



Climate-Wise &
Weather-Prepared

Municipality of the
District of West Hants

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 of the Municipality of the District of West Hants.

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Executive Summary

The Municipality of West Hants has completed a Municipal Climate Change Action Plan, fulfilling a requirement of the 2010-2014 Gas Tax Agreement and Municipal Funding Agreement.

The process of developing the Municipal Climate Change Action Plan (MCCAP) created an opportunity to respond to changing natural hazards in an informed way. It has provided perspective on the impacts of climate change on West Hants and initiated discussions about policy and procedures that could help protect people, properties, special places, and essential municipal services that are susceptible to changing climate conditions. The Municipal Climate Change Action Plan also updates and summarizes West Hants' greenhouse gas emissions and presents strategies to limit those emissions. Actions to reduce greenhouse gas emissions reduce energy costs and demonstrate leadership in addressing a substantial threat to our ecosystem.

An interdepartmental Climate Change Committee collaboratively assessed if and how projected changes in climate might exacerbate eight natural hazards, what the potential impacts of the hazards would be, and the municipality's capability to reduce related threats. The eight hazards analyzed were: drought, wildland fire, inland flooding, coastal flooding from storm surge, winter ice events, tropical storms and hurricanes, and coastal erosion. When considering what the impacts from these hazards have been, and how the nature of the impacts could change in the projected future climate, the Climate Change Committee analyzed not only physical threats, but also socioeconomic impacts.

The analysis revealed that coastal flooding, drought, and inland flooding are the three most concerning natural hazards in terms of risks to life and safety and damage to infrastructure. While there is a fairly small amount of municipal infrastructure vulnerable to these high-risk hazards, the municipality as a whole is particularly susceptible to failings of provincial and privately owned infrastructure in extreme events; namely, breaches of dykes, and the dams of the Avon and St. Croix River hydroelectric systems.

The analysis also revealed that five of the eight natural hazards assessed by the Climate Change Committee are not specifically mentioned in the Emergency Preparedness Plan of the Regional Emergency Management Organization, including coastal flooding,

drought, and inland flooding. Although this Municipal Climate Change Action Plan is an amendment to the Municipality's Integrated Community Sustainability Plan, it also complements emergency preparedness planning and has laid the groundwork for an update to the Hants County-Western Zone Emergency Response Plan.

An insight that arose during the development of this Climate Change Action Plan was that a key adaptation to climate change is to become a change-oriented culture of governance and management: in other words, an adaptive organization. Adaptive organizations embrace the idea that continuous learning and preparation for the future is not only critical to sustainability, but also a core leadership competence. In fact, the *process* of analyzing climate change impacts to municipal operations and services was a stepping-stone toward new views of contemporary local governance.

The Climate Change Committee identified 47 actions intended to improve organizational adaptive capacity, strengthen emergency management capabilities and reduce risks of adverse effects from unwanted impacts. Most of the actions can be easily absorbed into existing operations, programs and activities. Meaning, they are not new undertakings. Instead, they are climate-wise tactics that can be incorporated into existing goals and objectives.

The Climate Change Action Plan also updates West Hants' inventory of greenhouse gas emissions, sets targets for further emissions reductions, and outlines actions that would achieve set targets.

1. Introduction

Contemporary climate change planning consists of two basic components: (1) adapting to observed and anticipated climatic changes, and (2) mitigating the release of greenhouse gases that, cumulatively, are altering the Earth's natural climate change processes. The Municipality of West Hants (West Hants) developed this Municipal Climate Change Action Plan (MCCAP) in 2013 to address both components.

An interdepartmental Climate Change Committee (Committee) in partnership with external consultants and subject experts completed the work. The process was structured on a series of work sessions that balanced technical presentations with collaborative discussions and decision-making. The work was multidisciplinary and highly engaging. Insights and learning that occurred during these discussions have been, and will continue to be, as valuable to the municipal organization as the completion of the MCCAP itself.

1.3 Fulfillment of Gas Tax Fund Requirement

The federal government has committed to transfer funds equivalent to a portion of the federal excise tax on gasoline to municipalities. This transfer has now become permanent. The federal government and Nova Scotia entered into a Municipal Funding Agreement that set out the terms and conditions of the program. As a requirement for funding, Nova Scotia municipalities were asked to submit Integrated Community Sustainability Plans (ICSP) in 2010. In 2013, municipalities were asked to amend their ICSPs with the submission of a MCCAP, again, a requirement of funding.

West Hants received \$618,688 in gas tax revenue in 2012-2013. Gas tax revenue can be spent on "environmentally sustainable municipal infrastructure projects: community energy systems, public transit infrastructure, water infrastructure, wastewater infrastructure, solid waste, local roads and bridges, capacity building, and active transportation infrastructure" (Gas Tax Fund).

The MCCAP requirement stemmed in part from the fact that collectively, the ICSPs submitted in 2010 identified climate change as a key challenge to maintaining infrastructure and overall financial health in the future. Citizens also expressed concern over losing socially valued assets: natural places, services or facilities that shape one's sense of place and community.

In 2012, the Municipal Services Division of Service Nova Scotia and Municipal Relations released a MCCAP Guidebook outlining a suggested framework for MCCAP development. The Guidebook presents a 6-step adaptation planning process for identifying hazards, impacts (physical, social, economic and environmental) and priority areas for adaptive action. The mitigation component of the Guidebook summarizes corporate emissions of greenhouse gases and establishes (or updates) goals for emissions reduction. The development of this MCCAP was shaped by the Guidebook's framework and provides all the mandatory information as outlined in the Guidebook's Appendix A (Submission Template—Mandatory Plan Content).

