents the Richards and Daigle (2012) worst case scenario which assumes the largest storm surge measured, Hurricane Juan at the Halifax tide gauge, coincides with an extreme high tide with sea-level rise of 1.54 by 2100 to give a value of 5.47 m CD in Liverpool. Therefore when this number of 5.47 m CD is converted to CGVD28 it becomes 4.43 m or **4.4 m** CGVD28.

Two Coastal Flood Risk maps were created. The critical water elevations were superimposed over the shaded relief model (5 times vertical exaggeration) of the lidar DEM (Figure 5), and a Digital Surface Model that shows vegetation. On both maps, additional GIS layers from the NS topographic Database (NSTDB) have been added.

Technical Brief about the Coastal Flood Risk Map

The coastal flood risk layers representing critical thresholds have been generated from a lidar derived Digital Elevation Model (DEM). The lidar point cloud was classified by the data provider and delivered to the NS Geomatics Centre and in turn the County of Shelburne. The classes represent points that are interpreted to be the bare earth, low and high vegetation. The DEM was constructed from the lidar ground points and used to extract the critical elevations associated with coastal inundation during a storm surge or with long term sea-level rise. In addition the DEM, a Digital Surface Model (DSM) was constructed that represents all of the valid lidar points and incorporates the buildings and vegetation. It was observed through examining the shaded relief maps of the DEM and DSM, and subsequent lidar point cloud that some ground classification errors were observed in the vicinity of the Marine Terminal Wharf in Shelburne that was not classified as ground. As a result this feature was not represented in the DEM and not included in the flood layer construction. The elevation of the wharf deck ranges from 2.7 to 3 m, so it would be overtopped by water greater than 3 m.

Applying the Coastal Flood Risk Analysis to Land Use, Emergency Measures and Infrastructure Planning

It is important to understand that the Committee looked at end of century water level projections because the intent of the MCCAP exercise was to apply a long-term risk perspective to land use and infrastructure decisions, which in turn influence the nature and extent of emergency incidents. Given the static nature of development (i.e., once built, structures remain in place until decay, disaster, or redevelopment) it makes sense to base land use decisions on this kind of time scale.

However, **it is financially and technically/scientifically practical, and recommended by the MCCAP consulting team, that a lesser time scale be applied to decisions about certain types of infrastructure** if that infrastructure requires costly maintenance or has a operating life that is less than 50 years.

In most cases, infrastructure will need significant repair after 25 years at which time there is opportunity to rebuild (e.g., go higher). Using a protective berm as an example, the higher the berm the higher the cost and the less the stability. As well, high berms block the view of the waterfront. If over-built initially (i.e., built higher than risk probability warrants), it is possible the Town would be paying for maintenance costs that are, essentially, unnecessary. The opportunity with a protective berm is to maintain it to the height necessary for the next 20-30 year period, and then add to it as needed given the most recent data available about sea level rise and water level projections. As it stands, current scientific literature indicates that most sea-level rise will occur in the last 20 years of the century. Furthermore, the science underpinning sea level projections continues to improve, and variables for these projections continue to be discovered. Thus, sea level rise projections will undoubtedly change (for better or worse) in the next few decades.

If a *new* piece of major infrastructure (e.g., new waste treatment plant) is being built, then by all means it is advisable to take a land use planning perspective and locate that infrastructure out of harms way considering recent information about a worst-case flood scenario.

It is important to remember that level of risk is inversely proportional in many ways to the flood height chosen. The higher the flood height, the lower the probability of such a flood occurring. Therefore, **there are two key questions the community must consider: What is a realistic flood level to protect against, and what is your level of acceptable risk?**

The critical flood layers as mapped have been used to inform climate adaption actions using tools for land use planning and emergency measures planning. Land use planning adaptation actions largely focus on new developments and re-developments. Emergency planning is intended to shape response readiness, so being aware of worst-case flood scenarios given the best and latest information available is appropriate, even if probabilities are low.

For existing residences and businesses in the areas mapped as flood risk vulnerable, the Town's adaptation actions can be described as education and outreach. The Committee believes the Town's best course of action is to provide reasonable protective coastal infrastructure (e.g., berm, revetment, sea wall) given the best available data on sea level rise and storm surge projections, and the share this data with homeowners and businesses so that they can manage their own risk.

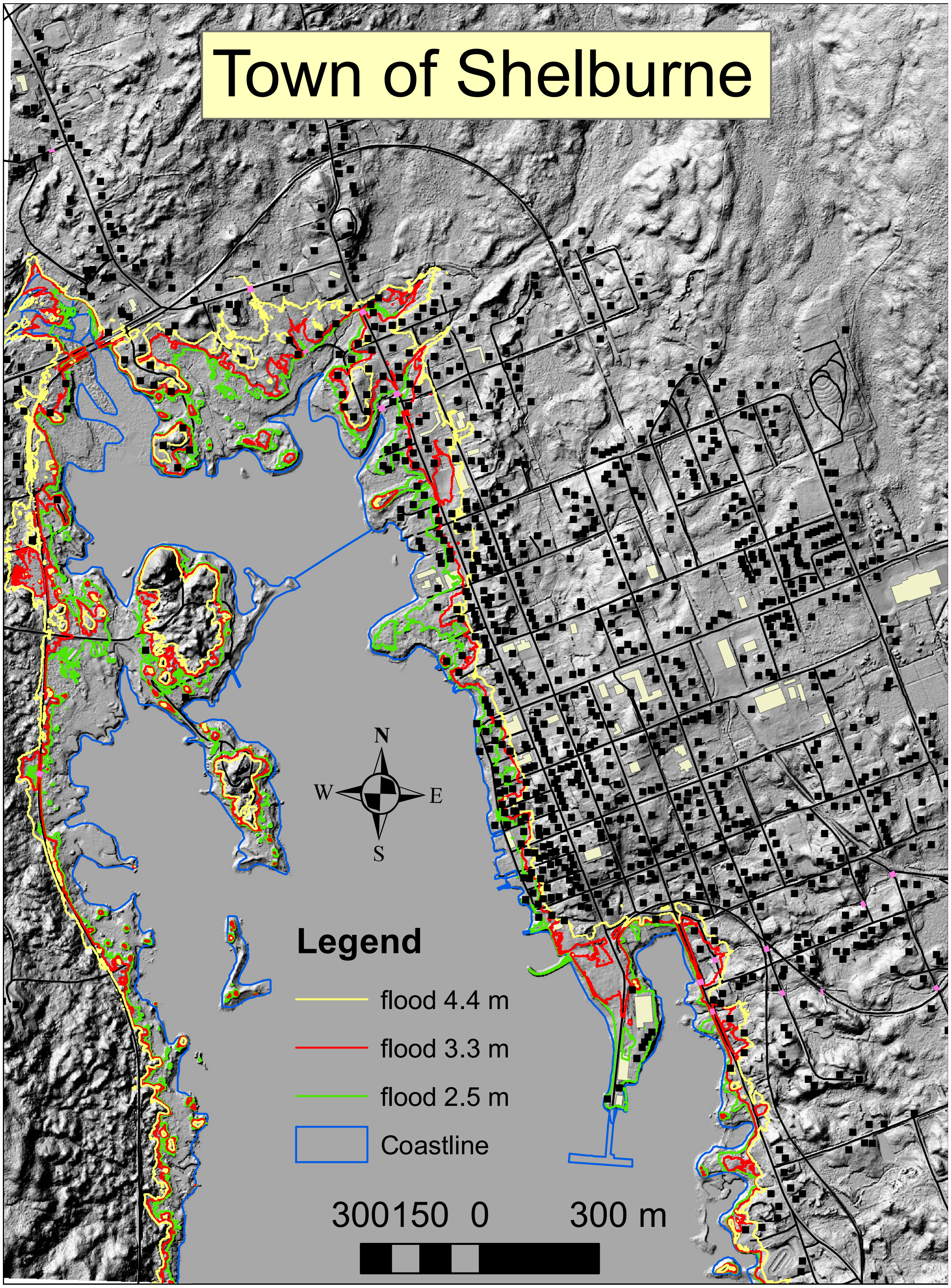


Figure 5 Town of Shelburne Lidar Derived Digital Elevation Model

Coastal Flooding / Storm Surge Hazard Impact Matrix

Coastal flooding occurs when seawater inundates coastal landforms. This can be influenced by sea level rise, storm surge, wind, waves and tidal variations. Storm surge is a temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). A total water volume of 3.51m triggers Municipal planning/response.

Resulting Impacts	Susceptible Locations	Severity	Frequency	Level of risk tolerance	Overall risk
Risks to public safety	103 (bridges); Dock Street; wave watchers on the shore	2	4	Medium	Moderate
Evacuation	Dock Street; low lying areas in general as per mapping generated	2	4	Medium	Moderate
Private property damage	As per above & mapping; rocks at waterfront	1	4	Low	High
Infrastructure damage	Wastewater treatment plant; marine terminal; floating dock; town dock; marina fuel dock; local streets; power outlets along Dock St. to Marine Terminal; lift stations; public works barn; bridges (Arthur St., Black's Brook, along Trail);	1	4	Medium	High
Power disruption	Concerns for power supply by marina/dock area; outlets on Dock Street down to Marine Terminal	2	4	Low	Moderate
Transportation disruption & erosion	Dock St.; Causeway; Sandy Point Road	4	4	Medium	Moderate
Food & fuel shortages	Unknown impact from larger provincial perspective	2	4	Low	Low
Economic disruption	Interruption to marine transportation (harbour lease) & recreational boating; interruption in tourism; damage to heritage buildings & local food establishments	1	4	Medium	Moderate

Winter Storm

A winter storm or blizzard is a severe weather condition characterized by reduced visibility from falling and/or blowing snow and strong winds that could be accompanied by low temperatures.

Climate trends are clear that temperatures are increasing in every season, but the greatest amount of change will be felt in the winter season. Winters are also expected to be wetter. One of the anticipated results of these shifts in seasonal conditions is a number of ice events.

Winter Storm Impacts

The frequency of ice events already being experienced has a significant impact on Public Works operations and the municipal wallet. Salting roads and sidewalks is expensive. So too is sanding. And when the need to do so for public safety is interspersed with snow and rain—as is so common in Nova Scotia—the salting and sanding often needs to be done repeatedly.

From an emergency management perspective, the biggest risk involves the high probability of vehicle collisions, including on the Highway 103. In fact, “multiple car crash” is listed as the most probable hazard in the Shelburne County East Emergency Management Operations Plan (EMO PLAN) because of very dangerous intersections on the 103 at exits 24 (blind intersection), 25 (stop lane on high speed highway), 26 (accident prone history and very busy) and 27 (blind intersection). Icy situations could make these circumstances more dangerous if people are traveling at inappropriate speeds.

“Ice Storm” is listed in the EMO Plan as the fourth most probable hazard. It states: “The ice storm scenario poses a significant risk to our aging population as electrical power, communications and transportation will be disrupted. Lack of heat and water along with the inability to call for help will place this segment of the population at significant risk. The establishment of comfort stations at a number of local fire halls is an excellent response to this threat.” While a “major winter storm” is listed as ninth in the EMO Plan, it is reasonable to assume that impacts could mirror that of an ice storm, though probably with less severity.

Another huge concern is power interruption. Power and communication lines can operate approximately eight hours after losing power. After that, it is up to a truck carrying a generator to provide power. Furthermore, the Shelburne region is at the tail end of power, cellular, paging and cable systems: meaning they are the last to get fixed if problems are widespread throughout the Province.

Winter Storm Hazard Impact Matrix

A Blizzard is a severe weather condition characterized by reduced visibility from falling and/or blowing snow and strong winds that may be accompanied by low temperatures. Triggers for Municipal Response include: power outages over 48 hours or with potential to extend beyond 48 hours or if prediction includes 4 hours or more of freezing rain.

Resulting Impacts	Susceptible Locations	Severity	Frequency	Level of risk tolerance	Overall risk
Risk to public safety	Entire area	3	1	High	High
Evacuation	Exposed populations may require evacuation to warming centres due to utility outages	3	1	High	High
Private property damage	Entire area	4	2	High	Low
Infrastructure damage	Utility & telecommunications most at risk, none owned by Town	2	1	Medium	Moderate
Transportation disruption	Entire population; Fuel shortages due to loss of power for distribution centers/gas stations	3	2	Low	Moderate
Supply (food & supplies) shortages	Entire population may be isolated if storm impacts rest of province	2	2	Low	High
Economic disruption	No specific location; fish and seafood require time sensitive transportation	2	1	Low	High
Financial burden to Town	NA; increasing cost of salt and road maintenance	3	1	Medium	Moderate
Community lifeline/emergency infrastructure damage	As per Isolation; lifeline concern from provincial standpoint, impacts unknown	1	3	Low	High

Hurricane Force Winds

When disorganized clusters of showers and thunderstorms become organized so that a definite rotation develops and winds become strong, the system is upgraded to a tropical depression. If winds continue to increase to 63 kilometers per hour, the system becomes a tropical storm and is given a name. The system becomes more organized and the circulation around the centre of the storm intensifies. As surface pressure drops and wind speed reaches 118 kilometers per hour the storm becomes a hurricane. An eye develops near the center of the storm with spiral rain bands rotating around it. Once a tropical cyclone reaches hurricane strength it is given a rating from 1 to 5 on the Saffir-Simpson Hurricane Intensity Scale. A category 1 storm has the lowest speeds, while a Category 5 has the highest.

Hurricanes, tropical storms or the threat of such events is tracked provincially through Environment Canada and Nova Scotia EMO. Hurricane Juan in 2003 made landfall as a Category 2 hurricane in the Halifax area. Since then a number of storms have been tracked or made landfall throughout Nova Scotia. An Environment Canada warning of the potential for a Category 1 or above storm entering Canadian waters with potential to make landfall in the Atlantic region will trigger the municipalities to begin monitoring events for potential mitigation or response.

Current data does *not* indicate more frequent hurricanes. However, there is strong potential for storm *intensity* to increase. That being said, more research is needed on shifting storm tracks. Scientists at the Bedford Institute of Oceanography caution that the Canadian Regional Climate Model and possibly other models, "*underestimate the track density over the northwest Atlantic area* (Guo et al. 2012).

The most likely scenario for the region indicates storm tracks could bring heavy rains and **strong winds** to the area causing flooding and infrastructure damage, including utility disruptions.

Hurricane Force Winds Impacts

One of the most obvious impacts from tropical storms or hurricanes is flooding. As well, the intense precipitation that can be associated with these storms can worsen both inland and coastal flooding simultaneously. Those impacts are captured in the flooding matrices. The hazard impact analysis for hurricane force winds is focused on strong winds. That being said, the Committee is well aware that winds contribute to flooding and noted that **winds coming from the southwest cause the most significant flooding issues**.

The Town of Shelburne has experienced many high wind events from both un-named as well as named storms. Impact analysis reveals concerns that power and telecommunications will be disrupted during such events. Recent mitigation efforts to trim trees will help decrease the local impacts to power supplies. However, due to Shelburne's geographical positioning at the end of the supply line for these utilities, depending on problems experienced throughout the province, the impact of and restoration time to fix such outages could be extended and may not be mitigated with current battery back-up supplies. While the impact will affect the Town, the resources are not owned or operated by the municipality. A worst-case scenario with less probability but potentially catastrophic impact would involve extensive damage throughout the province or Atlantic Region leaving the area without mutual aid support, external resources, and the usual supply chains. The impact of long term utility disruption and transportation cut off of food and fuel supply is unknown, but would certainly escalate the impact.

Wind damage to vulnerable living structures, particularly mobile homes, could necessitate evacuation. Comfort Centres and evacuation shelters are established with Red Cross to assist residents during storms resulting in power outages. Demand on these facilities is likely to increase.

Mitigation strategies to lessen the impact include mapping of vulnerable groups such as mobile home parks, summer camps, livestock owners, and campground residents. Coordination with public health officials to identify those at risk during extended utility outages could also provide increased warning and pre-storm response efforts, lessening the impact of an event.

Hurricane Force Winds Hazard Impact Matrix

When disorganized clusters of showers and thunderstorms become organized so that a definite rotation develops and winds become strong, the system is upgraded to a tropical depression. If winds continue to increase to 63 kilometers per hour, the system becomes a tropical storm and is given a name. The system becomes more organized and the circulation around the centre of the storm intensifies. As surface pressure drops and wind speed reaches 118 kilometers per hour the storm becomes a hurricane. A eye develops near the center of the storm with spiral rain bands rotating around it. Once a tropical cyclone reaches hurricane strength it is given a rating from 1 to 5 on the Saffir-Simpson Hurricane Intensity Scale. A category 1 storm has the lowest speeds, while a Category 5 has the highest. Environment Canada Warning of Cat. 1 or above entering Canadian waters with potential to make landfall within Atlantic Canada will trigger Municipal planning/response.

Resulting Impacts	Susceptible Locations	Severity	Frequency	Level of risk tolerance	Overall risk
Risk to public safety	Entire Population,	3	1	High	High
Evacuation	Vulnerable groups at risk due to loss of services	3	1	High	High
Property damage	Entire Town; increased risk along coastline; Dock Street	2	1	Medium	High
Infrastructure damage	As per coastal flooding; utilities throughout town	2	1	Medium	High
Utility disruption (power and telecommunications)	Entire Population	3	1	Low	High
Transportation disruption	Entire town, particularly impacted if other areas of province affected; could impact supply chain	2	2	Medium	High
Economic impact	Fishing industry (lobster & seafood) unable to fish due to high winds	3	1	Medium	High

Coastal Erosion

Coastal erosion is the process whereby geological materials comprising the coast are loosened, dissolved, or worn away and simultaneously moved from one place to another. Forces at play include long-term erosion, erosion from storms, and erosion from changing water levels and associated wave action.