1.1 Adaptation

In the context of municipal planning, operations and services, adaptation approaches seek to “alleviate current and projected future impacts; reduce sensitivity and exposure to climate-related hazards; and increase resiliency to climatic and non-climatic stressors” (MCCAP Guidebook). In order for West Hants' selection of adaptation approaches and actions to make sense, the Committee first needed to examine the plausible ways in which existing natural hazards are anticipated to change given climate trends and projections. The Committee turned to recent climate research to determine if new hazards might be introduced, and how existing hazards might change. The Committee then asked, what would be the resulting potential impacts? Does the anticipated severity of the impacts, and West Hants' lack of tolerance for such consequences, warrant adaptive action? If so, what should be the intent of the adaptive action; to preserve, avoid, protect, accommodate or retreat (Table 1)?

Table 1 Adaptation Approaches. MCCAP Assistant, 2012

Adaptation Approaches
Preserve and enhance lands for natural resource and habitat values (e.g., the preservation of land surrounding wetlands and beaches to allow for their inland migration as the seas rise).
Avoid developing in areas considered at moderate to high risk to a hazard. Avoidance measures are typically limited in application to future development or redevelopment (e.g., setbacks, zoning that aligns land use with flood risk).
Protect areas considered at moderate to high risk to a hazard from development. Avoidance measures are typically limited in application to future development or redevelopment.
Accommodate climate change effects by adapting land-based structures and activities to tolerate an impact (e.g. warning and evacuation protocols, rolling easements).
Managed Retreat is defined as any strategic decision to withdraw, relocate or abandon private or public assets that are at risk of being impacted by coastal hazards.

The Climate Change Committee was introduced to the concept of organizational adaptive capacity. An adaptive organization has a change-oriented culture of governance and management that embraces the idea that continuous thinking and preparation for the future is critical to sustainability. Adaptive organizations appreciate that the ability to make strategic and sound tactical decisions in the midst of change and uncertainty is a core leadership competence. Adaptive organizations do not make decisions and then sit and wait to see how the decision plays out. They monitor external forces (e.g., energy prices, demographic shifts, labour trends, climate trends, shifts in service of the provincial government) to evaluate what is unfolding, and then revisit their strategies seamlessly during planning processes and decision-making. The requirement to develop a MCCAP has been an interesting stepping stone not only toward an improved understanding of climate change, but also toward new views of contemporary governance. Indeed, working toward being an adaptive organization will prove to be the Municipality's best hope for successfully navigating the social, cultural, financial and regulatory changes that will inevitably shape the Municipality's ability to cope with climate change impacts and capitalize on climate opportunities.

1.2 Mitigation

The MCCAP Guidebook (2012) identifies the purpose of the mitigation plan as the following:

“to start the process of identifying where and how municipal facilities, infrastructure and operations produce emissions and to develop an approach to reducing emissions over time. Ultimately this will result in cleaner air for all Nova Scotians.”

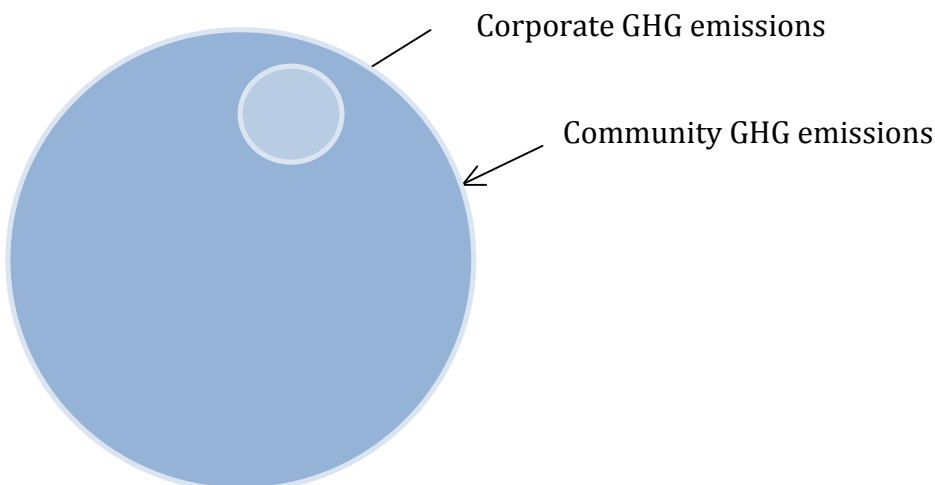
The Guidebook limits the scope to corporate greenhouse gas (GHG) emissions and recommends the use of the Municipal Climate Change Mitigation Workbook prepared by the Union of Nova Scotia Municipalities (UNSM) and Stantec Consulting.

The MCCAP Guidebook lists three steps as part of the mitigation scope (Table 2).

Table 2 MCCAP GHG mitigation steps

Step	Task
1.	Collect energy and emissions information
2.	Complete energy and emissions inventory table
3.	Set goals and identifying actions for mitigation

Note that corporate emissions tend to be a very small portion of the GHG emissions associated with a community. The municipal vehicle fleet tends to be very small relative to the total number of vehicles in a community, and the number of buildings operated by a municipality is small relative to the total number of residential and commercial buildings in a community.



West Hants' emissions inventory and discussion about goals to reduce GHG emissions can be found in Section 10.

1.4 The Municipal Climate Change Committee

In December of 2012, West Hants' Committee of the Whole passed a motion to issue a Request for Proposals for the purpose of engaging a consultant to assist in the development of the West Hants MCCAP. In February 2013, Elemental Sustainability Consulting was awarded the contract in partnership with Sustainability Solutions Group. In March 2013, a process-oriented framework structured around a series of work sessions was initiated with West Hants' thirteen-member Climate Change Committee (the Committee). Council formed the Committee as a project-based working group assembled for the purpose of contributing to and advising on the development of the MCCAP for eventual adoption. The Committee's Terms of Reference can be found in Appendix A.

Table 3 Climate Change Committee Members

Municipality of West Hants Climate Change Committee Members	
Voting Members	
Committee Chair, Victor Swinamer	Councilor, Polling District #9
Randall Matheson	Councilor, Polling District #3
Jennifer Daniels	Councilor, Polling District #7
Jeanne Bourque	Planner
Cheryl Chislett	Chief Administrative Officer
Lynn Davis	Director of Planning
Rick Sherrard	Director of Public Works / Municipal Engineer
Sean Conohan	REMO Coordinator
Kathy Kehoe	Director of Recreation
Non-voting Members	
Michael Edgar	Former Lead Operator Water/Wastewater System
Tracy Robinson	Planning Technician
Jerry Wood	Director of Finance
Velma Macumber	Administrative Assistant

Between April and November of 2013, the Committee progressed through six collaborative working sessions, totaling more than 170 collective hours in discussion. The focus of the Committee's working sessions included, but was not limited to:

- Introduction to climate trends and projections relevant to West Hants;
- Discussing water level estimates and an assessment of storm surge impacts along the Southern Bight of the Minas Basin, leading to the selection of an elevation to delineate an area of increasing risk from storm surge impacts;
- The identification of natural hazard and extreme weather event impacts and a means by which to assign rankings for impact severity, and frequency;
- Gaining an understanding about the practicalities and limitations of assessing coastal erosion and learning about West Hants' varying levels of erosion susceptibility;
- Discussing economic opportunities and vulnerabilities in the context of regional climate trends;
- Framing the MCCAP as a means of improving organizational adaptive capacity and municipal resilience, and discussing the importance of taking social vulnerabilities into consideration when assigning impact severity rankings;
- Using scenarios to contextualize the generation and selection of MCCAP action item ideas, and
- Prioritizing MCCAP action ideas using a process that considers level of risk, adaptive capacity to implement an idea, urgency to act, and threat reduction capability.

1.5 Stakeholder Involvement Throughout MCCAP Development

West Hants' Climate Change Committee selected a process that largely drew from existing research on adaptation planning, climate trends and projections, and locally relevant climate impacts. Elemental Sustainability Consulting, in partnership with the Sustainability Solutions Group, led West Hants' MCCAP Development process and in doing so brought into the room, so-to-speak, what they had learned from interactions with federal, provincial, and academic institutions both generally, and specifically on West Hants' behalf. Examples of subject experts who were consulted during MCCAP development included:

- Professional Geoscientists, Geologists, Hydrogeologists and a Forester within the Nova Scotia Department of Natural Resources: Philip Finck, 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*.
- Nova Scotia Department of Agriculture, Land Protection Section, Agriculture and Flood Advisory Services: Craig Bauchman, Aboiteau Superintendent.
- Dr. Danika van Proosdij and colleagues from the Department of Geography, Maritime Spatial Analysis Research Unit and Intertidal Coastal Sediment Transport Research Unit at Saint Mary's University.
- 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. Greenburg, Department of Fisheries and Oceans Research Scientist, Bedford Institute of Oceanography.
- Tim Webster, Research Scientist at the Applied Geomatics Research Group (AGRG), Centre of Geographic Sciences (COGS), Nova Scotia Community College.
- Dr. Bob Robichaud of Environmental Canada's Meteorological Services Centre, Atlantic Storm Prediction Centre.
- Heather MacKenzie-Carey, REMO Coordinator, founder of HMC-EMC Inc., and author of a Hazard Risk Vulnerability Analysis tool for the Nova Scotia Emergency Management Office.
- Nova Scotia Department of Environment Climate Change Unit, Climate Change Specialist, Kyla Milne.
- Alix d'Entremont, GIS Technician, Yarmouth-Argyle District Planning Commission.
- Jo Ann Fewer, Executive Director, Nova Scotia Commission on Building our New Economy.

All Climate Change Committee meetings were open to the public and the minutes from all work sessions were placed in the public record. The municipality's website also hosted a webpage dedicated to informing citizens of the work being undertaken by the Climate Change Committee. In June of 2013, a mid-term progress report was posted to the website describing the work being undertaken, the need for the exercise, and key findings.

While public participation and comment was always welcome, a program to solicit public engagement was not employed for several key reasons. First, the Committee recognized that the municipality

needed to build technical understanding and capacity on the subject of climate change before meaningful public engagement could be designed and, perhaps more importantly, before information gathered from the public could be interpreted and used in a way that was technically sound.

A lesson learned from subject experts early in the MCCAP development process was that a layperson's perception of a natural hazard may not always be an accurate interpretation of what is actually happening geologically. For example, coastal property owners will associate land loss after a major storm with a coastal erosion trend, when in fact one weather-related event may mask sediment deposition or coast 'building'. Case in point, a lack of understanding of geological processes often leads to maladaptive actions, such as armouring in a manner that alters sediment processes and increases erosion. There have also been regional situations where residents erroneously attributed coastal erosion to runoff in areas where, in fact, the erosion is occurring not from runoff but instead from being undercut at the base by the rising sea level and wave action. Along the coast, maladaptive actions often appear to mitigate hazards in the short term, but can make eventual, long-term erosion or slope failures more spectacular and dangerous. Therefore, the Committee's MCCAP development process focused on increasing the knowledge capacity of municipal staff and Council, and doing so in a way that improved organizational adaptive capacity. Having this base of shared understanding among Committee members and their respective departments positions the Committee to design more meaningful public education and engagement on climate change in the years to come.