Coastal Erosion Geographic Overview

The Town of Shelburne is located on the extreme north and northeast side of Shelburne Harbour. The southern end of the town is located over 15 kilometres from the open Atlantic Ocean. The entrance to Shelburne Harbour is partially blocked by McNutts Island, with entry through either the Eastern Way or the Western Way passages. These two passages join north of McNutts Island and narrow between Fort Point, Sandy Point and Burnt Head. The harbor bifurcates at Harts Point with Birchtown Bay to the west and Shelburne Harbour proper to the east.

Topography, on a regional scale, can be generally described as rising steeply from the harbour. However, the town only has a two-kilometre waterfront, measured on a straight north – south direction from the mouth of the Roseway River. Thus, when examined on the scale of tens of metres to 100 metre scales, there are areas of low and relatively flat topography, i.e. typically individual property scales.

A large number of factors may influence an area's susceptibility to erosion. There are important factors specific to this particular location and geological environment. The Town of Shelburne is underlain by highly competent, non-erodible granite. The presence of non-erodible bedrock is the most important factor in determining the susceptibility of a coastline to erosion. At Shelburne this is not a dominant factor since there appears to be little bedrock outcrop along the shoreline. However, the granite bedrock, when eroded by glaciers has produced a sandy, boulder and cobble rich till. When this till is exposed to wave action along a coast, the finer components of the till are eroded, leaving a cobble—boulder natural armour along the shoreline. This natural armour significantly reduces the rate of erosion.

A second important factor in determining the susceptibility of a coastline to erosion is its exposure to wind and thus wave action. In the immediate area of the town, Shelburne Harbour ranges in width from a few hundred metres up to about 1.5 kilometers wide. It is sheltered by rising topography on the west, north and east sides. Thus, the shoreline is well sheltered and wave action is minimal even during large storms, relative to more exposed types of coastlines. Thus, long-term energy levels in the form of normal wave action along the shoreline of the town are low.

Erosion occurs on a daily, monthly, and yearly basis in a generally steady state manner. However, individual shorelines may be impacted to a greater extent by short term, high-energy events such as hurricanes, post- tropical storms, and other seasonal severe weather events. The Town of Shelburne, as described in the above section, is over 15 kilometres from the open Atlantic Ocean. Thus large swells from large storms are greatly reduced before they reach the town. Energy in the swells is dissipated and reflected by McNutts Island. Swells that penetrate past McNutts Island experience both bottom drag and drag along each side of the channel as they travel up the harbour. Due to drag the swells are bent so that they impact the shoreline on either side of the harbour, and over the 15 kilometre distance loose most of their energy, size, and thus their ability to erode the shoreline of the town.

Sea-level rise is a third highly important factor that will typically result in high rates of coastal erosion and or coastal submersion. When coasts are characterized by erodible bedrock and or erodible unconsolidated material, sea-level rise will typically result in high rates of coastal erosion. Alternatively, given suitable conditions such as low coastal energy levels, high rates of sediment supply, or low topography, erosion may be minimal and submersion with the resulting growth of mud flats and salt marsh may be common. Nova Scotia is experiencing rapid sea-level rise typically ranging from approximately 32 cm/century in Halifax to approximately 46 cm/century in Yarmouth. Shelburne is likely experiencing a rate of sea-level rise between these two ranges. However, Shelburne has been settled since 1783 and thus the local inhabitants have been adapting to sea-level rise for over 230 years. The results of adapting to sea-level rise will be discussed in the following section.

Findings of the Erosion Susceptibility Analysis

As far as the Committee or their MCCAP consulting team is aware, there are no formal measures or estimates of the rate(s) of coastal erosion along the town waterfront in the scientific literature. Armouring of the shoreline and low rates of erosion elsewhere makes it impossible to estimate erosion rates from rectified historic air photographs.

There is very little evidence of erosion along the waterfront of the town. Individual headlands (e.g. at the end of the McGill Point road, Commisary Island) appear to have experienced erosion; however as a result, landowners have placed armour stone in these areas. Thus, erosion on multi-decadal time scales has been essentially eliminated. Erosion was noted along the west side of the McGill Point subdivision up to the Roseway River Bridge. However, in this instance erosion, is not believed to be due to what would be considered as marine or saltwater influences/processes. In this case, erosion is controlled by the strong current from the Roseway River along the eastern bank of the river. A local resident reported erosion of 10 feet over a period of 30 years. This is approximately equivalent to .1 m/yr. To the individual property owner the loss of 10 feet of property is a concern. However, erosion rates in many areas of Nova Scotia, e.g. along parts of the Bay of Fundy and the Northumberland Strait, are in the order of .6 to .8 m/yr. Based on my personal experience, a common rate of coastal erosion in Nova Scotia is .3 - .4 m/yr.

The only other area that has a natural shore face and isn't armoured is the shoreline at the south end of town along the road leading to the town sewage treatment plant. Here, where there was apparently minor erosion, landowners have armoured the shore face. Elsewhere, nature armour reduces the potential for erosion such that actual erosion rates are interpreted as being low.

A rate of erosion is subjective to the observer. Residents or town officials might consider a .1 or .2 m/yr. rate of erosion to be high. On a provincial basis, however, or compared to many other areas in Shelburne County, this is a very low to extremely low rate of erosion.

Commisary Island stands out as an unusual part of the town waterfront. Examination of the area indicates that a significant part of the `island' on the north side is composed of an unknown depth of coarse sawdust-like material. The areal extent of this material is unknown. The shoreline of Commisary Island is completely armoured. Armouring along the north side appears to be older and more haphazard than the west and south sides of the island. The armouring has stabilized the shoreline. Near the shore, grubbing and infill has raised the elevation of the `island'. Commisary Island is similar to any other relatively low-lying area as far as construction is concerned. Development needs to consider the potential for storm surges and needs to plan accordingly. In this instance, given the unknown depth of the `sawdust', a qualified person should be consulted to ensure foundation and or slab stability prior to residential or commercial development.

Slow submersion of the shoreline is also occurring along parts of the waterfront, particularly in low lying areas from Commisary Island north and west to the end of McGill Point subdivision. These areas are characterized by salt marsh and intertidal grasses and are subject to inland flooding. Elsewhere, there are areas where low armour stone has been placed along the shore in front of homes. In these areas it appears that there has been minor amounts of infilling to reclaim land that would otherwise be submerged during sporadic high water events. The armour is necessary to prevent erosion of the fill.

The main part of the town waterfront, from King Street in the north to the end of the fish plant at the south end of town, is entirely stabilized by a variety of measures. The Yacht Club area south—referred to as the working waterfront—is characterized by low to moderate angle armour stone. Along the east side of the point of land leading out to the main wharf, there is minimal armour. However, from a distance it appears to be mostly fill and or remnants of historic human activities. It is highly sheltered and erosion is minimal, evidenced by the lack of armour.

Along the historic part of the waterfront, from the Historic Shelburne Shipyards building north to King Street, the shore face is predominantly steep stone revetments with lesser wood wharf (wood retaining walls) and a vertical stone seawall. Because of the armouring there is no natural intertidal zone. This armouring will prevent erosion for the foreseeable future. However, it was observed that there is considerable washout behind the armour stone; for example in the area below John Street.

The specific construction techniques used in the placement of the armouring along the Shelburne waterfront is unknown. Typically, proper sized riprap and use of a geotextile behind armour stone revetments will prevent this type of washout. Therefore, there are suspected problems with the design elements of the revetment. This leads to long-term maintenance issues and associated costs. As well, it is noted that the top of the revetments are often lower than the area immediately landward of the revetment. This may have been the way it was originally constructed, or it may reflect a failure to plan for subsidence of the structure. The low elevation of the revetment leads to uncontrolled overtopping and erosion of gravel and fine sediment behind the revetment. Water overtopping the revetment also flows downward and out through the revetment, leading to further subsidence.

The consulting team has recommended that the Town ensure that new revetments and repairs to existing structures utilize proper construction techniques, if this has not been the case in the past. It was also recommended that revetments be constructed with a low berm to reduce over-wash, recognizing that in severe flood or surge situations, such berms would still be overtopped. In the case of this situation, allowance for runoff behind the berm (parallel to the berm) in a controlled manner that does not result in erosion behind the berm is necessary.

Coastal Erosion Susceptibility Map

The shoreline along the waterfront of the Town of Shelburne was examined on January 10, 2014. It was mapped on foot from the McGill Point subdivision along the Roseway River south to the town sewage treatment plant (Figures). Assigned levels of erosion susceptibility ranged from Low to Stable (Table 9), and a GIS file illustrating observed susceptibility has been provided to the Town by consulting team members Philip Finck and Dr. Tim Webster. With appropriate software, the GIS file was allows the user to point to a section of the coast and see the following attributes:

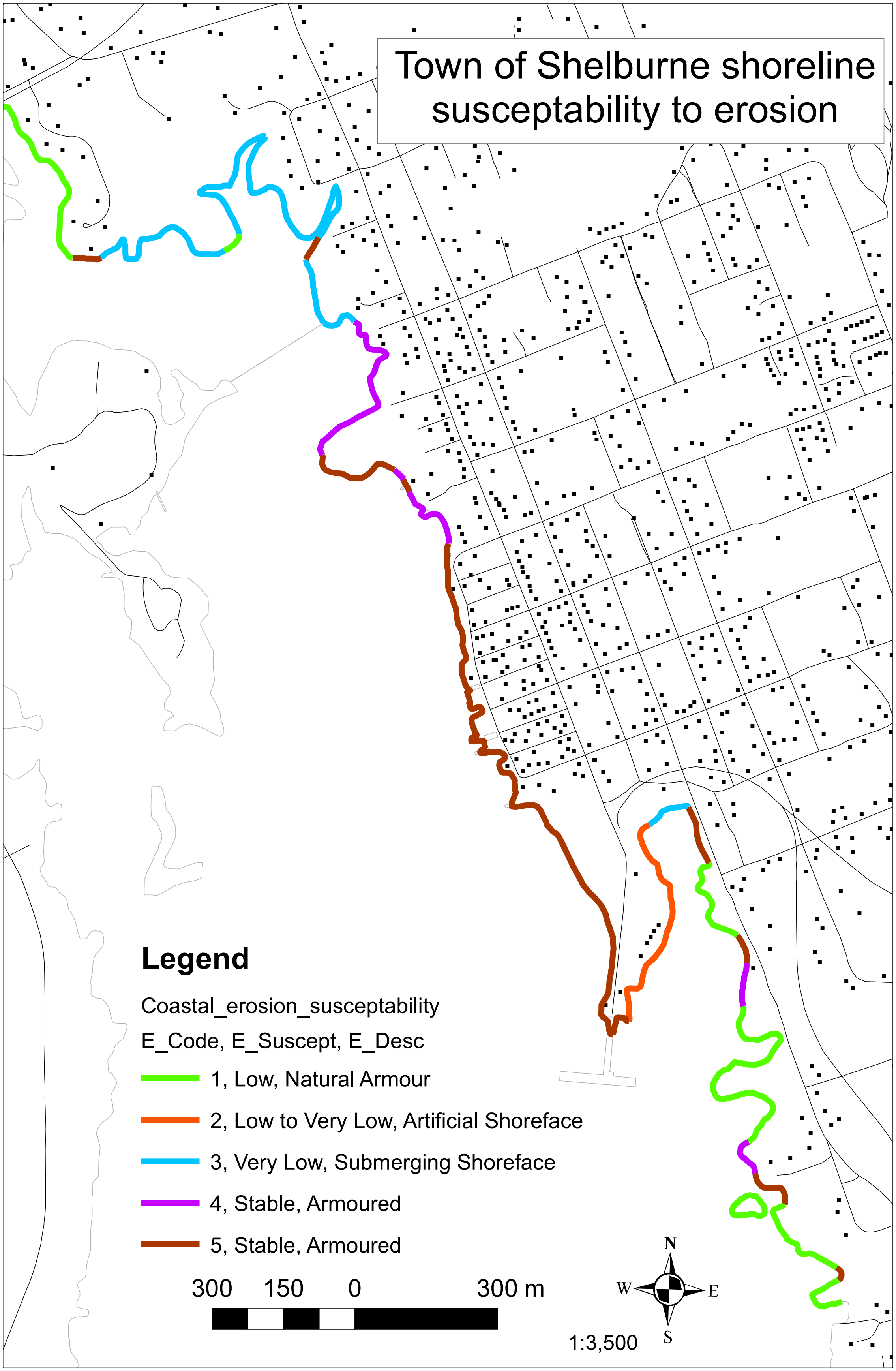
- E_Code – the numeric code based on the 1-5 scale of erosion susceptibility
- E_Dec – the erosion susceptibility description that accompanies the numeric code, as described in Table 9
- E_Suscept – the 'name' of the level of erosion susceptibility: low, low to very low, very low, or stable
- E_Details – text describing what the shoreline is composed of, as described in this section of the MCCAP Report.

The resolution of the map is on a +/- 50 metre scale, however this varies on the ability to access the shoreline due to ice conditions, private property concerns, and how rapidly the coastal characteristics vary. The map should *not* be applied on an individual property basis. Typically, the intertidal and supra-tidal zones would be examined in this type of survey. However, in this case shore-fast ice prevented examination of parts of the intertidal area. In addition, along much of the waterfront, revetments and seawalls have been built so that there is essentially no natural intertidal zone present.

A GIS file was created to illustrate the areas of erosion susceptibility as described in this section of the report. The GIS file not only

Table 9 Levels of Mapped Erosion Susceptibility for Town of Shelburne

Erosion Susceptibility Key	
As Mapped	**Low**
1. Light green	**Natural Armour;** Coastline characterized by variably vegetated or exposed slowly eroding till. Till has a sandy matrix, and is rich in cobbles and boulders. When eroded, cobble and boulder lag creates natural armour that reduces the rate of erosion. Erosion rate is estimated at being in the range of .1 m/yr.
	Low to Very Low
2. Orange	**Artificial Shoreface;** Coastline characterized by exposed fill, old wharf structures, rocks, logs, etc. Material is interpreted as representing historic placement of soil, debris, and historic occupation. Erosion is reduced as the shoreline is highly sheltered.
	Very Low
3. Blue	**Submerging Shoreface;** Coastline has a very low slope with the result that variations in the height of high tides and winds result in greater and lesser inland salt water penetration. Shoreface is swampy, typically narrow salt marsh and/or poorly developed, very narrow mud flat. In some areas infill by residents and low armour placement to protect the fill, gives an incorrect impression of natural erosion prevention.
	Stable
4. Purple	**Armoured;** Shoreface is generally armoured though there may be small areas without armour. The armour may be dumped, poorly placed, or degraded.
5. Dark brown	**Armoured;** The shoreface is entirely armoured. The armouring is in various forms including vertical seawall, steep angle boulder revetment, low angle boulder revetment, and wood wall or wood in filled crib. Erosion and subsidence behind the revetments is common.



Town of Shelburne shoreline susceptibility to erosion
Legend
Coastal_erosion_susceptability
E_Code, E_Suscept, E_Desc
1, Low, Natural Armour
2, Low to Very Low, Artificial Shoreface
3, Very Low, Submerging Shoreface
4, Stable, Armoured
5, Stable, Armoured
300 150 0 300 m
1:3,500
N
W
E
S

Coastal Erosion Impact Matrix

The process whereby geological materials comprising the coast are loosened, dissolved, or worn away and simultaneously moved from one place to another. Forces at play include long-term erosion, erosion from storms, and erosion from changing water levels and associated wave action.					
Resulting Impacts	**Susceptible Locations**	**Severity**	**Frequency**	**Level of risk tolerance**	**Overall risk**
Private Property Damage	End of McGill Point Road, Commisary Island	5	5	High	Low
Damage to existing revetments	Shelburne Waterfront; North side of Commisary Island; Historic Shelburne Shipyards north to King Street (in the area below John St.)	1	1	Low	High

Drought

A climate indicator of drought is water deficit defined as the amount by which the available moisture fails to meet demands for water. Water deficit is also understood as "water that could evaporate if it were available to do so" (Richards and Daigle, 2012). The severity of this hydrologic imbalance depends upon the degree of moisture deficiency, the duration and the size of the affected area (National Weather Service, Flagstaff Weather Forecast Office).

Drought can be defined/experienced in four different ways:

- Meteorological—a measure of departure of precipitation from normal. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- Agricultural—refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop.
- Hydrological—occurs when surface and subsurface water supplies are below normal.
- Socioeconomic—refers to the situation that occurs when physical water shortages begin to affect people. (National Weather Service, Flagstaff Weather Forecast Office).
-

Table 10 Richards and Daigle Water Deficit Projections for the Liverpool Climate Station

Parameter	1980s	2020s	2050s	2080s
Water deficit (mm)	39.0	46.8	56.0	66.3

Water deficit is projected to increase across Nova Scotia. The water deficit projections relative to the Town of Shelburne (Table 9) indicate an increase in the water deficit—effectively the amount of water that will be 'short' of meeting the needs of vegetation and agricultural crops. This long-term trend conceals the presence of extreme shortages, or times of surplus, due to annual climate variability (Langsdale et al., 2007).

Water quantity and quality is the number one climate concern globally. "While a community can often endure single-year events without permanent losses, a prolonged deficit in the water balance could deplete water storage in reservoirs and groundwater aquifers, and even collapse industries dependent on water" (Langsdale et al., 2007). Droughts of this severity are already occurring in western and southern areas of North America. While the trend does not indicate water shortages to be as severe in Nova Scotia, Drought is still a major concern within the Province and warrants careful monitoring and prudent planning.

Water Quality Hazard Impacts

Significant fluctuations in the availability of water (i.e., shifting from times of water surplus to deficit) can exacerbate issues of heavy metal contamination. The Town's concern over arsenic and other contaminants is significant enough to warrant the extension of the water service to people most exposed, as resources allow.

Rodney Lake, the Town's water supply, sits outside of Town boundaries (Figure 6). The Lake is relatively small and quite tannic (i.e., pH is regularly measured at 4.5-5). The Water Treatment Plant has protocols for response (i.e., chemical treatment) to rainfall-induced changes in the lake water's quality (i.e., increased pH, alkalinity, or presence of solids). There are, however, cost implications when certain chemicals need to be applied. The Lake is not spring fed, to the knowledge of staff. Therefore, lack of rainfall would serve to increase the water's acidity resulting in increased treatment costs.

It is believed that drought would have to be quite severe, in combination with overpumping (or lack of conservation measures) amongst waterfront properties before saltwater may intrude into wells. Development opportunities are fairly limited along the waterfront (due to space) so the risk of 'over pumping' is minimal.

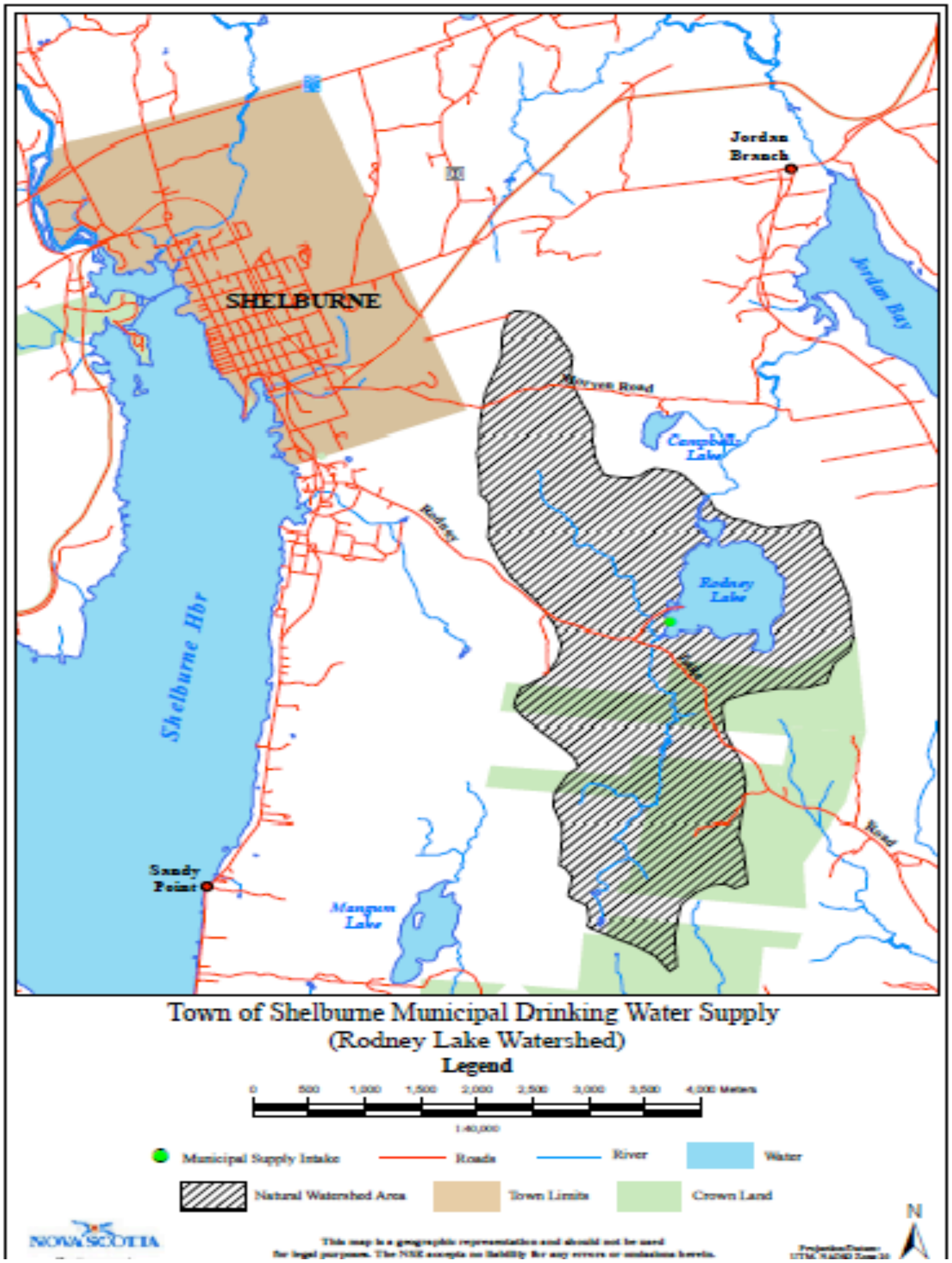


Figure 6 Town of Shelburne Municipal Drinking Water Supply

Water Quantity Hazard Impacts

About 75% of the Town's population has private wells. Most of these are shallow dug wells. Some of the dug wells are shared. There is no map indicating where wells or water supply lines are. While the Province has a database of wells, there are understandable inaccuracies regarding location. Now that the Town has lidar data, it would possible to map the location of private wells, while simultaneously surveying residents for known water quality or quantity issues. It is known that some local wells currently run dry on a frequent basis (location specific) and are routinely filled by the Fire Department.

Rodney Lake is 100 hectares, with an average depth of only ten feet. As mentioned previously, is not spring fed (to the knowledge of Public Works), but seems to rely primarily on rainfall as a water source. Public Works staff has pictures indicating that in 1984 the Lake fell to the five-foot mark.

It is not only Town citizens that are affected if Town water supply is diminished. The Town also supplies water to the Roseway Hospital, Roseway Manor and the local Nova Scotia Community College Campus.

Drought conditions also increase the risk of Wildland fires and could coincide with decreased water supply for fire suppression. Currently, 5 days of water based on average household consumption rates is held in the Town's two water towers when they are at full capacity. If the Towers are used for fire suppression, the amount of water would last 5 hours. The Towers are fed by the water treatment plant, so if the plant loses power the Town no longer has the ability to fill these Towers, which could be a point of concern if incidents of power outages and wildland fires coincide.

The Town is aware of potential for a secondary water supply based on a previous study by the firm AquaTerra. This information needs to be reviewed and the secondary source confirmed, delineated, and protected to the extent possible using land use policies and by-law. This will not be an easy task in that the secondary source is believed to underlie existing development. However, there are exciting possibilities to use this source to augment the Rodney Lake water supply.

Drought Hazard Impact Matrix

Drought can be defined as a prolonged period of abnormally dry weather that depletes water resources for human and environmental needs.					
Resulting Impacts	**Susceptible Locations**	**Severity**	**Frequency**	**Level of risk tolerance**	**Overall risk**
Increased Demands on Health Care System	Entire population	3	5	High	Low
Decreased Water Supply/Watershed	Both those on Town water & private wells	2	5	Medium	Moderate
Pest Infestation	Entire population	2	5	High	Unknown
Increased Wildland Fires	Town surrounded by wildlands	2	5	Medium	Moderate
Decreased Water Availability and Resources for Fire Suppression	Entire population	2	5	Low	Moderate
Increased Town Financial Burden	Higher treatment costs at water plant; aquifer recharge/water availability is limiting factor for select industries/commercial enterprises	3	1	Medium	High

Wildland Fire

Wildland Fire is defined as any wildfire that is burning in forested areas, grass or barrens. Within this definition there are three major types: Ground Fire, Surface Fire and Crown Fire. Ground fire burns in the ground fuel layer. Surface fire burns in the surface fuel layer, excluding the crowns of tree. A fire that advances through the crown fuel layer, usually in conjunction with a surface fire is a Crown Fire.

Climate trends that increase wildfire risk vulnerability are increased air temperatures (Table 10) and incidents of drought. Simply put, extended periods of warm and dry weather. As well, the climate-influenced changes in species composition may result in periods of elevated fire risk. As pointed out in a study about wildfire under climate change by the School for Resource and Environmental Studies, "Fire prone coniferous species are projected to decline, replaced by pioneer deciduous species. As conifers are a significant factor in fire risk in mixed wood forests, the removal of these species will act as a negative driver of future fire risk. The maladapted species and dead conifer stands will, however, increase woody debris and ladder fuels on the landscape in the short term, acting as a temporary positive driver of risk" (Whitman, et al., 2013). As well, changing climate conditions are increasing the severity and duration of insect outbreaks. These outbreaks can exacerbate fire risk by increasing the amount of dead or dying woody debris in a forest system.

Table 11 Richards and Daigle Air Temperature Projections for the Liverpool Climate Station

Parameter	1980s	2020s		2050s		2080s	
	Value	Value	SD	Value	SD	Value	SD
Temperature-annual	7.4	8.5	0.4	9.8	0.6	11.0	1.0
Winter	-3.2	-1.9	0.6	-0.5	0.8	1.0	1.1
Spring	5.3	6.4	0.4	7.5	0.7	8.6	1.1
Summer	18.0	19.1	0.4	20.3	0.7	21.4	1.0
Autumn	9.4	10.5	0.4	11.7	0.6	13.0	0.9
Value shows the change in degrees in annual average temperature							

Wildland Fire Impacts

The Shelburne County East Emergency Management Operations Plan lists "major structure fire" as the sixth most probable hazard, and "forest fire" as the tenth.

The Committee's analysis of impacts from wildland fire revealed that the primary concern is one of water availability when fire suppression is called for. As previously mentioned, there is five hours of water available from the Town's two water towers if they are at full capacity. As well, the Tower's can only be replenished if electrical power is available to do so. As well, there are concerns that aged water pipes throughout the Town could collapse. Public Works noted that there is an odd sized pipe between the waterplant and the rest of the water distribution system which serves as a bit of a 'bottleneck' point if water is needed for water suppression. Should that pipe collapse, fire fighters have three hours of water available from one of the Town's two water towers (i.e., the other tower would no longer be available). Another point of concern is the potential for pipes under School and Commission Street to collapse if used for fire suppression.

In addition to concerns about having enough water to fight fires, there is also concern about what fire would do the quality of the water. The Town's Source Water Protection Plan states, "Due to the fact that the water source area is surrounded by forest, there is potential for fire and degraded water quality from the loss of forest cover and possibly from the use of chemical suppressants."

Similarly, but of less concern, is the potential risk of the Water Treatment Buildings catching on fire. Resulting debris and use of chemical suppressants would affect water quality.

Wildland Fire Hazard Impact Matrix

Wildland Fire is defined as any wildfire that is burning in forested areas, grass or barrens. Within this definition there are three major types; Ground Fire, Surface Fire and Crown Fire. Ground fire burns in the ground fuel layer. Surface fire burns in the surface fuel layer, excluding the crowns of tree. A fire that advances through the crown fuel layer, usually in conjunction with a surface fire is a Crown Fire. The following would trigger a Municipal response: evacuation of more than 10 units or 25 people; Municipal fire services unable to respond with request for DNR; Major transportation route shut down at request of Incident Commander or request for provincial resources beyond mutual aid agreements.

Resulting Impacts	Susceptible Locations	Severity	Frequency	Level of risk tolerance	Overall risk
Risks to public safety	Entire area	2	3	Low	Moderate
Evacuation	Entire area	2	3	High	Low
Private property damage	Entire area	1	3	Low	High
Infrastructure damage	Town facilities; Water and Waste Treatment Plants	1	3	Low	High
Long term environmental impacts	Entire area; Watershed area surrounded by wildlands & increased chance of water contamination	2	3	Low	Moderate
Air pollution	Entire area	3	3	Medium	Low
Long term economic impacts	Entire area	2	3	Medium	Moderate

Extreme Heat Event

Heat events or "heat waves" occur when weather conditions combine to create higher than normal temperature and/or humidity levels over a period of several days. Hot days are defined as 30° degrees Celsius and above. Very hot days are defined as 35° degrees Celsius.

Health Canada and Nova Scotia Health and Wellness summarized the effects of extreme heat events on the three most vulnerable segments of the population: older adults, physically active people and children. A webinar prepared for EMO and health professionals pointed out that:

- "many patients and health care workers are unable to assess the risk of heat related illness;
- there is limited awareness and knowledge of effective prevention and treatment measures; and
- heat illnesses are probably under-recognized and under reported" (Simpson, 2013).

Table 12 Richards and Daigle Projected Changes in Heat

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Hot Days (Tmax > 30)	6.2	11.8	20.4	29.9
Very Hot Days (Tmax > 35)	0.0	0.5	1.1	2.6

Extreme Heat Event Impacts

The Town of Shelburne has not had a history of heat waves or extreme high temperatures and for the most part. It is possible that a *slight* increase in the number of hot days (over 30° Celsius) might benefit the tourism industry, as the Town offers a respite from urban temperatures, world-renowned sailing, and sits amidst a beautiful region with an abundance of river and seaside cottages.

With no history of events, there are also no protocols or procedures to respond or adapt to extreme heat. There is limited municipal jurisdiction to address health related issues, other than collaborate with provincial bodies issuing heat warnings. This effort would most likely be undertaken through the Town's Emergency Measures Organization Coordinator (EMC). The EMC can also address extreme heat by planning for accessible cooling shelters in partnership with area service organizations.

One impact between municipal operations and services and extreme heat relates to water restrictions and utility bills. Water restrictions would result from extended extreme heat in conjunction with a water deficit causing water capacity issues in Rodney Lake. That same heat could cause heightened utility bills if air conditioning units are used in municipal buildings. Given the nature of increasing power bills, this could pose municipal concern. As well, there are currently no policies in place to identify when town employees (outside workers in particular) should cease working due to unsafe temperatures, thus making them 'vulnerable' to heat related stress.

Extreme heat events also pose a threat to the quality of surface water. Given that Rodney Lake is only ten feet deep, it is extremely susceptible to changes in water temperature. Temperature increase affects water quality in that it impacts processes such as diffusion, mineralization and vertical mixing. More specific examples of how increasing temperature can affect water quality include, but are not limited to:

- increased acidity,
- decreased dissolved oxygen,
- potential introduction of or increase in cyanobacteria and cyanotoxins,
- potential introduction of or increase in waterborne pathogens, and
- an increase in nutrient loads (though more of concern in streams).

The above listed impacts can be addressed through standard operating procedures at the water treatment plant. However, the cost of the chemicals needed to treat for these conditions could pose a significant burden to the Water Treatment Plant's budget.

Extreme Heat Event Hazard Impact Matrix

For purposes of this analysis, a heat wave is defined as 3 consecutive days in which the temperature reaches 30 degrees Celsius or higher					
Resulting Impacts	**Susceptible Locations**	**Severity**	**Frequency**	**Level of risk tolerance**	**Overall risk**
Risks to public Safety	Increased impact seniors; young children; outside workers	4	4	Low	Moderate
Changes in source water quality	Rodney Lake	3	1	Low	High
Increased electricity demands	Entire Population	5	4	High	Low
Work slow down/ stoppage	Outside workers (public works & recreation)	4	4	High	Low
Increased water supply demand	Entire Population	4	4	Medium	Moderate
Pest infestation	Unknown impacts	?	2	Medium	Unknown
Increased wildland fires	As per Wildland matrix	2	4	High	Moderate

Section III

Supporting Information & Analysis

Emergency Preparedness for Natural Hazards and Severe Weather Events

Review of the All-Hazards Plan

The Town of Shelburne has a Shared Services Agreement with the Municipality of the District of Shelburne through which an Emergency Measures Organization and associated Emergency Measures Coordinator is made possible. The Emergency Measures Coordinator also serves the Town of Lockeport.

The Shelburne County East Emergency Measures Organization Plan (EMO Plan) is an "all hazards" emergency *response* plan, which means that "(it) has been developed to provide for an efficient, effective and fully integrated emergency response to any form of emergency or disaster that may confront the residents of Shelburne County East." Although the interests of the emergency measures organization officially span prevention, mitigation, adaptation, preparedness, response and recovery, the reality is that most effort is put into preparedness and response. This is not for lack of interest in mitigation and adaptation, but more a case of limited capacity and support. A great benefit of the MCCAP process was that the discussions reminded all involved of the relationship between land use planning and emergency mitigation and response. More specifically, it was an opportunity to talk about the tension that can be found between the desire for development and the need to define the municipality's role in guiding development to avoid or mitigate risks from natural hazards.