The second reason engagement of West Hants residents was welcome but not actively sought was that the Committee anticipates extensive public engagement in the next few years as a review of the Municipal Planning Strategy (MPS) is initiated (as early as 2014). During the MPS review, multiple MCCAP action ideas will be brought forward as new planning strategies or improvements to existing strategies and by-law.

1.6 Partnership in the Atlantic Climate Adaptation Solutions Program

West Hants was among thirteen municipalities in six locations across Nova Scotia that partnered on climate impact and adaptation research in the Atlantic Climate Adaptation Solutions (ACAS) program. The

ACAS program was a federal cost-shared program aimed at stimulating climate adaptation planning and decision-making, particularly at the municipal level. The program terminated in 2012. In Nova Scotia, the Climate Change Unit (formerly the Climate Change Directorate) of Environment Nova Scotia was the Provincial ACAS lead.

The ACAS program was of great benefit to West Hants. The seminal ACAS report, *Scenarios and Guidance for Adaptation to Climate Change and Sea-Level Rise-NS and PEI Municipalities* (Richards and Daigle, 2012) provided locally relevant climate trends and projections for Nova Scotia municipalities, and was foundational to other ACAS research. These climate projections underpinned West Hants' interpretation of how changing climate conditions will continue to be experienced by the people and landscape of West Hants. Additional (non-ACAS) research about climate trends and projections, particularly sea level rise and storm patterns, confirmed the findings of the Richards and Daigle report and secured its role as the primary document from which West Hants' assessment of hazards could be based.

In addition to the Richards and Daigle report, another key area of ACAS research that will directly benefit West Hants is the analysis titled *Best Practices for Climate Change Adaptation in Dykelands*. Completed by Danika van Proosdij (2012) along with colleagues and students from the Department of Geography and Maritime Spatial Analysis Research Centre at Saint Mary's University, the research involved:

- An assessment of physical stability of a significant portion of the dykes in West Hants;
- Determination of suggested critical elevations and associated engineering modifications to mitigate overtopping or breaching;
- An assessment of current and potential future management practices (e.g. maintenance of foreshore, placement of armour rock, creek modifications); and
- Recommendations for mitigation strategies and recommendations for coastal engineering practices to protect existing foreshore marsh, which in turn mitigates storm surge flooding and protects the dykes from erosion.

Although the Nova Scotia Department of Agriculture, Land Protection Section, Agriculture and Food Advisory Services is responsible for the

protection of agricultural land behind dykes and the maintenance of dykes (which are privately owned), it is critical that municipalities understand what is known or being planned for dyke upkeep and maintenance and engage in conversations about how to lessen dyke vulnerabilities to climate impacts and extreme weather events. Thanks to ACAS dykelands research (van Proosdij, 2012), West Hants now has up to date geographical and geotechnical information about the exact location, height and physical stability of most dykelands in West Hants. As well, a related body of ACAS research, the Nova Scotia Department of Agriculture - Marshlands Atlas Cumberland, Kings & Hants County (Pietersma-Perrott and van Proosdij, 2012) provided West Hants with accurate mapping of historically recognized marsh bodies and recommended new boundaries based on how those wetlands have grown or shifted since their original designation in the 1950s. All of these datasets, along with multiple other layers of natural and built features, are now available to West Hants' as ArcMAP documents. A person trained in the Municipality's existing GIS software could use these datasets to easily make maps for land use, infrastructure and emergency preparedness planning.

As well as benefiting from ACAS research, West Hants contributed a Case Study Report to the ACAS program (Municipal Climate Adaptation Case Study Report). The report described the municipality's "physical, ecological, social, economic and management makeup; climate change issues of importance; an evaluation of ACAS research projects and activities; identification of existing and proposed climate adaptation projects and activities that may be considered by West Hants; identification of limits or restrictions to implementing those projects; and overall conclusions and lessons learned from the ACAS program." This MCCAP report builds on the Municipality's ACAS Case Study Report. The process of developing the MCCAP was rich in its effort to interpret and communicate technical research, to develop a better understanding of how climate change will continue to affect West Hants, and to apply this information to existing operations and services in a manner that is prudent.

2. West Hants' Approach to Climate-Wise Governance

Four core beliefs were foundational to how West Hants approached the adaptation portion of 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.

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.

Third, climate change planning is most effective if designed to improve adaptive capacity. 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. It also brings to light the role and importance of professional experience, flexibility, and redundancy within the system. 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.

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 data sharing and decision making are a core competence of a municipal organization in today's world. The MCCAP development process is an opportunity to recognize and strengthen the mutually beneficial relationship between land use and emergency management skill sets. Doing so allows West Hants to improve municipal resilience in the context of both present-day weather variability and long-term change in climate.



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

3. A Method Focused on Impacts and Implementation

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 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:

1. Drought
2. Wildland Fire
3. Inland Flooding
4. Coastal Flooding / Storm Surge
5. Winter Storm
6. Tropical Storm / Hurricane
7. Coastal Erosion
8. Extreme Heat Events

3.1 Hazard Impact Matrices

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.

The use of a hazard impact matrix aligns with the guidance provided by Service Nova Scotia Municipal Relations in their MCCAP Guidebook explaining submission requirementsⁱ. While the Guidebook suggests a hazard impact matrix to convey results of assessing key hazards, West Hants choose to assess impacts instead. Therefore, instead of presenting one matrix assessing hazards, West Hants' MCCAP presents a matrix per hazard.