When emergencies or disasters do occur, the municipality does not respond alone. Organizations, agencies or groups that may be called upon to help in the event of a weather-related emergency are described in the EMO Plan as being within the "Emergency Operations Control Group" (EOCG). These groups include:

- Town administrators: Mayor/Warden, Town Clerk/Treasurer, Public Works, and the EMO Coordinator
- Fire Chiefs
- RCMP Detachment Commander
- Department of Community Services
- Officer from Shelburne County Amateur Radio Club (40-member club)
- Transportation (School Bus Transportation Manager)
- Health Services (Roseway Hospital, Public Health and Emergency Health Services representatives)
- Barrington Ground Search and Rescue

- Red Cross Society
- Clergy
- St. John Ambulance
- Salvation Army
- Service Clubs
- Lockport Volunteer Fire Department Mobile Command Post

The EMO Plan lists, though does not describe, potential emergencies in order of perceived probability (Table 12). Climate trends and projections were not taken into consideration when ranking these probabilities, so the ranks themselves are not as important or interesting as a look at *which* natural hazards were analyzed.

Table 13 Shelburne County East EMO Plan

Shelburne County East Emergency Measures Organization Plan Hazard Priorities	
1	Multiple car crash
2	Chemical spill (as a result of a motor vehicle accident or industrial accident)
3	Hurricane
4	Ice storm
5	Oil spill (from ship wreck)
6	Major structure fire
7	Electrical black out
8	Flash flood
9	Major winter storm
10	Forest fire
11	Boating accident

Four natural hazards that have been analyzed in the MCCAP, but are *not* listed in the Shelburne County East EMO Plan (Table 12) are inland flooding, drought, extreme heat and erosion. Two of these warrant analysis from an emergency measures perspective through the lens of climate projections: inland flooding and drought.

The risk of coastal flooding was considered in the EMO Plan's assessment of hurricane probability. It is unclear to what degree that assessment considered high winds, whereas in the MCCAP, coastal flooding and hurricane force winds have been analyzed separately.

The point of ranking emergency probabilities in an EMO Plan is that this information is used to guide resource allocation and preparations. In essence, it sets the stage for asking, 'what will be needed when this happens?' In addition to ensuring procedures are in place when the Emergency Operations Centre is partially or fully activated, the EMO also needs particular assets at a moments notice. In the Town of Shelburne, these assets include but are not limited to:

- Two designated Rest and Information Centres, one in Lockport and one in the Town of Shelburne. These are mandated by Red Cross and serve as the places where people can get the information they need for response and recovery.
- Room to sleep 400 in the Town's Community Center. There is room for 700 standing.
- 25 cots for overnight guests. When more are needed, they are borrowed from neighbouring communities.
- A HAM radio club that is 40 members strong and capable of conveying and receiving information in the worst of circumstances.
- A contract with the RCMP for fuel supply during times of emergency response. This is important in that if power is out, there is no way to buy gasoline or diesel.

Overall, the Town of Shelburne's level of emergency preparedness is strong thanks to a wealth and depth of local understanding and relationships. It was acknowledged that the communication protocols are in place to quickly call in partners in Mutual Aid, the Nova Scotia Emergency Management Office, or other provincial departments as needed. Indeed, this is exactly what is supposed to happen as it is unreasonable to expect that rural areas can afford the personnel training, pay for personnel, purchase of gear, or gear upkeep to be ready to respond to the wide array of emergencies that naturally exist.

Consideration of Hazardous Materials

The only issue that came up during MCCAP development for which there was questionable response readiness was the potential for hazardous material spills. The link between hazardous material spills and climate change is one of extreme weather events (e.g., flash floods, high winds) that can damage stores of any of the twenty-four materials found in Schedule A of the Nova Scotia Environmental Emergency Regulations. There is local knowledge of which businesses house hazardous materials, but there is not an existing inventory or map with this knowledge.

The Municipality of the District of Shelburne operates a Household Hazardous Waste Depot at the Public Works Garage to collect and temporarily store hazardous materials from households. The depot provides a fee-based collection service for residents of the Town of Shelburne. The Municipality of the District of Shelburne's MCCAP explains that, "No hazardous waste is kept at the depot for more than 90 calendar days. The purpose of the facility is to prevent landfilling of residual hazardous materials and process hazardous waste in a save and cost-effective manner while providing maximum protection to the environment. Operation of the facility is guided by the document "Operation Procedures for the Temporary Storage of Hazardous Materials at the Public Works Facility for the Municipality of Shelburne" (December, 2002)." The District's MCCAP also notes that, "the Household Hazardous Waste Depot is not at significant risk of climate impacts due to its location. However, in the event of a spill or loss of containment, the largest weather-related risk would be high intensity rainfall that would cause dispersion of the spilled material." To mitigate this impact, in 2013 "the District of Shelburne installed secondary containment at the site in the form of a curb to provide 110% containment for waste volumes stored at the site, as well as a roof shelter and controlled drainage system to prevent rainwater from accumulating in the storage area."

Given the financial realities of maintaining response-readiness for chemical spills, it is prudent for the Town of Shelburne, the District of Shelburne and the Town of Lockeport to encourage First Responders to ensure there is an up-to-date procedure that identifies who First Responders call during an incident and what needs to be done to keep themselves and the public safe until a trained team with appropriate equipment arrives. That may mean doing large-scale evacuations while waiting for teams due to long (4 hour plus) arrival times.

There is legitimate concern about the safety of the First Responders. For example, there are no ventilators in Shelburne County. This was a point of discussion during the MCCAP process as people remembered the June 2011 incident of a tractor-trailer carrying 32,000 liters of gasoline and 9,000 liters of diesel fuel erupting in fire after a collision on Hwy 103. Fire crews from nearby Shelburne, Clyde River and Gunning Cove worked to put out the blaze for eight hours after the crash. In addition to concerns for human health, were concerns for the environment. Indeed, the two realistically cannot be separated. Officials determined that the oil spread at least 250 metres to a nearby wetland.

Review of Contingency Plans

The Town of Shelburne has two Contingency Plans in place: Contingency Plan for Incidents Possibly Encountered in Wastewater Treatment Facility Having a Potential of Generating an Environmental Nuisance; and the Rodney Lake Water Treatment Contingency Plan.

As explained in section 4.1 (Inland Flooding), Climate projections for precipitation convey an increasing probability of inland flooding as the years progress through the 2080s. The uncertainty of precipitation patterns beyond that climate normal (30 year period) is inconclusive, but *is* a key area of continued research so will be important for municipalities to monitor. One of the impacts of this rainfall is the potential for increased transport of heavy metals and flushing of organic matter or debris into surface water. In tandem with this are the effects of drought, such as the potential oxidation of heavy metals, concentration of dissolved substances, and decomposition organic matter. All of which can be carried into surface water with the next rainfall. It is critically important that

Contingency Plans take drought-rewetting cycles into consideration given the array of potential impacts to water quality.

Facilities and Infrastructure

Municipal Assets

Table 13 lists municipal facilities and infrastructure. The Town of Shelburne is rather unique in that it owns a large number of assets used (leased) by non-profit groups; such as, the town dock, boat launch and ramp, and floating dock (all managed by Yacht Club). While the Marina Fuel Dock is located on Town-owned land, the Fuel Dock itself is owned by the Yacht Club. As well, the Town owns the King Street Centre, Little Peoples' Place, and Heritage Hall. Contrary to public sector trends, the Town has not divested any of these assets. Construction or alterations of these assets to accommodate changing climate conditions would be the responsibility of the Town, with the exception of changes to the interior of the buildings (e.g., the Yacht Club is responsible for the interior of their building and the marina only).

Table 14 presents an array of assets in the area that are socially valued: that give shape to the characteristics of the Town and its quality of life. Although not directly owned by the Town, the Town recognizes its jurisdictional responsibility to plan for and control development in a manner that ensures consistency with the valued characteristics of the community.

Table 14 Municipal Facilities and Infrastructure

Municipal Facilities & Infrastructure
Shelburne Civic Centre & Fire Hall (also evacuation centre)
Shelburne Marine Terminal
Industrial Sites (e.g., Ven Rez, Shelburne Industrial Park; Harlow's Construction)
Water & Waste Management systems: Water treatment plant, wastewater plant, lift stations, Rodney Lake pumping station; 2 water towers
Bridges: Arthur St., Black's Brook, over Trail
Public Works Garage
Town Hall / Offices
*Roseway Manor
Yacht Club and Osprey Arts Centre
Town Dock, Floating Dock, Boat Launch and Ramp

* Roseway Manor Inc. is a Corporation that was formed under the Municipal Housing Corporation Act by the Towns of Shelburne and Lockeport and the Municipality of the District of Shelburne, October 10th, 1974. These three municipal units are equal partners in this corporation. The operation and management of the home is under the direction of a Board of Directors made up of nine members, with three appointed by each of the municipal units.

Table 15 Socially Valued Facilities and Infrastructure

<table>
<tr><th>Socially Valued Sites in Area</th><th colspan="4">Identify Owner</th></tr>
<tr><th></th><th>Private</th><th>Municipal</th><th>Prov.</th><th>Federal</th></tr>
<tr><td>Historic Dock Street Buildings</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td>King St. Centre</td><td></td><td rowspan="5">X</td><td rowspan="5" colspan="2">(leased and privately managed)</td></tr>
<tr><td>Heritage Hall</td><td></td></tr>
<tr><td>Little Peoples' Place</td><td></td></tr>
<tr><td>Osprey Arts Centre</td><td></td></tr>
<tr><td>Yacht Club, Town Dock, Floating Dock, Boat Launch and Ramp</td><td></td></tr>
<tr><td>Schools (Hillcrest Academy; High School)</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>Marina Fuel Dock</td><td>X</td><td colspan="3">(Town owns land)</td></tr>
<tr><td>Beaches /Sand Dunes (Islands Park)</td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td>Shelburne Mall</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>NSCC- Shelburne</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>Shelburne County Arena</td><td>X</td><td>X</td><td></td><td></td></tr>
<tr><td>Shelburne Museum Complex</td><td>X</td><td>X</td><td>X</td><td></td></tr>
<tr><td>Roseway Hospital</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>Roseway Manor: 65 beds, plus one respite bed, plus community outreach services</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Shelburne Group Home</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Privately owned property (homes)</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Industrial Sites (e.g., Ven Rez, Shelburne Industrial Park; Harlow's Construction)</td><td>X</td><td>X</td><td></td><td></td></tr>
<tr><td>Commercial areas (Shelburne Mall, Dock St.)</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Power Supply (Lines, transformers, poles 1 major substation in town; 5 in County)</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>Water & Waste Management systems: Water treatment plant, wastewater plant, lift stations, Rodney Lake pumping station; 2 water towers</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Roadways: Hwy 103, route 203, Town Streets</td><td></td><td>X</td><td>X</td><td></td></tr>
<tr><td>Bridges: 6 critical on Hwy 103, 2 on Roseway River, Arthur St., Black's Brook, over Trail</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>Town Hall / Offices</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Telecommunications (telephone & cable TV line; Radio/TV station)</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>RCMP Detachment (station & equipment)</td><td></td><td></td><td></td><td>X</td></tr>
</table>

Risk Vulnerabilities of the Marine Terminal

The Town of Shelburne serves as the Port Authority for the Marine Terminal. The Port Authority is a committee of Council. Berthage space on the Marine Terminal is currently leased to Clearwater, a commercial fishery. Additional berthage space is available on a first-come-first-serve basis.

A condition assessment and feasibility study completed for the Town by YMCL Engineering Limited in association with Dillon Consulting Limited found a number of significant deficiencies, many of which affect the load carrying capacity and safety of the facility. These deficiencies are high priority for the Town in order to keep the Terminal open for business.

The affects of sea level rise in conjunction with storm surge and wave action have a direct effect on the integrity of the Terminal. Although a coastal engineering wave analysis was beyond the scope of the condition assessment, the report stated:

> It is assumed that the wave break is required since the concrete deck is not tied down to the concrete pile caps. It is likely that any wave uplift forces on the underside of the deck would lift the deck and cause extensive structural damage. Therefore, it is recommended that the wave wall be maintained. (page 16)

As stated in the Technical Brief about the Coastal Flood Risk Map, the elevation of the wharf deck ranges from 2.7 to 3 m, so it would be overtopped or uplifted by total water volumes of 3 m or greater. The Town is already experiencing storm surge in this range. An MCCAP action item to address this concern reiterates a recommendation from the YMCL report: “Study the effect of waves and wave loading on the South side of the Wharf.”

Risk Vulnerabilities of the Sewer Treatment Plant

The water treatment plant and distribution system, sewer treatment plant and distribution system, Town Hall, and Public Works Garage, are facilities owned and directly managed by the Town. Of these assets, **the most vulnerable to climate impacts is the sewer treatment plant** and its distribution system, including lift stations. Of the waste treatment plant’s twelve lift stations, the six that are most at risk of inland or coastal flooding are:

- Brewhouse Lane; 43o 45'28.53 N, 65o 19'02.92 W; Elev 3.9 m
- Continental; 43o 45'20.17 N; 65o 19'12.19 W ; Elev 1.2 m
- Dock Street; 43o 45'43.43 N; 65o 19'27.48 W; Elev 1.8 m
- Hardy's Lane; 43o 46'03.14 N; 65o 19'37.24 W; Elev 2.1 m

- Arthur Street; 43o 46'16.27 N; 65o 19'45.99 W; Elev 2.7 m
- Mc Gill Point Lower; 43o 46'13.93 N; 65o 20'06.07 W; Elev 3.9 m

Also vulnerable to flooding due to exposure are the waste plant's Man Hole on the shore, which sits at an elevation of .6 m, and the contact chamber, which sits at an elevation of 2.4 m.

In addition to being risk vulnerable to impacts of flooding, the waste treatment plant is also impacted by loss of power. The Plant's operator explained that the lift stations and plant would be okay for a few hours but if the power was to be out for a day or more all of the lift stations would discharge. None of our lift stations are equipped with a generator therefore the pumps would not be pumping. Because the sewer system is gravity fed in a lot of areas, waste would still flow to the lift stations. Without the lift stations working, none of the sewage would come to the facility. The lift stations most likely to discharge are also the six most vulnerable to flooding (listed above).

In addition to impacts that impede normal operations and/or cause incidents of discharge (e.g., loss of power), there is also a **significant financial impact** due to the fact that the volume of effluent being treated is unnecessarily high. **Despite the fact that there is a separate stormwater system, it has been estimated that approximately 50% of what the Waste Plant treats is stormwater**. For example, it is known that a swampy area on Wright's Road is infiltrating a concrete pipe that is part of the sewer system. As well, it is observed that the waste treatment plant runs at full capacity *when it rains*. Compounding this problem is the fact that in the 1970's residents were 'encouraged' to hook their sump pumps into the sewer system. It is unknown how many of these hook ups there are, but it *is* understood that these hook ups exacerbate volume issues during rain events.

Risk Vulnerabilities of the Water Treatment Plant

The infrastructure concerns regarding the water treatment plant concern not the plant itself, but the distribution pipes. However, changing climate conditions do not directly exacerbate concerns about pipe collapse. In fact, climate projections indicate fewer passes through the freeze-thaw cycle. If this impacts the pipes at all, it would be a positive impact (Table 15).

Table 16 Richards and Daigle projected changes in Freeze-Thaw Cycle

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Freeze-Thaw Cycle Annual	109.8	99.2	83.8	70.2
Winter	48.8	48.7	46.5	43.9
Spring	37.3	32.3	24.4	18.1
Summer	0.1	0.1	0.0	0.0
Autumn	23.6	18.1	13.0	8.3

The key climate concern associated with the water treatment plant is financial. The intensified drought-rewetting cycles projected for the next seven decades will affect water quality and quantity, and thus effect treatment costs.

Facilities and Infrastructure Vital During Emergencies

The nature of the emergency, of course, dictates which facilities and infrastructure may be vital. However, it is easy to imagine that certain facilities and infrastructure will be vital in any emergency situation. These are listed below, with Town owned assets in bold:

- Shelburne Civic Centre and Fire Hall (also serves as an RNI Centre)
- Power supply infrastructure (Lines, transformers, poles 1 major substation in town; 5 in County
- Waste water treatment plant
- Water treatment plant
- Roads: Hwy 103, route 203, Town Streets
- Bridges: 6 critical on Hwy 103, two on Roseway River, Arthur St. and Black's Brook
- Telecommunications: telephone, cable, cellular systems, radio tower
- Roseway Hospital
- RCMP detachment
- **Two Standpipes** (water towers)

Opportunities & Challenges to Municipal Operations

The trend for warmer winters is likely to reduce heating bills. This is confirmed by the climate index of heating degree days, which shows a decreasing trend (Table 16). Heating degree days is a qualitative measure of how often the day's mean outdoor temperature is below 18°C. It is a metric used to judge how often heating is required above a certain temperature. Conversely, summer temperatures are increasing; so increased cooling loads (power demand) will offset financial savings from the winters.

Table 17 Richards and Daigle Climate Projections, Degree Days, for the Liverpool Climate Station

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Heating Degree Days	4017.2	3679.6	3321.7	2975.0
Cooling Degree Days	153.0	220.0	313.9	425.1
Hot Days (Tmax>30)	6.2	11.8	20.4	29.9
Very Hot Days (Tmax>35)	0.0	0.5	1.1	2.6
Cold Days (Tmax<-10)	2.5	1.5	0.7	0.2
Very Cold Days (Tmax<-20)	0.0	0.0	0.0	0.0

Warmer, wetter winters are also anticipated to result in less snowfall and more ice events. To the municipal budget this may mean less snow clearing, but more salt and/or sand distribution. Another climate trend of interest to Public Works is a shift in the annual freeze-thaw cycle (Table 15); the number of days per year when the temperature passes through the melting point. Freeze-thaw is generally related to stress on the built environment (e.g., concrete deterioration of sidewalks, potholes).

The maintenance regimes of parks and *all* municipally maintained outdoor spaces should respect the increase in growing degree days. Growing degree days is a measure of heat units available for plant growth and uses a determinant of appropriate plant varieties for a given area. A shift in the growing degree days affects choices about what is financially and ecologically appropriate to plant. Landscaping and maintenance choices should also take into consideration increased water deficits. Prudent property maintenance should, by design, require zero irrigation and minimal maintenance.

Table 18 Richards and Daigle Projections Affecting Landscaping

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Growing Degree Days: Base temperatures are +5 C°	1915.9	2150.8	2432.0	2743.8
Growing Degree Days: Base temperatures are +10 C°	1001.6	1169.0	1371.6	1594.6
Growing Season Length (days)	182.4	196.8	213.6	229.1
Freeze Free Season (days)	184.8	211.7	231.9	249.4

Canada-Nova Scotia Infrastructure Secretariat Preliminary Risk Assessment

The Preliminary Risk Assessment of infrastructure developed for the MCCAP, as required as part of MCCAP submission in fulfillment of the terms and conditions of the 2010-2014 Gas Tax program.

Climate Change Adaptation Plan

Municipal Asset	Sea Level Rise		Precipitation (extreme event)				Extreme Wind		Flooding		Temperature				Erosion		Earthquake		Total
			Snow		Rain						High		Low						
Water System																			
Water Source (Wells, Surface Water, Other)	L	1	N	0	N	0	N	0	N	0	L	1	N	0	L	1	N	0	**3**
Water Treatment Plant	N	0	N	0	N	0	N	0	L	1	N	0	N	0	L	1	N	0	**2**
Water Storage Facilities	N	0	N	0	N	0	L	1	N	0	N	0	N	0	N	0	L	1	**2**
Water Pumping Facilities	N	0	N	0	N	0	N	0	N	0	N	0	N	0	L	1	L	1	**2**
Water Distribution System	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	L	1	**1**
Individual Water Service Lines	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	L	1	**1**
Total	**1**		**0**		**0**		**1**		**1**		**1**		**0**		**3**		**4**		**11**
Sanitary Sewer System																			
Wastewater Treatment Plant	L	1	N	0	M	2	L	1	H	3	N	0	N	0	N	0	L	1	**8**
Buildings	L	1	L	1	L	1	L	1	L	1	N	0	N	0	N	0	N	0	**5**
Wastewater Gravity Sewer	L	1	N	0	M	2	N	0	M	2	N	0	N	0	N	0	L	1	**6**
Wastewater Pressure Sewer (Forcemain)	N	0	N	0	M	2	N	0	M	2	N	0	N	0	N	0	L	1	**5**
Pumping Stations	M	2	L	1	M	2	L	1	M	2	N	0	N	0	N	0	L	1	**9**
Total	**5**		**2**		**9**		**3**		**10**		**0**		**0**		**0**		**4**		**33**

Municipal Asset	Sea Level Rise		Precipitation (extreme event)				Extreme Wind		Flooding		Temperature				Erosion		Earthquake		Total
			Snow		Rain						High		Low						
Storm Sewer System																			
Catchbasins	L	1	N	0	L	1	N	0	M	2	N	0	N	0	N	0	N	0	**4**
Manholes	L	1	N	0	L	1	N	0	M	2	N	0	N	0	N	0	N	0	**4**
Pipes	L	1	N	0	N	0	N	0	M	2	N	0	N	0	N	0	N	0	**3**
Total	**3**		**0**		**2**		**0**		**6**		**0**		**0**		**0**		**0**		**11**
Municipal Buildings																			
Buildings	L	1	L	1	N	0	N	0	N	0	N	0	N	0	N	0	L	1	**3**
Total	**1**		**1**		**0**		**0**		**0**		**0**		**0**		**0**		**1**		**3**
Landfills/Solid Waste Facilities																			
Flooding	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Access Road	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Leachate Collection	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Leachate Treatment	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Buildings	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Total	**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**		**0**
Dams																			
Flooding	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Control Gates	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Access Road	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Fish Passage	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**

Municipal Asset	Sea Level Rise		Precipitation (extreme event)				Extreme Wind		Flooding		Temperature				Erosion		Earthquake		Total
			Snow		Rain						High		Low						
Roads																			
Bridges	L	1	L	1	L	1	M	2	M	2	N	0	L	1	N	0	N	0	**8**
Traffic Signals	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	**0**
Street Lighting	N	0	N	0	N	0	L	1	N	0	N	0	N	0	N	0	N	0	**1**
Signs	N	0	N	0	N	0	L	1	N	0	N	0	N	0	N	0	N	0	**1**
Culverts	N	0	L	1	L	1	N	0	M	2	N	0	N	0	N	0	N	0	**4**
Sidewalks	N	0	L	1	L	1	N	0	L	1	N	0	L	1	N	0	N	0	**4**
Local Roads	L	1	M	2	L	1	N	0	M	2	N	0	L	1	N	0	N	0	**7**
Collectors	L	1	M	2	L	1	N	0	M	2	N	0	L	1	N	0	N	0	**7**
Total	**3**		**7**		**5**		**4**		**9**		**0**		**4**		**0**		**0**		**32**

*Please note all of the drop boxes must be filled in for each of the asset classes

Social Considerations

The Committee considered direct and indirect health effects of climate change as summarized by the Canadian Public Health Association (CPHA). The CPHA states that:

There are two types of **direct health effects** of climate change. The first are those caused by projected higher temperatures. Examples include increases in illness and death from heat stroke and dehydration. The second are injury, illness and death caused by projected increases in extreme weather, such as tornadoes, floods and winter storms.

Climate change could also have significant **indirect health effects**, as changes in climate trigger other changes that could affect health. An example would be the transmission of infectious diseases such as malaria, dengue and yellow fever as insects carrying diseases migrate northward into the Canadian climate.

A summary of potential impacts can be found in Table 18. It is also aware that the health impacts from climate change will not be distributed uniformly across the population (see Table 19). And while it is acknowledged that families and the local health system would carry the burden of treating health impacts, the Town would be impacted socially.

Table 19 Potential Climate Change Impacts to Human Health

Human Health Impacts	Inland Flooding	Coastal Flooding	Winter Storm / Ice	Hurricane Force Wind	Coastal Erosion	Drought	Wildland Fire	Extreme Heat Event
Heat stroke & dehydration								X
Transmission of infectious diseases (vector-borne)	X	X				X		X
Drowning	X	X						
Impacts from flying objects or objects carried by fast moving water	X	X			X		X	X
Falls on ice			X					
Vehicle collisions / accidents	X	X	X	X	X			
Increased respiratory illness						X	X	X
A rise in allergic respiratory disease	X	X				X	X	X
Increase in water-borne disease and illness (increase in bacteria, viruses, protozoa and parasites)	X	X		X				X
Mental stress and related disorders, or compounded existing disorders	X	X	X	X	X	X	X	X
Increase in food-borne diseases	X	X				X		X
Injury from fire							X	
Contact with hazardous materials	X	X	X	X		X	X	

Table 20 Risk 'Vulnerable' Populations

Risk Vulnerable Populations	Inland Flooding	Coastal Flooding	Winter Storm / Ice	Hurricane Force Wind	Coastal Erosion	Drought	Wildland Fire	Extreme Heat Event
Chronically ill	X	X	X	X		X	X	X
Older adults (elderly)	X	X	X	X		X	X	X
Children	X	X	X	X	X	X	X	X
Working poor / low income	X	X	X	X	X	X	X	X
Individuals with mental health issues	X	X	X	X	X	X	X	X
Outdoor workers	X	X	X	X	X		X	X
Emergency responders and health care workers	X	X	X	X	X		X	X
Mobility challenged individuals	X	X	X	X			X	X
Drug dependent individuals	X	X	X	X			X	X
Medicine dependent individuals	X	X	X	X			X	X
Mobile home residents				X				

Three general things determine how vulnerable someone is to the impacts of climate change: how exposed one is to the hazard, how sensitive they are, and their capacity to cope with the type of environmental change being imposed at the moment (Figure 7).

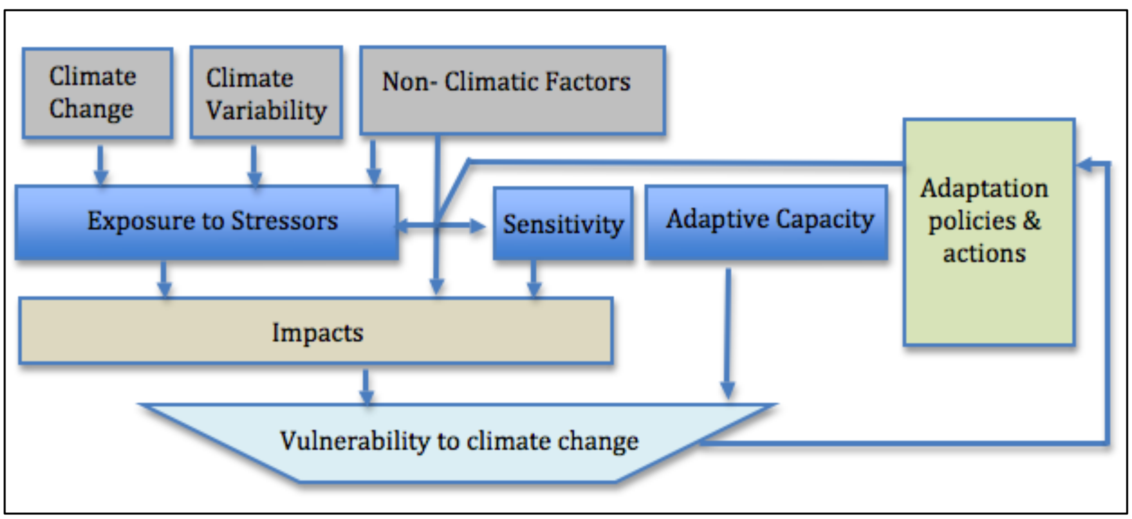


Figure 7. Adapted from Fuessel and Klein, 2006

When considering the question of whom within the municipality may be particularly vulnerable to climate change hazards, the Committee used its knowledge about observed and projected exposure to natural hazards that can be spatially described; such as, inland flooding, coastal flooding and coastal erosion. However, most hazards analyzed within the MCCAP process would likely be at a scale so large that all (or most) citizens would be 'exposed' (e.g., extreme heat event, winter storm, hurricane force winds, drought). In cases of analogous exposure to a hazard, what determines differences in vulnerability is one's *sensitivity* to the 'event' or climate condition.

The question of "sensitivity" is not straightforward. Sensitivity can confound (or ameliorate) the social and economic effects of climate exposure" (Cinnear et. al, 2013). Social sensitivity can be understood as the extent to which a person's ability to secure the necessities of life is affected by an impact. A broad view of social sensitivity could take into account someone's financial means, physical and mental health, level of education or level of emergency preparedness.

The following documents were examined to see if they identified *who* would be most vulnerable during emergency events:

- Contingency Plan for Incidents Possibly Encountered in Wastewater Treatment Facility Having a Potential of Generating an Environmental Nuisance
- Rodney Lake Water Treatment Plant Contingency Plan
- Private Water Supply Wells A Guide to Construction, Maintenance and Sampling
- Shelburne County East Emergency Management Organization (SCEEMO) Plan
- Shelburne County East EMO Plan
- Shelburne County East Emergency Management Organization (SCEEMO) Presentation to Audit & Program Services Committee – January 30, 2013
- Draft Source Water Protection Plan

None of the above plans name distinct populations that may be particularly vulnerable in an emergency event or where vulnerable populations are located. The Committee did not see this as a weakness of the plans, but instead a reflection of the fact that **every single person is sensitive to natural disaster or severe weather impacts in their own individual suite of ways**. **This confirms the importance of limiting exposure to natural hazards to the extent possible through precautionary land use planning, and simultaneously striving to improve organizational adaptive capacity so that response and recovery is optimal.** In essence, adaptive capacity is akin to a ratchet that can increase or decrease vulnerability.

For a municipality, organizational adaptive capacity is its dynamic ability to respond and adapt in the face of change. Instead of considering deficiencies in infrastructure, wealth, or other characteristics that could theoretically place a community at a disadvantage during a crisis, adaptive capacity considers multiple options, processes and response (Adger et al 2003, 2004, 2005, 2007; Posey 2009, Brown & Westaway 2011). Aspects such as municipal flexibility, professional redundancy, experience, and networks of support are key factors of adaptive capacity. So even if municipality is limited in its ability to address an individual's *sensitivity* to a particular type of weather event or the gradual stress of climate change, **the Town *will* strive to minimize risk vulnerability through prudent land use planning, environmental stewardship, and emergency preparedness**.

Economic Considerations

Tertiary Sector

One cannot consider the potential economic impacts of climate change on the Town of Shelburne in isolation from surrounding communities, and in fact, the entire south shore region. Perhaps the only factor that sets the Town apart is its concentration of services. In fact, based on information assimilated by the Province of Nova Scotia, Department of Finance, Economics and Statistics Division for their Community Counts website, the labour market in Shelburne is dominated by the tertiary sector (services)—approximately 45-50%. The affects of climate change to the services sector are indirect. For example, if those employed in the resource sector are struggling financially, their ability to afford services provided in Town will diminish in parallel. As well, natural disasters in other parts of the world will undoubtedly continue to affect food prices, so those engaged in the **food sector** may struggle due to increased supply costs.

Health services will feel increased strain as the baby boomers continue to age, and if severe weather impacts become more frequent and result in injuries. However, this sector is also a large employer for the area, so the Town and District reap some economic benefit from hosting the Roseway Hospital and other health related services.

The **tourism industry** certainly struggles with dips during stints of 'bad' weather (e.g., numerous days of rain). As well, there are concerns that news stories of coastal storms and related flood events will scare tourists away due to concerns for their safety. However, one can also take the perspective that bad weather elsewhere is an economic opportunity. **The south shore region would be wise to promote its quality of coastal life to urban dwellers sweltering from summer heat, or its water 'richness' in areas that are drought-stricken**. The reality is that while the Nova Scotia does have significant climate-related impacts to address (e.g., sea level rise), the province is in one of the best positions in the world in relation to changes in temperature and availability of water, if prudently managed. In fact, climate change will play far less of a role in affecting tourism than oil prices and people's financial capability to travel.

Primary Sector

Primary services (e.g., resource-based industries) represent about 14% of the area's labour force. Fishing, fish processing and related marine industries are primary economic activities in the South Shore and directly shape the Town's financial health. Scientists at the Bedford Institute of Oceanography explain that (Chabot et al, 2013):

> Climate change is expected to affect marine ecosystems through a suite of physical changes in the properties of water masses, such as sea level, temperature, acidification, salinity, oxygen, upwelling, stratification and the subsequent decrease in nutrient input from deeper waters, storm intensity and frequency, and changes in coastal run-off. These factors can directly impact the physiology of marine species, which can result in changes in growth rate and reproduction, as well as distribution changes (through emigration or differential survival). Changes in physical properties of water can also effect indirect changes on marine species, via changes in trophic webs (i.e., changes in productivity and distribution of prey species or changes in the timing of their availability to predators). Together, these changes produce changes in community species composition and biodiversity.

The Municipality of the District of Shelburne and Town of Shelburne are case study sites for research being conducted by the Partnership for Canada-Caribbean Community Climate Change Adaptation (ParCA). The research is focusing on the vulnerability of the Fishing and Tourism industries to climate change. As stated in the MCCAP of the Municipality of the District of Shelburne:

> Preliminary findings from the ParCA study indicate that fishers in the area are already finding it increasingly difficult to predict natural cycles such as weather patterns, storms, fish spawning, species migration, which is impacting their ability to fish effectively and increasing their vulnerability. As the climate continues to change vulnerabilities in the fishing industry also include damage to physical infrastructure (wharves, vessels), increased maintenance costs, and increased risk to health and safety due to increasing intensity and severity of weather. Opportunities for fishers include the possibility of increased lobster catches, as are already being observed, but this introduces an economic vulnerability in the form of low wharf pricing for lobster.

Secondary Sector

Secondary sectors (manufactured goods) represent about 14% of Shelburne's labour force. As is the case with tourism, the affects of climate change to this sector will likely be indirect. More profound impacts will emerge in relation to circumstances of international trade and the macro economy. There are, however, ways in which climate changes may influence the type of manufactured goods that will or will not locate in the Shelburne area. While issues of drought are not anticipated to be of concern on the scale already being experienced in the southern and western regions of the continent, water quantity /availability is still a noteworthy concern to a water-dependent manufacturing process. This is not to say that a water-intensive industry could not reside successfully in the area, but rather effort should be made to ensure that aquifer recharge capabilities will satisfy manufacturing needs without adversely effecting surrounding properties. If the desire of the industry is to be on Town water, a secondary water supply should be secured to augment Rodney Lake.