What does *that* mean?

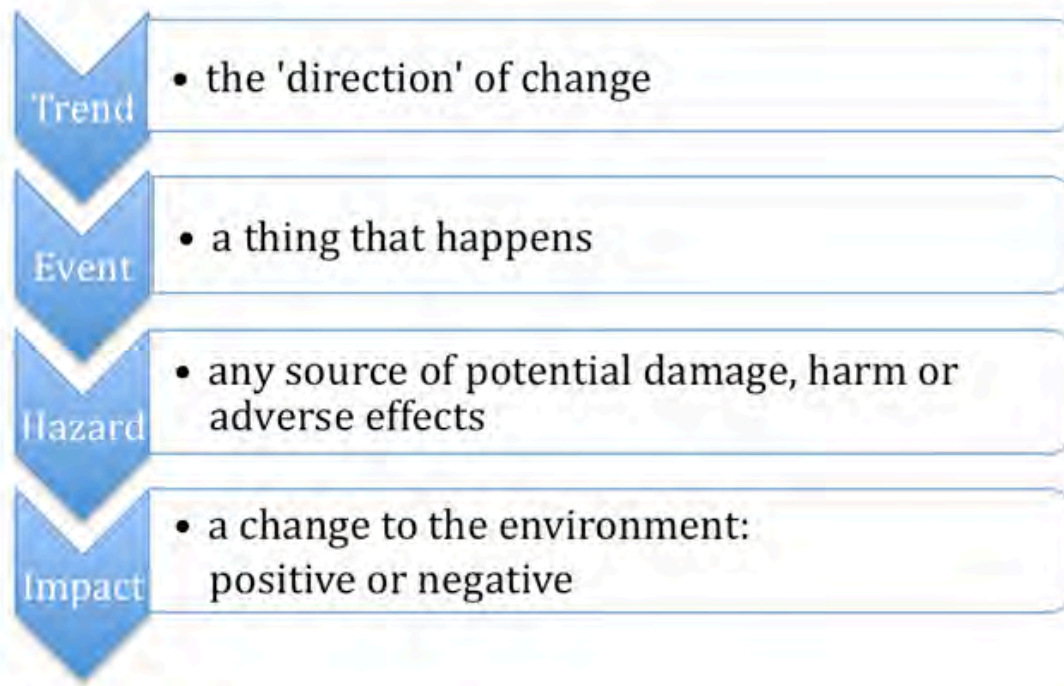


Figure 2: Definition of Hazard and Impact

West Hants was motivated to assess risk of individual impacts (instead of assigning a risk rating to an overarching hazard) because while it is possible to compare collective consequences and rank hazards relative to each other, it is more useful at the operational level to consider what environmental changes (positive or negative) the hazards may induce. Environmental changes are impacts (Figure 2), and it is the impacts that will require a response from the municipality. For any given hazard, the impacts will likely range from extreme to negligible. There may even be welcome changes. 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, the intensity of storms) 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.

For this reason, West Hants borrowed from an existing Nova Scotia EMO tool for ranking risk vulnerability. The tool is called the Hazard Risk Vulnerability Assessment (HRVA). In this tool, the 1-5 scale used to evaluate impact severity is called the Overall Impact Score (Table 4). The HRVA also uses a 1-5 scale for ranking probability (Table 5). West Hants modified the HRVA probability scale so that the scale's timeframes reflect timeframes found in climate research, such as the Williams and Daigle report. As well, the HRVA introduced into West Hants' 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 ensure accessible transportation networks). 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) are considered threatening because of the potential for diminished trust in, or credibility of, elected officials and municipal staff.

Because of West Hants' inherent need to consider an array of impacts that is wider than the net cast by EMO, the HRVA narratives for Overall Impact Score were modified slightly and then employed as high-level guidelines. Simply put, the Committee 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 how infrastructure would be damaged if the hazard in question were not mitigated.

Not unlike EMO, land use planning arose from the desire to protect the safety of citizens. It was from this historical intent that separation of land uses became so commonplace. Land use planning’s responsibility for safety has not diminished over time, but like other corporate cultures, that role has been largely allocated to a subset of the municipality: EMO (Warburton and MacKenzie-Carey, 2013). Incorporating aspects of the HRVA process during MCCAP development served as a reminder of the connections between land uses, development controls, municipal services, and citizen safety and well-being.

Table 4 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 5 HRVA Impact Severity Scoring Used for MCCAP

Overall Impact Score: Considering each of the impacts identified and the guidelines below, select an overall impact score.	
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 6). 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. For example, the coastal nature of our culture has created a high degree of tolerance for coastal erosion. Although the coast is eroding rapidly in locations and our attempts to control it are often maladaptive, the public has not historically looked to the municipality to mitigate this natural hazard. This historically ‘high’ risk tolerance was thus taken into consideration when evaluating how to rank the risks from coastal erosion. That being said, it is undeniable that public expectation for the level of service, including protection from hazards, is rising. What were once culturally acceptable levels of risk are shifting as quickly as the hazards themselves.

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

Figure 3 HRVA Formula for Hazard Prioritization

Table 6 HRVA Risk Prioritization Scoring

Score	Risk Ranking	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.
1-5	High	
6-10	Medium	
12-25	Low	

3.2 Bridging Impacts and Implementation

To prepare for efficient MCCAP implementation, West Hants took the actions derived from each impact and evaluated them in terms of the municipality's capability to absorb the action into existing operations and services. The hazard-impact risk and the municipality's capacity to act are combined to generate an urgency rating. Essentially, the less able the organization is to address/implement the risk, the higher the urgency rating. This approach reflects the municipality's need to attend to an impact that has been judged to carry substantial consequence, but doing so falls outside the normal scope of familiar weekly activity, accessible capital or an existing skill set.