Self-Employed

During public consultation for the Town's ICSP, one of the core values identified by residents was the "independent nature" of its residents. The do-it-ourselves attitude manifested into a key area of economic sustainability: the intent to foster and assist entrepreneurship. While a sociocultural dedication to primary and secondary industries remains steadfast, citizens recognize there are opportunities to capitalize on Shelburne as a "creative economy and place to provide an idyllic life for those who can telecommute or establish 'high-tech' related services." Changing climate conditions magnify the importance of these opportunities, and call upon the Town to actively market itself in this light.

Statistics reveal that approximately 17% of the area's census respondents claim they are self-employed. Most self-employed workers have not incorporated their business (80%). Although there is not enough information about the nature of the services offered by this labour force, the Committee speculates that many of the self-employed entrepreneurs are involved in trades. Others may be involved with the care of children (e.g., home day care), horticultural pursuits (e.g., locally grown and sold food), or artisans. The sociocultural resourcefulness of self-employed people is an asset after a community has experienced a disturbance such as a natural disaster or severe storm. In fact, the rich network of trades people in rural areas is an immensely important, yet often under-appreciated characteristic of a resilient community.

Environmental Considerations

The Town of Shelburne is nested within the UNESCO designated South West Nova Biosphere Reserve, which encompasses Queens, Shelburne, Yarmouth, Annapolis and Digby Counties. The South West Nova Biosphere Reserve Association seeks "to balance the conservation of nature and cultural heritage with sustainable resource development to support prosperous local economies and healthy communities. The most amphibians and reptiles east of Ontario can be found in the Biosphere Reserve. The biosphere reserve is a hotspot for biodiversity and is home to 75% of Nova Scotia's species at risk. It encompasses many terrestrial and aquatic ecosystems including the Acadian Forest, rolling plains, drumlins and coastal cliffs." (Southwest Nova Bioshpere Reserve Association)

Within Town boundaries there is a surprising amount of forested land in the north and northeast portions of the municipality (Figure 8). There is considerable connectivity of the forested land in this area and surrounding region, with the main interruption to this connectivity being roadways such as Highway 103. To date, there have been no notable environmental emergencies due to weather in this forested ecosystem. It is anticipated that climate change impacts to this Acadian forest will be gradual; causing a potential shift is species composition over the long term. The introduction of wood-boring pests and diseases is a highly probable stress within this century, as is wildland fire. However, there is little the municipality can do to address these impacts other than to cooperate with provincial and post-secondary institutional efforts to monitor forest health, partner with woodlot associations to promote climate-wise stewardship, and encourage property owners to manage their woodlot in a manner that reduces fire risk.

In the developed portions of the Town, there have been no notable environmental issues experienced in the past due to weather, other than minor erosion along streambeds. Issues that *have* been experienced deal with the *built* environment and largely result from not taking natural drainage patterns and total volume of water flow into account before allowing development.

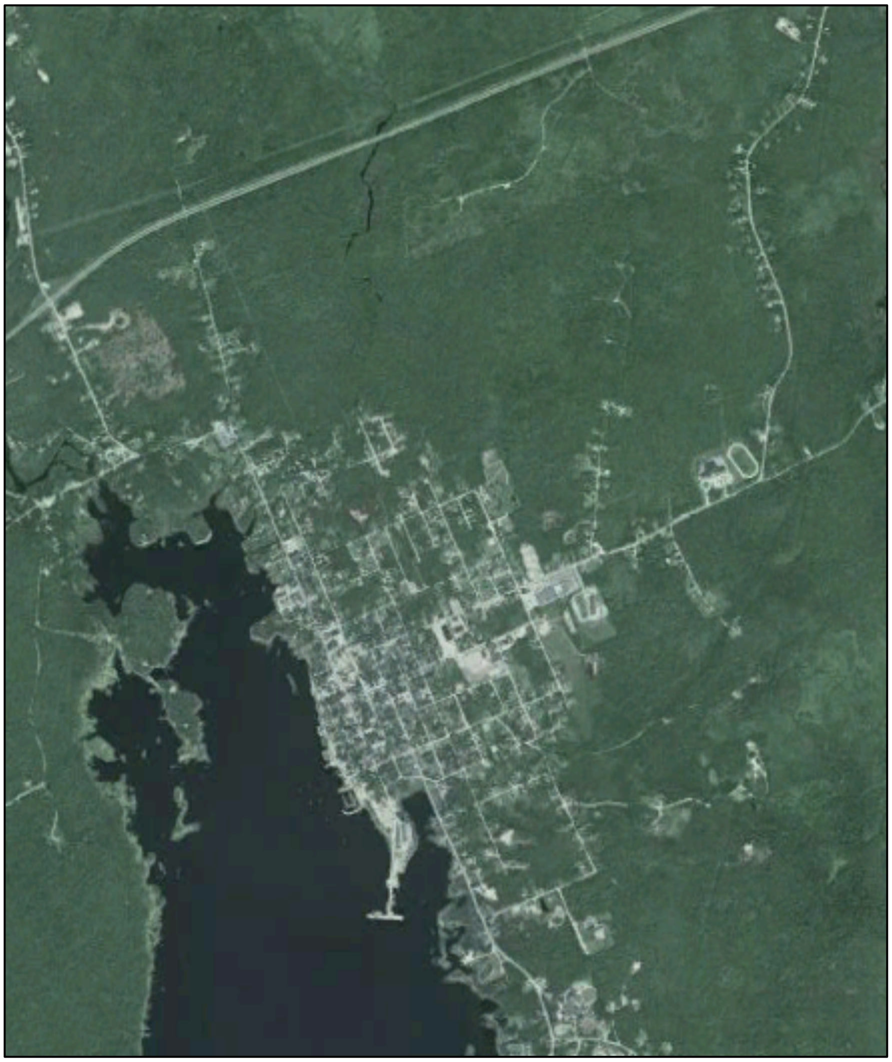


Figure 8 Google Earth Image of Town of Shelburne Area

Environmental Emergencies

Environmental problems are created by environmental emergencies. The Nova Scotia Environmental Emergency Regulations define environmental emergencies as situations in which "there is a release or an impending release of a substance in such quantities that mitigation of the release is beyond the capability of the person responsible because the person responsible lacks the resources, is unknown, or is otherwise unwilling or unable to control and manage the release." A list of known contaminant spills within the Town's boundaries is found in Table 20.

Table 21 Known Contaminant Spills in Town of Shelburne

Date	Location	Contaminant	Volume	Comments
mid 1980s	160 Water Street	Fuel oil	Unknown	Clean-up.
Early 1990s	206 Water Street	Gasoline	Unknown	Former service station. Plume went across street.
Early 1990s	27 Falls Lane	Gasoline	Unknown	Shell Station-cleaned up using groundwater treatment system.
Early 1990s	13 King Street	Gasoline	Unknown	Water supply well contaminated. Source likely Esso Station or possibly town garage. Hooked up to town water. No clean-up.
1994	John Street well	Sewage	Unknown	Shared water supply well. Source, leak in sewage lines on Water Street. No known clean-up. House connected to another shared well.
1 Apr 1998	152 Water Street	Fuel oil	~ 225 L	Cleaned up to Provincial requirements.
	Irving bulk tank farm	Petroleum	Huge	No clean-up.
23 May 2007	30 Jackson Lane	Diesel & hydraulic oil	115 L diesel	Truck accident on 103. Cleaned up to Provincial requirements.
Dec. 2007	234 Water Street	Fuel oil	~900 L	Partial clean-up. No measured impact to groundwater.
~2009-10	20 Falls Lane	Fuel oil	Unknown	Cleaned up.
~2010-11	41 Falls Lane	Liquid propane? Or fuel overfill	Unknown	Contaminant flowed onto Spears property. Test pits dug & samples collected. Results unknown.
2013	155 Mowatt Street	Fuel oil	Unknown	Oil in water supply well. Hooked up to town water. Source and clean-up status unknown.
2013	Trailer court	Sewage	Unknown	Water supply contaminated. Clean-up status unknown.
Please note: these are spills that are known. Undoubtedly there are others.				

As discussed in section 4.9, the release of hazardous substances is an omnipresent concern, potentially made more probable by extreme weather events. The Town of Shelburne acknowledges that there is only anecdotal understanding of where hazardous materials are kept, and this information is not mapped. It is also understood that every single household most likely has substances listed in Schedule A of Nova Scotia's Environmental Emergency Regulations.

Findings of the MCCAP reinforce the Town's existing commitment to support local fire districts and other emergency personnel in their efforts to establish, review, and keep updated a protocol for response to be enacted until fully equipped and trained hazardous material teams arrive on the scene of an incident.

Corporate Greenhouse Gas Emissions

In 2009, the Town engaged Acadia Management Group Inc. to perform a basic energy audit on municipal buildings and operations. The fundamental aim of the energy audit was to "identify energy management opportunities, for improvement in terms of energy savings, alternative energy sourcing or distribution and reductions in costs and greenhouse gas emissions for municipal operations." The energy audit was completed in conjunction with similar activities for two other Municipalities in the region, resulting in savings of cost and time in completing the work and also identifying opportunities for the three Municipalities to address common opportunities for savings in cost and greenhouse gas emissions.

At the time of the audit, minimal emissions were associated with fleet vehicles and street lighting (Figure 9). The bulk of the corporate energy emissions resulted from buildings and operations. Fifteen municipal facilities were assessed and recommendations provided for short, medium and long term energy management opportunities (Figure 10 and 11). Opportunities primarily involved operational changes through the education of staff that control and maintain heating or cooling equipment, and lighting. As well, the energy audit report suggested changes in insulation, refrigeration equipment (arena) and furnace controls. Of the fifteen facilities assessed, however, the Town pays the energy costs for only five: the Fire Hall / Community Centre, Town Hall, Public Works Garage, the Water Treatment Plant and the Waste Treatment Plant. The energy emissions and related costs of the other ten facilities are borne by the tenants. Unfortunately, the Town is not in the financial position to spend significant money on reducing these costs at the time of writing. Additionally, most of these facilities are quite aged, bringing into question whether energy upgrades should be invested in, or activities relocated.

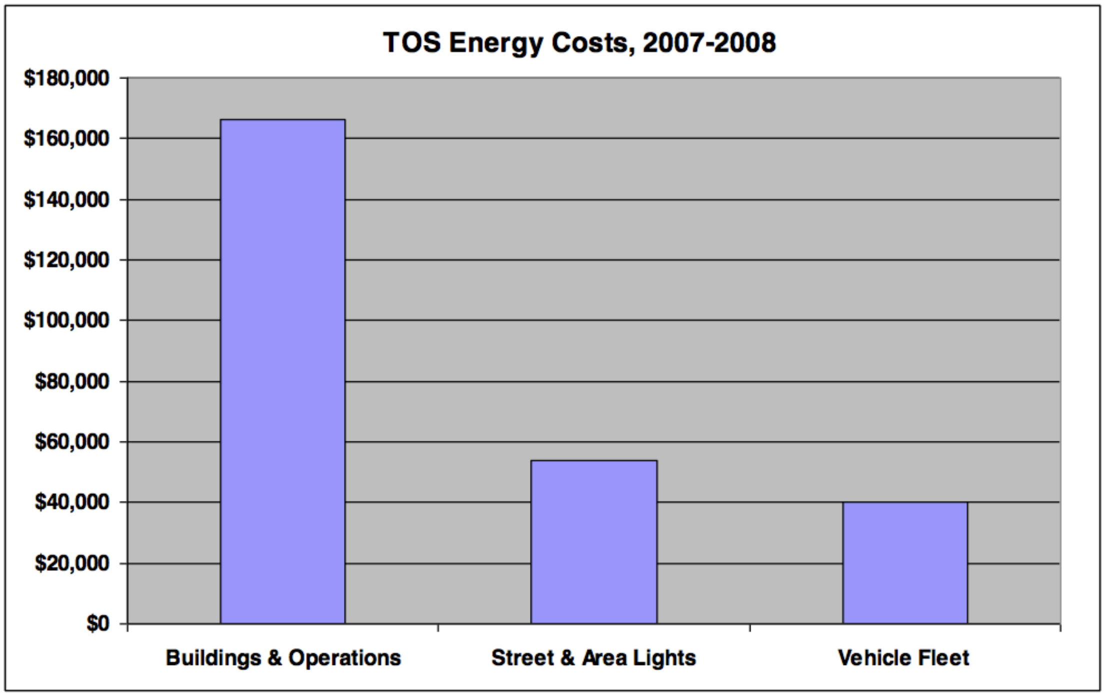


Figure 9 Town of Shelburne Average Energy Costs 2007-2008, Acadia Management Group Inc. Energy Audit, 2009

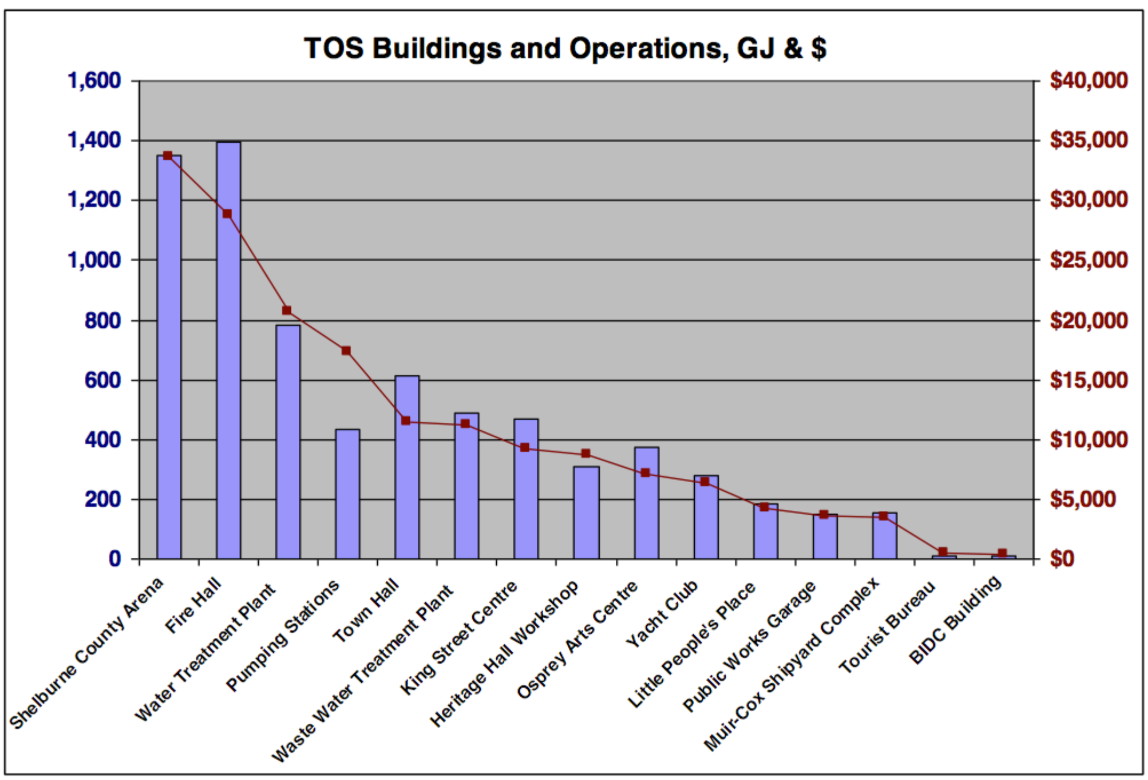


Figure 10 Town of Shelburne energy consumption and energy costs for the 15 buildings and operations, Acadia Management Group Inc. Energy Audit, 2009

GHG Coefficients (UNSM) kg/kWh 2.34 kg/ L Gasoline 2.63 kg/L Diesel & Fuel Oil 1.52 kg/L Propane
Conversions to GJ GJ/kWh 0.038 GJ/Litre 0.0252 GJ/Litre

Building	Electricity			Fuel Oil				Propane				Total		
	$'s	GJ	GHG, T	Litres	$'s	GJ	GHG, T	Litres	$'s	GJ	GHG, T	$'s	GJ	GHG, T
Shelburne County Arena	$25,959	922	222	11,265	$7,650	428	29.6					$33,609	1,351	252.0
Fire Hall	$11,461	395	95	26,316	$17,350	1,000	69.2					$28,811	1,395	164.5
Water Treatment Plant	$20,718	785	189				0.0					$20,718	785	189.2
Pumping Stations	$17,266	434	105				0.0					$17,266	434	104.6
Town Hall	$2,194	72	17	14,220	$9,273	540	37.4					$11,467	612	54.7
Waste Water Treatment Plant	$11,197	487	117				0.0					$11,197	487	117.3
King Street Centre	$2,142	70	17	10,547	$7,091	401	27.7	4,705	$4,452	119	7.2	$13,685	589	51.8
Heritage Hall Workshop	$2,026	66	16	3,281	$2,208	125	8.6					$4,234	190	24.5
Osprey Arts Centre	$1,811	62	15	8,154	$5,340	310	21.4					$7,150	372	36.5
Yacht Club	$3,207	102	25	4,678	$3,134	178	12.3					$6,341	280	36.9
Little People's Place	$2,371	77	19	2,769	$1,808	105	7.3					$4,179	183	25.9
Public Works Garage	$2,285	74	18	2,035	$1,272	77	5.4					$3,557	152	23.3
Muir-Cox Shipyard Complex	$2,066	67	16				0.0					$2,066	67	16.2
Tourist Bureau	$497	12	3				0.0					$497	12	2.8
BIDC Building	$346	9	2				0.0					$346	9	2.2
Total	$105,546	3,634	876	83,266	$55,125	3,164	219.0	4,705	$4,452	119	7.2	$165,123	6,917	1,102.4

Figure 11 Totals for Energy Consumption, Cost and Greenhouse Gases for Town's Buildings and Operations, Acadia Energy Management Group Inc., 2009

The information from the 2009 energy audit has been translated into an Energy and Emissions Inventory Table (Table 21). In the buildings category, only facilities for which municipal operations are responsible for greenhouse gas emissions and fuel costs have been calculated: Fire Hall / Community Centre, Public Works Garage, Town Hall, treatment plants and pumping stations.

Table 22 Town of Shelburne Energy and Emissions Inventory Table, 2009

Emission Category		Energy Type	Energy Consumption	Cost ($)	Units	Emission Factor (tCO2/units)	Emissions (tCo2e)
2009-2010	Buildings	Electricity Fuel Oil	541 GJ 42,517 L	\$15,930 \$27,895	GJ L	0.868 kg CO2 / KWh (2006 coefficient) 2.68kg CO2/L	130 109
2009-2010	Water & Wastewater	Electricity	1,706 GJ	\$49,191	GJ	0.868 kg CO2 / KWh (2006 coefficient)	411
2007-2008	Streetlights	Electricity	1, 726 GJ	\$52,300	GJ	0.868 kg CO2 / KWh (2006 coefficient)	416
2007-2008	Vehicles	Gasoline and Diesel combined – mix unknown	Unknown	\$28,182	L	2.34 kg CO2 / L 2.63 kg CO2 / L	Estimated between 50-70
2007-2008	Solid Waste	Unknown. Garbage collection, recycling and waste management services for the Town of Shelburne are provided by the District of Shelburne through a Shared Services Agreement.					

The 2009 energy audit recorded the expense of fueling vehicles, but not the liters consumed or equivalent emissions. Without accurate data for liters consumed or the price per liter at the time of the study, it is difficult to estimate resulting emissions.

Existing Energy and Emission Reduction Measures

After the energy audit in 2009, an effort was made by staff to ensure the building was managed in the most basic, energy efficiency manner possible. For example, it is a daily procedure of staff in the Town Hall to turn down all thermostats when leaving for the evening. They are not turned back up until the building is occupied the next business day. Similarly, staff are cognizant of lights (i.e., turning them off when not in use) and stealth power loads. In addition to the education of staff on energy saving procedures, the Town replaced windows and lights in the Town Office and some lights in other facilities.

The Town looked at modifications to the water treatment plant and its operations with the intention to reduce power consumption. So some efforts have been made to date.

Regarding streetlights, all but four of the streetlights in the Town are High Pressure Sodium. In June 2013, the Town decided to have NS Power proceed with the conversion of all streetlights in town to LED.

The Town participated in and supported studies on the viability of solar energy in the area. As well, in October of 2013 the Town installed its first electric car charging station. It is classed as a level 2 station (220 volts), capable of loading electricity into a car's battery at a rate of about 35 km of driving for each hour of charging. At the time of installation, it was one of twelve charging stations across Nova Scotia. In 2014, another 15 communities will be added to the circuit. The hope is that more motorists go the 'green' route for their next vehicle purchase. As well, the Town recognizes the benefit of servicing electric motorists in a manner that brings them into Town.

On a similar note, the Town has expanded sidewalks, trails and other active transportation infrastructure in recent years with an eye to reducing private GHG emissions from vehicular transportation. Continuing to support active transportation is a Town priority. Additionally, the Town recently began providing ongoing funding to Sou'West Nova Transit to provide a public transportation option in Shelburne County (also partially aimed at reducing private GHG emissions from vehicular transportation).

Energy and Emission Reduction Initiatives

The Town will continue with initiatives already underway, as noted above (Existing Energy and Emission Reduction Measures) including (but not limited to): replacement of streetlights with LED lights (NSPI), expansion of active transportation infrastructure (especially sidewalks), and continued support of public transportation.

Additionally, select recommendations from the 2009 energy audit are carried forward as part of the Town's MCCAP. Practical action items relating to the Fire Hall / Community Centre, Town Hall, and Waste Treatment Plant are reiterated as MCCAP Action items. In addition to the continued recognition of these initiatives, the Town is also pursuing emission reduction measures that were *not* highlighted in the energy audit. For example, the Committee is intrigued by the notion that the South-facing exterior wall of the Fire Hall / Community Centre is well suited for a solar air heater. The Committee suggests that the Town also learn about the feasibility of installing heat pumps and solar hot water, and inquire about provincial or federal incentive programs that could aid with equipment purchase and installation. A heat pump for Town Office has been planned, The Town is interested in pursuing wind energy to 'offset' energy consumption and emissions through Nova Scotia Power's COMFIT program. Such a project would likely be pursued in cooperation with the Municipality of the District of Shelburne.

A Tree Planting Program currently under development will ensure new trees are planted each year (in excess of any removed, as the current policy is to plant replacements). The goal of this program is to increase the presence of trees in Town for appearances, but not without benefits to GHG reduction.

Section IV

Climate Change Strategies and Actions

Impact Research and Mitigation Efforts Completed or Underway

The Town of Shelburne is actively addressing a range of weather and climate-related infrastructure challenges. In terms of water handling, there is a phased culvert replacement project underway to mitigate inland flooding and drainage issues in the South end. A MCCAP action item is to continue with this project through to completion. As well, it is standard practice for Public Works to replace pipes and culverts, when necessary, with larger diameter pipes to address known issues of concern.

A condition assessment and feasibility study was completed for the Town by YMCL Engineering Limited in association with Dillon Consulting Limited in 2012. While the intent of the report was not to evaluate the Terminal in the context of changing climate and sea conditions, it did explain the need to further evaluate the Terminal's capability to withstand a changing wave environment as sea level increases. The Town is currently (at time of writing) drafting a request for proposals (RFP) for a major Terminal renovation project. As a result of the MCCAP process, the RFP will require that any proposed design take shifting storm surge return periods, sea level rise, and potential consequences of wave action (particularly on the south side of wharf) into consideration.

For more than a decade, the Town's Emergency Measures Organization Coordinator advocated that Nova Scotia Power Incorporated assertively trim trees to minimize risk of power outages in high winds and ice storms. This has indeed been happening with noticeable benefit. In addition to maintaining pressure for tree trimming, the Town is advocating for a 30-40 foot double feed that would further mitigate the risk of power outages. Currently, electricity is supplied to the Town with two separate feeds, each serving approximately half of the Town. Meanwhile, the Town reaps some benefit from the fact that some power lines were buried in the historic district during the filming of the movie, Scarlet Letter, in order to make the Town appear more historically accurate. However, the Town was not given, to their knowledge, a map of the exact location of these buried wires. Hence, an MCCAP action item is to acquire this information.

In conjunction with the Municipality of the District of Shelburne, the Town is seeing some exciting progress in terms of data acquisition and mapping capabilities. The two municipalities participated in the large scale mapping program through the Nova Scotia Geomatics Centre to obtain digital elevation models and topographic vectors (Figure 12).

Product	Description	Format
Orthophoto Image, LiDAR generated bare earth DEM, & Topographic Vectors (Contours, and annotation)	"GIS-Ready" 15 cm resolution digital ortho-rectified color image, & compiled vectors including annotation, spot heights, and contours at a 2 metre interval (in NAD83 CSRS Datum, 3° MTM Projection or 6° UTM Projection), bare earth DEM (digital elevation model) with a one metre resolution.	GeoTIFF (Ortho Image), DEM file – raster format, & Shapefiles (vector files), Annotation – file geodatabase

Figure 12 Nova Scotia Geomatics Centre Large Scale Mapping Program Product Description

The lidar information is now being used in four research projects using the Municipality of the District of Shelburne and the Town as study sites:

1. The ParCA (Partnership for Canadian-Caribbean Community Climate Change Adaptation) project managed by CARIBSAVE, a non-government organization based out of Barbados
2. A Natural Resources Canada (NRCan) project that serves as an extension of the ACAS program through ACASA (Atlantic Climate Adaptation Solutions Association), led by University of PEI, Saint Mary's and Dalhousie Universities
3. Two student research projects through the Saint. Mary's Department of Geography, class GEOG 4496 *Applications in GIS*

The ParCA Project

Through the ParCA project, Saint Mary's University (SMU) has been tasked with assessing and comparing coastal vulnerability and associated adaptive capacity to sea level rise within the ParCA selected study areas in Nova Scotia and Tobago. The similarities of these areas, such as a heavy reliance on fisheries and tourism, provides an ideal scenario for a comparative cross-cultural research project as well as an opportunity to collaborate with, and engage multiple coastal stakeholders on an international level.

As part of this project, Samantha Page, a master's student at Saint Mary's University spent the summer of 2013 characterizing the shorelines of key coastal communities in Shelburne and Queens counties, including the Town of Shelburne. Shoreline Characterization involves the development of an integrative georeferenced GIS database of coastal zone characteristics for three different shorelines; the backshore, which is the area of the beach profile that is only inundated during storm conditions, the foreshore, which is the intertidal zone between mean high and low tides and the nearshore, which is the area of coast bounded by the point at which waves begin to form and the low tide line. Most coastal studies only take into consideration what is present at one point in the coastal zone and consequently do not exemplify the dynamic nature of coastal systems. The incorporation of three shorelines in this database, allows for a more comprehensive picture of what is present along the coastline and the detailed data that was collected allows for more precise analyses to be conducted when looking at potential effects of sea level rise and the adaptive capacity of coastal communities. Collected data includes geomorphology, elevation, stability, and material type for each of the shorelines as well as points of observed erosion, presence and condition of small structures such as wharves, stairs, ramps etc. and information about coastal protection structures (i.e., height, width. slope, condition, angle to shore, function and material).

This detailed georeferenced, coastal characterization database, developed for the Town of Shelburne, will provide base data that can be used by the town, or other researchers to conduct further coastal analyses and will help guide future coastal management decisions.

ACASA Project

ACASA is in the beginning stages of developing a long-term coastal adaptation guidance strategy for Atlantic Canada. The goal of this project is to determine criteria for selecting appropriate coastal adaptation options, through the development of a decision key for planning and engineering strategies applicable to rural Atlantic Canadian communities.

As part of the project, Brittany MacIsaac, a master's student studying at Saint Mary's University will be developing key principles to determine the success of specific adaptation tools and strategies available to Atlantic Canada. Interviews will be conducted in order to provide a better understanding of how current coastal management and planning decisions are addressed within rural communities. This information is important in determining main motivating factors and variables that go into coastal adaptation. Research conducted within this project is one of the key focus areas of the ACASA coastal adaptation guidance project, which is to create a decision key for guiding sustainable coastal adaptation strategies to climate change in rural Atlantic Canada. The decision key will be a web-based decision making tool, which will lead users through a sequence of queries in order to lead them to the most appropriate adaptation strategies and instruments for their particular coastal situation.

The ACASA project is still in the planning stages. However, it has been confirmed that the Town of Shelburne and the Municipality of the District of Shelburne are two of the five main communities that will be looked at in detail.

Research Projects of Saint. Mary's University, *Applications in GIS* Class

The 4th year, one semester *Applications in GIS* course is designed, under the supervision of Dr. Danika van Proosdij, to provide an opportunity for students to be involved in GIS projects with real world applications. In winter of 2014, two projects were chosen to expand work conducted by ParCA during the summer of 2013 and provide some base level data for the upcoming NRCan project in 2014.

The overall purpose of these projects is to determine the vulnerability of Shelburne harbour, including Sandy Point, to sea level rise and storm surge. Current projections of sea level rise for 2050 and 2100 will be modeled using ArcGIS 10.1, augmented by storm surge projections by Richard and Daigle, 2011, which were used by the Committee for the coastal flood risk analysis. The resultant GIS flood layers will be used to:

- Quantify the type, distribution and amount of infrastructure that will be inundated under these scenarios including depth of water. Buildings will be coded according to level of risk (student: Jonathan Bray)
- Develop and map social vulnerability as an index (based on the Canadian Social Determinants of Health) to visually represent the distribution of residential areas and populations in the study area with high levels of social vulnerability. The Canadian Social Determinants of Health Indicators chosen include: low income; government transfer payments; unemployment; children; seniors; seniors living alone; lone parent families; no secondary education; no knowledge of English or French; recent immigrants; visible minorities; and Aboriginal identity. This assessment will identify areas most at need of assistance, particularly in focusing adaptation and emergency management planning on high-risk populations and areas. (student: Graeme Matheson)

The final project will culminate in a public poster reception at Saint Mary's University on April 3rd from 4-6 pm. Project 'sponsors' are invited and encouraged to attend. A scholarship from ESRI Canada ($1,000 and software) will be awarded to the top student project. A final written project report and all data (with associated metadata) will be provided to the Town and Municipality by the end of April 2014. In addition, the results of this study will be used in a climate change adaptation planning exercise to be undertaken in the area later this year in the NRCan/ACASA project

Further information about these projects can obtained by contacting Dr. Danika van Proosdij, Department of Geography, Saint Mary's University dvanproo@smu.ca.

Climate Change Action Plan

The Committee believes that *all* hazards identified in the MCCAP process warrant future action in order to avoid the cumulative financial and social affects that these hazards could create. However, the natural hazard analysis done for MCCAP development revealed that the natural hazards *most* warranting municipal attention and adaptive action in the near-term are coastal flooding, inland flooding, and drought. These hazards endanger public health and safety and present risk of damage to property and infrastructure. All three hazards also have the potential to disrupt local and regional economies by imposing financial hardship at the residential and municipal level. As well, flooding in particular could result in interruptions of municipal operations and services.

The cumulative effect of the proposed MCCAP action items on the community would be the empowerment of citizens to protect their safety and property. As well, Town Council, staff and citizens would benefit from improvements in governance processes (i.e., greater adaptive capacity within the organization) and a renewed focus on long-term decisions about infrastructure that are financially, environmentally and socially strategic.

The Town of Shelburne has identified 9 strategies to improve upon its adaptive capacity and characteristics of resilience:

1. Public education and outreach about coastal flood and erosion impacts
2. Address wastewater (sanitary sewage and stormwater)
3. Protect public and private assets from rising water volume and flash flooding
4. Environmental protection and monitoring
5. Protect future drinking water supply
6. Support emergency preparedness
7. Strengthen municipal resources and policies to protect municipal staff and citizens
8. Adaptive Actions that can be achieved in cooperation with the Municipality of the District of Shelburne
9. Reduce greenhouse gas emissions

Actions that help achieve the 9 strategies listed above are presented in the following tables. These actions *include* efforts to obtain additional information where it was deemed necessary to develop deeper analysis and understanding of the priority issues. As well, it should be noted that the MCCAP process drew attention to the importance of reviewing and updating the municipality's planning strategy and bylaw as a means of simultaneously addressing multiple issues, not the least of which is mitigating unwanted impacts from changing climate conditions and severe weather through a suite of planning approaches and tools. Therefore, a priority MCCAP action item is to, "Update Municipal Planning Strategy and Bylaw. Within update, enable the Town with the authority to use Development Agreements." Other related action items include:

- Adopt a Planning and Design Standard to guide development of new municipal infrastructure

- Create a municipal policy that all new municipal owned buildings are built to LEED (Leadership in Energy and Environmental Design) Silver standards
- Establish municipal policy and procedures for municipal work stoppages during incidents of extreme heat
- Establish municipal policy and procedures to address the safety of municipally coordinated outdoor events during hot and very hot days as defined as days that are 30°C and 35°C respectively
- Implement a municipal policy to protect staff at the Sewage Treatment Plant from hurricanes and/or storm surges

The intended use of the Development Agreement tool will be to guide all coastal development at or below 3.3 m CGVD28 in a manner that protects the structure (and inhabitants) from storm surge events. Similarly, it is the intent of the Town to use development agreements in areas of known and projected inland flooding. Criteria for flood proofing, vertical allowances and/or horizontal setbacks will all be considered during public consultation in which the introduction of Development Agreements will be discussed.