The urgency rating is then weighed against the action's capability to actually reduce the threat. In other words, is the action going to directly mitigate risk vulnerability? Does it reduce exposure to a hazard or lessen sensitivity? Exposure and sensitivity are, in the study of ecosystems, two of three factors influencing vulnerability. The more exposed something or someone is, or the more sensitive (i.e., prone to being negatively affected by) they are to an impact, the greater the risk vulnerability. The third driver is adaptive capacity. The more adaptive the organism or organization is, the less vulnerable it is to unwanted negative consequences of climate change or extreme weather events. Alternatively, weak adaptive capacity undermines resilience and can magnify disaster outcomes.

The result of weighing the urgency of an action against the action's threat reduction capability results in a high, medium or low priority ranking. What's important to remember with this prioritization process is that the priority ranking represents a marriage between the significance of the impact and the nature of the effort municipal staff would have to invest to achieve the action's intent. For example, if the effort falls outside the normal scope of familiar activity, accessible capital or existing skill sets, but achieving the action would substantially lessen municipality's risk vulnerability (or position the municipality to capitalize on positive changes in climate), then the action is a high priority. Comparatively, if it is straightforward for municipal staff to achieve the action's intent but the action itself did not reduce the threat, the action's priority ranking is low.

In many cases, there are action ideas that provide an appropriate response to an impact once the threat/hazard is experienced. These are completely legitimate actions to include in the MCCAP because they are important to the municipality's ability to respond to or recover

from an event. In essence, their institution contributes to the municipality's resilience. However, these actions were ranked low priorities because they do not *prevent* damage or harm from happening. Therefore, it is important to remember that low priority does not mean low importance. It is safe to say that all action items listed in the MCCAP are important, for each action item presented survived critical discussions about its appropriateness to the municipality's community characterizations and circumstance.

As a general rule, it is understood that a high urgency rating requires immediate initiation to understand and/or address the impact and implement appropriate responses within 1-3 years of the final deployment of the MCCAP. A medium urgency rating would require the initiation of action in 3-10 years. A low urgency rating suggests that there is no need to act within the next 10 years as the risk is low or there is a lot of capacity to absorb the identified impact.