Climate Change Strategy	Climate Change Actions	
1. Public Education and Outreach	1.1	Post a one-two page brief describing what is currently understood about susceptibility to coastal erosion and associated mapping on the municipal website
	1.2	Post a one-two page brief describing what is currently understood about coastal flood risk vulnerability and associated mapping on the municipal website, and have a hard copy available in brochure form in the Town Office.
	1.3	Communicate the results of the MCCAP, and progress in accomplishing MCCAP Action items in the Shelburne Coastguard
	1.4	Host a public launch of a calibrated stick for recording total water volumes (tide plus surge levels) in Bill Norman Park or other waterfront location. Include the schools in this special event.
	1.5	Post completed post-storm analyses on the Town website
	1.6	If a tide gauge is located in Shelburne Harbour (action 8.7), facilitate the school's participation as a receiving site for data collection so the data is available to faculty for use in the curriculum

Climate Change Strategy	Climate Change Actions	
2. Address Wastewater	2.1	Have a stormwater management plan completed by end of 2015 to guide efforts to reduce inland flooding and inflow to the wastewater collection system
	2.2	Evaluate the cost of treating infiltration/inflow to wastewater system versus costs for rehabilitation of system. Establish renovation priorities (if selected) and estimate required annual expenditure.
	2.3	Establish protocol for dealing with wastewater overflow so as to minimize associated impacts on nearby receiving waters

Climate Change Strategy	Climate Change Actions	
3. Protect Infrastructure from Rising Water Volume and Flash Flooding	3.1	Continue and expand culvert replacement project to mitigate inland drainage issues throughout Town
	3.2	Address the effect of waves and wave loading on the South side of the Marine Terminal as part of a wharf renovation project
	3.3	Identify options for protecting flood risk vulnerable lift stations, and in the interim develop a Public Works protocol describing when motors should be temporarily removed from lift stations vulnerable to flooding (inland or storm surge) to avoid damage. Most vulnerable lift stations include: • Brewhouse Lane; 43o 45'28.53 N, 65o 19'02.92 W; Elev 13 ft • Continental; 43o 45'20.17 N; 65o 19'12.19 W ; Elev 4 ft • Dock Street; 43o 45'43.43 N; 65o 19'27.48 W; Elev 6 ft • Hardy's Lane; 43o 46'03.14 N; 65o 19'37.24 W; Elev 7 ft • Arthur Street; 43o 46'16.27 N; 65o 19'45.99 W; Elev 9 ft • Mc Gill Point Lower; 43o 46'13.93 N; 65o 20'06.07 W; Elev 13 ft
	3.4	Waterproof or heighten public outlets along Dock St. and Marine Terminal
	3.5	Reconstruct (and raise) armouring along Bill Norman Park. Seek the input of a Geoscientist for design recommendations and approval.
	3.6	Require that a geoscientist be consulted during the design/repair or revetments or seawalls to ensure proper construction techniques with contingency in design for being raised over time. Revetments should be constructed with a low berm to reduce over-wash, recognizing that in severe flood or surge situations such berms would still be overtopped.

Climate Change Strategy	Climate Change Actions	
4. Environmental Protection and Monitoring	4.1	Add storm surge flooding to the list of incidents to be assessed in the Contingency Plan for Incidents Possibly Encountered in Wastewater Treatment Facility Having a Potential of Generating an Environmental Nuisance
	4.2	Add inland flooding to the list of incidents to be assessed in the Contingency Plan for Incidents Possibly Encountered in Wastewater Treatment Facility Having a Potential of Generating an Environmental Nuisance
	4.3	In the Rodney Lake Water Treatment Plant Contingency Plan, detail that the notes section of the Standard Operating Procedures includes weather related causes of impact and ensure such impacts are included in any Post Storm Analysis reports.
	4.4	Establish groundwater-monitoring sites around former 'dump'
	4.5	Erect a calibrated stick in Bill Norman Park that can be used to gauge total water volumes experienced (tide plus surge levels), and serve as a public education tool

Climate Change Strategy	Climate Change Actions	
5. Protect Future Drinking Water Supply	5.1	Update and approve a Source Water Protection Plan. The Plan should include the delineation and intent to protect a secondary water supply area.
	5.2	Revisit findings of AquaTerra study, which identified a secondary water supply, and pursue using this well to augment the Town's existing water supply (Rodney Lake)
	5.3	Evaluate impacts of drought-rewetting cycles in the Rodney Lake Water Treatment Plant Contingency Plan
	5.4	Update, adopt and disseminate the Well Head Protection Plan
	5.5	Phase in an increasing block rate to consumption rates for water charges
	5.6	Amend Snow Removal Standards to ensure private wells are protected from road salt infiltration
	5.7	Establish meters on unmetered water connections
	5.8	Extend Town water services to areas in Town where Private wells are contaminated or highly vulnerable to contamination
	5.9	Draft a Water Management By-law that allows for a conservation order restricting use of the public works water system (i.e., to be used to mitigate low water supply during extended drought)
	5.10	Work with NSCC to hire a Geographic Information Systems (GIS) summer/co-op student to map all private wells in Town, and for each well record known concerns, whether dug or drilled, number of supply lines, and which houses/businesses share which well.

Climate Change Strategy	Climate Change Actions	
6. Support Emergency Preparedness	6.1	Ensure that new Emergency Measures Organization Coordinators are adequately mentored by their predecessors and municipal staff
	6.2	Inventory ‘unopened streets’ and determine what Town intends to open. Rename street sections not anticipating connection in the future. Inform EMO of these intentions and progress to aid with evacuation planning, and create/update a Town Street map.
	6.3	Coordinate/host a presentation for the Shelburne County Amateur Radio Club about natural hazards in the context of changing climate conditions, and identify an opportunity to enlist their help in building a historical record of local weather
	6.4	Investigate whether or not the Town’s water supply infrastructure could adequately supply water capacity and pressure beyond regular draw levels if required for extended fire suppression needs during a large-scale fire.
	6.5	Link supply management issues planned for Pandemic events to emergency contingency plans for severe weather events and natural disasters.
	6.6	Enact a procedure that allows the Emergency Measures Organization Coordinator to provide input/approval on all land use planning decisions

Climate Change Strategy	Climate Change Actions	
7. Strengthen Municipal Resources and Policies to Protect Municipal Staff and Citizens	7.1	Update Municipal Planning Strategy and Bylaw. Within update, enable the Town with the authority to use Development Agreements
	7.2	Adopt a Planning and Design Standard to guide development of new municipal infrastructure
	7.3	Create an infrastructure map locating/describing municipal infrastructure and assets, and buried electrical lines
	7.4	Create a municipal policy that all new municipal owned buildings are built to LEED Silver standards
	7.5	Establish municipal policy and procedures for municipal work stoppages during incidents of extreme heat
	7.6	Establish municipal policy and procedures to address the safety of municipally coordinated outdoor events during hot and very hot days as defined as days that are 30°C and 35°C respectively
	7.7	Implement a municipal policy to protect staff at the Sewage Treatment Plant from hurricanes and/or storm surges
	7.8	Obtain Right of First Refusal from Nova Scotia Power Incorporated for the 2,400 HP hydropower dam on the Roseway River
	7.9	Create electronic and hard copy database of all maps for easy access during emergency situations to identify actual or predicted areas of concern
	7.10	Continue to pursue Nova Scotia Power Inc. to install a double feed electrical line in Town, which would mitigate power outages. (Currently the Town is fed by two separate electrical feeds).
	7.11	Revisit the Natural Hazards Analysis in the context of land use planning, infrastructure planning, and emergency measures planning, and update policies and protocols accordingly in before 2025.

Climate Change Strategy	Climate Change Actions	
8. Actions to Pursue in Cooperation with the Municipality of the District of Shelburne	8.1	Increase Public Awareness of Emergency Preparedness: Continue to take an active role in communicating to residents best practices for being prepared for an emergency.
	8.2	Water Conservation Education: Work with Nova Scotia Environment and explore other partnerships to communicate and promote water conservation strategies for residents and businesses.
	8.3	Watershed Mapping: Incorporate surface water systems into flood risk mapping to enable consideration of watershed features and drainage in land use and development planning processes.
	8.4	Inland Flood Risk Mapping: Work with the Nova Scotia Climate Change Directorate and the Applied Geomatics Research Group to use newly acquired lidar data to complete inland water level flood risk mapping to identify long term risk as well as to complete evacuation planning exercises. Contact Dr. Tim Webster.
	8.5	Public awareness about Flood Insurance: encourage UNSM and/or the Halifax Insurance Bureau of Canada to inform residents about what flood insurance does and does not cover, and how that relates to eligibility for Disaster Financial Assistance in a public campaign
	8.6	Monitoring Severe Weather Impacts: Establish an EMO protocol requiring the EMC to complete a post-storm analysis template that must include Public Works input detailing any damage to infrastructure. Completed template is to be given to the Town's Chief Administrative Officer, who will have one copy of the analysis filed (i.e., useful for future emergency preparedness planning and municipal mapping exercises) and send a second copy to the Atlantic Storm Prediction Centre care of Bob Robichaud.
	8.7	Meet with Michel Goguen, Director of Hydrography (Atlantic), Canadian Hydrographic Service, Department of Fisheries and Oceans about the possibility of establishing a community/municipally owned tide gauge in Shelburne Harbour.
	8.8	Recommend to NSEMO that they educate the public about the implications of interruptions in power supply and cellar systems during extreme weather events

Climate Change Strategy		Climate Change Actions	Time frame	Responsibility	Cost
9. Actions to Reduce Greenhouse Gas Emissions	9.1	Reduce Energy Consumption at Community Centre / Fire Hall: • Replace lamps and ballasts in all lighting fixtures • Continue with annual oil furnace maintenance/tune up • Investigate the feasibility of a Reset Controller for Furnace • Install a radiant in-floor heating solar thermal system coupled with solar hot-water if and when the concrete floor is re-poured • Investigate feasibility of heat pumps, solar hot water, and solar air heater for community centre • Inquire about provincial or federal incentive programs that could aid with equipment purchase and installation of energy systems	Medium term	Public works	Moderate to high
	9.2	Reduce Energy Consumption at Waste Treatment Plant: As T12 double fixtures burn out, replace bulbs	Short term	Plant operators	Low
	9.3	Reduce Energy Consumption at Town Hall: • Continue with annual oil furnace maintenance/tune up • As T12 double fixtures burn out, replace bulbs • Add insulation to walls of building (2009 report estimates that this would cost $10k and payback would be under 3 years. Would save an estimated 25% of heating costs) • Determine if ducting can be installed for air distribution of warm air in winter and cooled air in summer using air heat pumps to price conditioned air to supplement passive solar heat capture on the south wall. (payback could be approx. 2 yrs)	Medium term * A decision needs to be made if Town Hall offices will be relocated	Public works	Moderate
	9.4	Pursue a wind turbine(s) via the COMFIT program	Medium term	Admin. Staff and Council	Moderate

Recommendations

There are multiple opportunities for the Province to provide needed leadership to mitigate the consequences of natural hazards exacerbated by climate change. These opportunities can be categorized as public education and outreach, provision of tools and/or data for land use and emergency measures planning.

Public education and outreach

- During Union of Nova Scotia Municipalities training of newly elected Councilors, include a review of the roles and responsibilities of Emergency Measures Organization Coordinators (EMCs), as well as the process through which they are briefed on severe weather and the importance of reviewing and updating emergency preparedness plans and contingency plans. As well, explain the link between land use planning and development and risk mitigation, and the benefit of a collaborative approach that more fully involves not just planners, but also EMCs and public works.
- Work with the Insurance Bureau of Canada to develop and disseminate a public service announcement clarifying that home flood insurance does not cover overland flooding, and a homeowner that does not carry home insurance is not eligible for federal disaster financial assistance.
- Offer a seminar for newly elected officials on climate change trends and projections, and the role of adaptive capacity and adaptation strategy.
- Provide a practical framework for climate change action plan implementation and monitoring, and base future progress reports on this framework.

Tools and/or data for land use and emergency measures planning

- Develop and distribute directly to municipalities a mapping protocol so that municipal mapping regarding natural hazards can be assimilated into a larger provincial database for subject analysis and to inform province-wide climate change efforts.
- Prioritize the production of risk vulnerability assessment products through the Department of Natural Resources, such as susceptibility mapping for arsenic, radon, karst terrain and saltwater intrusion.
- Prioritize the production of a real-time, internet-based storm surge map that incorporates local information and observations / post-storm analyses.

- Improve the accuracy of the private well database and the ability to track incidents of dry wells.
- Provide municipalities with information and mapping about groundwater and susceptibility to drought. Explain characteristics such as quantity, patterns of flow and needs for recharge.

In addition to the above listed recommendations, the Town—along with other municipalities—recognizes the need for ***one* simple and provincially managed depository for information about experienced impacts and observations after storm events.** Case in point, with funding from Nova Scotia Environment's Climate Change Adaptation Fund, a Post-Storm Analysis Template to guide storm data collection. **Municipalities throughout the Province are being encouraged to make the completion of post-storm analysis templates standard practice after every weather event that includes flooding** (inland or coastal or a combination thereof). Once complete, one copy of the Template would remain with the municipality and one would be sent to the Warning Preparedness Meteorologist at Environment Canada's Canadian Hurricane Centre. The Hurricane centre will use the information to identify and/or update locally relevant indicators (based on experienced impacts) for Stage 1, 2 and 3 flood warnings. The Template also includes a "Storm Surge Decision Tree for Emergency Managers". This provides a flow chart they can follow in the warning phase of potential storm surge to better assess data and take appropriate action (Figure)13. However, the Hurricane Centre is not alone in wanting flood related data. Municipalities are receiving similar requests for flood-impact information from multiple post-secondary institutions, and even provincial departments. Therefore, **there should be one system for submitting and storing storm information digitally with controlled accessibility** that includes Environment Canada's Hurricane Centre, Provincial Departments, and all municipalities (i.e., Chief Administrative Officers, Planners and Emergency Management Coordinators). Arrangements to make this information also available to academic institutions should be considered.

Additionally, municipalities would like information on what provincial departments are doing to track or prevent damages from extreme weather events. The operations and services of Transportation and Infrastructure Renewal and Department of Agriculture are especially influential across the Province. Similarly, municipalities would benefit from knowing if, and to what extent, the Nova Scotia Emergency Management Office, or any other provincial agency, is liaising with Nova Scotia Power Incorporated, Minas Basin Pulp and Power, and other dam owners to ensure changing climate conditions are being accounted for in maintenance and upkeep, and contingency planning.

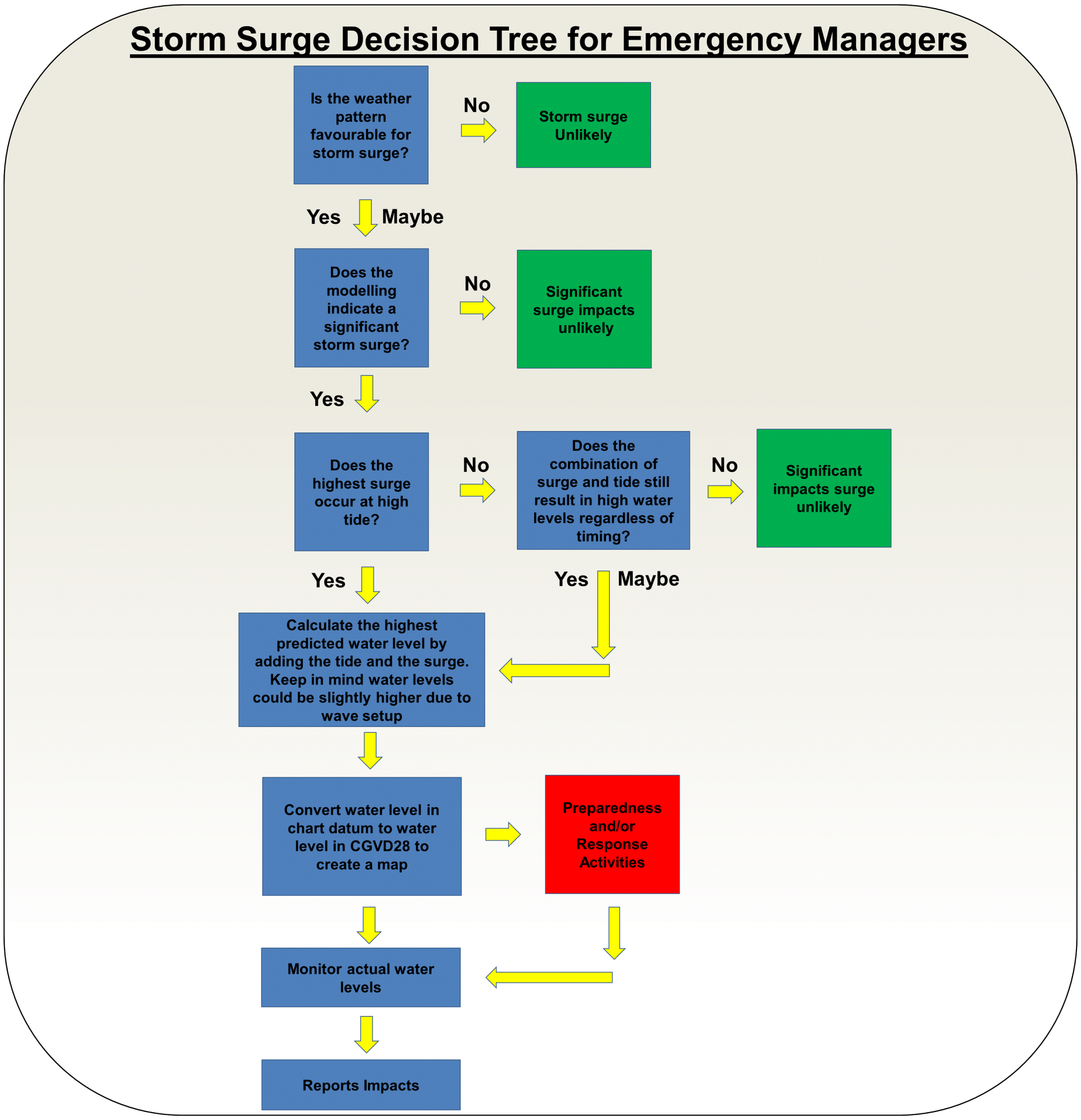


Figure 13 Post Storm Analysis Template Decision Tree. Product of a Climate Adaptation Fund Project via the Nova Scotia Environment Climate Change Unit

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