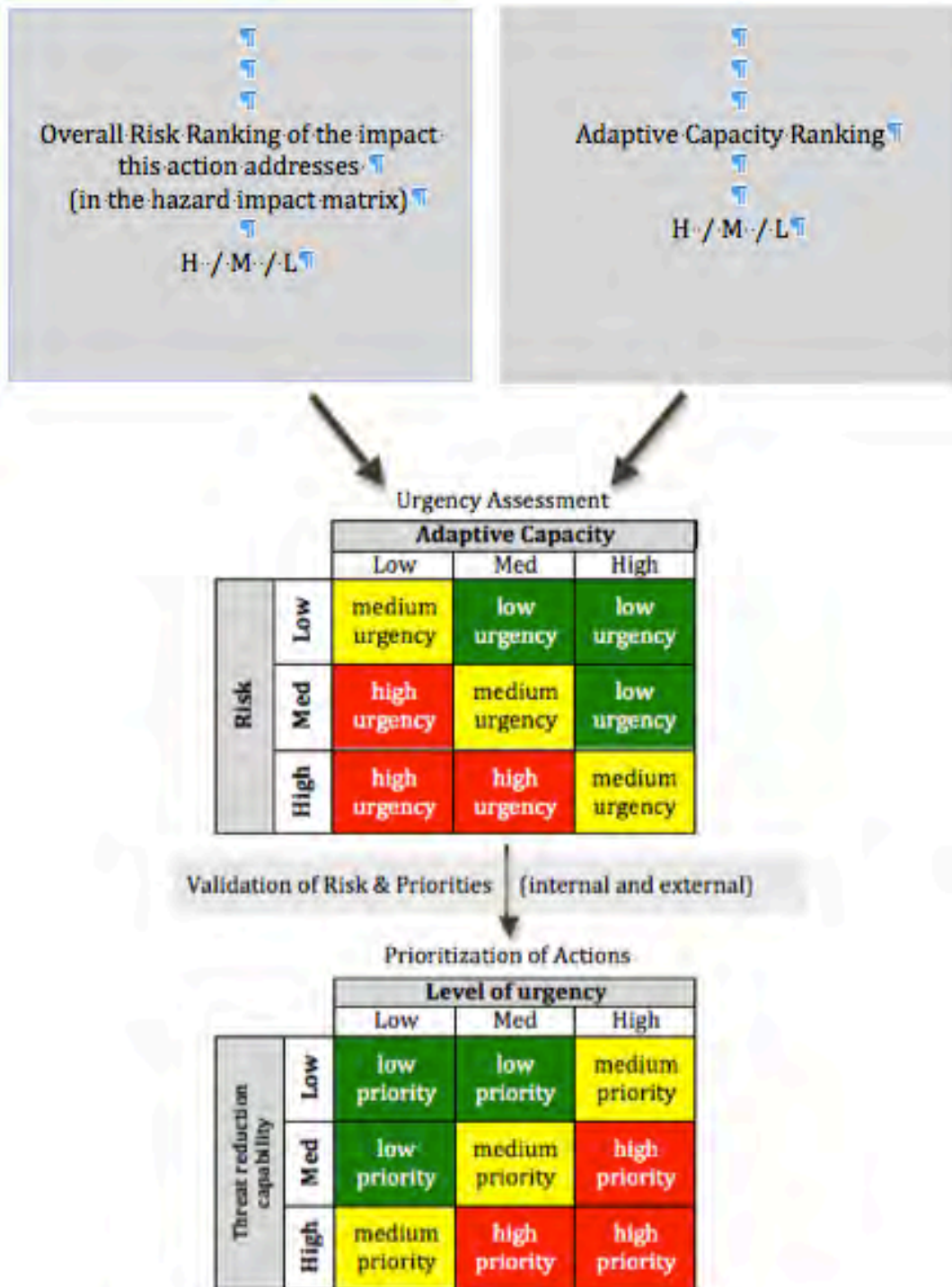


Figure 4 Action Prioritization Process: Modified from the Adaptation Work of Saanich British Columbia and Kings County, Washington

4. Analysis of Natural Hazards and Impacts

This section describes eight natural hazards that are of interest to West Hants. Each hazard is defined, a rationale for its inclusion presented, and a hazard impact matrix summarizes resulting impacts.

The rationale includes consideration of climate trends and projections, and general information regarding the potential of the hazard to affect the health and safety of residents. More specific information, such as locations of susceptibility, (when applicable) is summarized in the hazards matrix.

It is important to focus on the trends conveyed by the projections more than the specific values. Planning and infrastructure decisions will be well served to pay heed to the trend while understanding that the magnitude and frequency of annual water shortages will vary annually.

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 (Figure 5). 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 West Hants, historical climate data from a climate station in Kentville 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 West Hants, the CHS representative site used was Hantsport station 282, with a 15.26m 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'. In non-tidal waters, a low water level is adopted as datum.

<p>Climate Scenario A plausible description of a possible future state of the world. Climate scenarios are not predictions of future climate. They are used to assess impacts of climate change, address vulnerability to change and to develop adaptation strategies or actions.</p> <p>Climate Change Scenario Refers to the difference between some plausible future climate and the current climate.</p>
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Figure 5: Definition of Climate Change Scenario

4.1 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).

There are many important questions for West Hants and its residents to ponder. What is the effect not of annual variations in supply (precipitation), but of a continued decrease in supply over the long term? How will this affect the ability of groundwater aquifers to recharge? How will increased deficit change surface water systems in

each watershed (watercourses, ponds, lakes and wetlands)? To what extent will changes in surface water systems affect flora and fauna (presence, health, and diversity of aquatic plants and animals and waterfowl), and would such shifts negatively affect West Hants residents? How might the economic (e.g., agricultural), recreational, health, and psychological ramifications of stressed water supply emerge as municipal issues? And what can West Hants do now to preempt or mitigate water shortages, and in turn capitalize on (i.e., promote) West Hants as a municipality that manages water sustainably—a municipality that understands water quantity and quality is the future measure of wealth? Acting on that focus now could create the ‘hook’ that attracts future residents, commercial and industrial activity, and related services.

4.1.1 Water Quantity Rationale

Table 7 Richards and Daigle Water Deficit Projections for the Kentville Climate Station

Parameter	1980s	2020s	2050s	2080s
Water deficit (mm)	56.0	62.8	76.7	91.2

Water deficit is projected to increase across Nova Scotia. The water deficit projections for West Hants (shown in Table 7) 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. Again, 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 warranting careful monitoring and prudent planning.

Climatological research from Bedford Institute of Oceanography has revealed that for every degree of air temperature increase the summer onset is 0.9-1.4 weeks earlier (Galbraith 2012). The long-term air temperature warming trends are typically in the range of 0.5 to 2°C per century. This projected shift in air temperature patterns will trigger

an earlier onset of spring conditions (as we understand them today). Canada's Institute for Water Resources, Environment Canada and numerous academic institutions point out that an earlier spring freshet and decreased summer precipitation paired with warmer summer temperatures will "increase both evapotranspiration and the length of the growing season—two factors which increase crop water demand. As a result, crop water demand could increase . . . as climate change intensifies through the decades" (Langsdale, 2007). This scenario exacerbates the water deficit issue. It is likely that the critical months by the 2050's will extend from June through October, with August becoming the most severe.

4.1.2 Water Quality Rationale

Drought affects not just water quantity, but also quality. Unstable climatic conditions where rocks and soils alternate between being water starved and saturated 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.

4.1.3 Rationale for Considering Sinkholes

The Municipality of West Hants contains karst terrain, land that is prone or susceptible to sinkholes. There are many causes of sinkholes, but all causes share two commonalities: first, moving water dissolves gypsum or limestone (found in karst terrain), and second, if the water itself is not there to 'support' the earth above, collapse can occur. Dissolution of the gypsum or limestone can occur as surface water

percolates down through fractures and voids, groundwater circulates, or underground pipes leak. The link between sinkholes and drought is simply that diminished water quantity may exacerbate sinkhole susceptibility. If water levels drop in existing underground caverns, chances of cavern collapse (i.e., sinkholes) are increased.

From the municipal perspective, if development or infrastructure happens to be underlain by gypsum karst, there is risk of the ground literally falling.

“As well, planners should be aware that sinkhole development is of most concern when groundwater aquifers are over pumped. So planners need to know if karst terrain is present, where, what are the development patterns on that karst, and what thresholds for water withdrawal need to be established? Karst terrain is also particularly susceptible to groundwater contamination because surface water often has a direct path to the groundwater through the many voids in the bedrock. Therefore, any contaminants present at the surface can quickly be introduced into the groundwater. Also of interest to planners is the fact that finding a source of potable water in karst terrain can be a tremendous challenge” (Warburton, 2013).

The majority of residents of West Hants, with the exception of those living in the serviced areas of the two Growth Centres, depend on individual wells for their water supply; many already experience shortages, particularly in summer, and rely on water haulers to supplement their supply (Municipal Climate Adaptation Case Study Report, 2013). In addition to known quantity issues, there are also small pockets where quality is an issue. Arsenic is present in Three Mile Plains, and likely in other areas as well which have not been identified or confirmed. As well, seawater was encountered in drilled wells at two properties in Mantua.

4.1.4 Drought Impact Matrix

Hazard: Drought															
Drought can be defined as a prolonged period of abnormally dry weather that depletes water resources for human and environmental needs.															
Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk
		Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low
Water supply: quantity & quality	Watersheds French Mile Brook; Mill Lakes; Davidson Lake; Individual Wells		X					X						X	High
Crop / farm damage	non-specific		X						X			X			Moderate
Pest infestation/ wildlife disease-economic	non-specific		X							X		X			Low
Increase in sinkholes: public safety, infrastructure damage	in karst terrain		X				unknown						X		High
Increased solubility of metals in the environment (e.g., arsenic)	Some isolated incidents: Locations & effects of metals largely unknown			X			X						X		High
Elevated risk of saltwater intrusion	Driven by water withdrawal more than drought, but exacerbated by drought. Salt water encountered in drilled wells at two properties in Mantua				X					X				X	Low

4.1.5 Drought Action Items

Table 8 Action Items to Address Drought

High Priority Action Item	Impact Addressed
Support the completion of the drought impacts analysis and public works preparedness plan.	Water quantity & quality
* When undertaking the MPS review, incorporate integrated water resource management concepts/approach.	All impact listed in the hazard impact matrix
Partner with local industry, stakeholders and DNR to acquire mapping of karst terrain to build knowledge about sinkhole susceptibility.	Increase in sinkholes; public safety; infrastructure damage
During the MPS review, consider creating a policy to regulate the development of municipal infrastructure and facilities in areas known to be highly susceptible to sinkholes.	Increase in sinkholes; public safety; infrastructure damage
Medium Priority Action Item	Impact Addressed
During the MPS review, consider drafting a Water Conservation By-law that allows for a conservation order restricting water use on the public works water system, depending on withdrawal amounts and recharge rates.	Water quantity & quality
* Investigate how to make well water testing as accessible / convenient as possible for citizens in coordination with a local company located in the Windsor/West Hants Industrial Park.	Public Safety
Investigate the implications of instituting an increasing block rate to consumption rates for water charges.	Water quantity & quality
Low Priority Action Item	Impact Addressed
Assess preparedness for Emergency Response to drought	Water quantity & quality
Explore partnerships to disseminate an education and engagement program about water conservation.	Public safety

* Links to ICSP goal(s)

4.2 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.

4.2.1 Wildland Fire Rationale

Climate trends that increase wildfire risk vulnerability are increased air temperatures (as shown in Table 9) 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 9 Richards and Daigle Air Temperature Projections for the Kentville Climate Station

Parameter	1980s	2020s		2050s		2080s	
	Value	Value	SD	Value	SD	Value	SD
Temperature-annual	6.9	8.1	0.4	9.3	0.6	10.6	1.0
Winter	-4.4	-3.1	0.6	-1.7	0.8	-0.3	1.1
Spring	5.0	6.0	0.4	7.1	0.7	8.3	1.1
Summer	18.1	19.2	0.4	20.4	0.7	21.5	1.0
Autumn	9.0	10.2	0.4	11.3	0.6	12.6	0.9
Value shows the change in degrees in annual average temperature							

Increased forest fire risk is a concern, particularly in areas of increasing residential development in the southwestern part of the municipality (Municipal Climate Adaptation Case Study Report, 2013). In fact, in the REMO All Hazards Plan, “Forest / Brush Fire” was listed as the number one priority for an Emergency Preparedness Plan (EPP).

4.2.2 Wildland Fire Impact Matrix

Hazard: 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.																		
	Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk		
			Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 250 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low			
	Risks to public safety: life & safety	Non-specific -though a focus in SW part of municipality		X						X								Moderate
	Displacement of Residents due to Property Damage/threat	Non-specific			X					X								Moderate
	Power Utility Disruption	Non-specific			X					X								Moderate
	Water Utility Disruption	Non-specific		X						X							X	Moderate
	Transportation Disruption: roads and bridges	Hwy 14, Wentworth Road: local roads / cottage country		X						X							X	Moderate
	Crop/farm damage	Non-specific			X					X				X				Low
	Long-term environmental damage: e.g., affect on water table, affect to socially valued trails/places	Non-specific				X				X				X				Low

4.2.3 Wildland Fire Action Items

Table 10 Action Items to Address Wildland Fire

High Priority Action Item	Impact Addressed
none	na
Medium Priority Action Item	Impact Addressed
Provide information and/or a public education campaign targeted to private citizens and/or citizen organizations about fuel loading and landscape-level fire risk.	Public safety; property damage
Work with DNR to improve communications and understanding about local fire risk.	Public safety; property damage
Low Priority Action Item	Impact Addressed
Introduce a fire risk reduction program for municipally owned property (e.g. plant only low fire risk species).	Risks to public safety, life and safety; infrastructure damage

4.3 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 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.

4.3.1 Inland Flooding Rationale

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. There is also a risk of flash flooding if the dams that are part of the Avon and St. Croix River hydroelectric systems become compromised.

Two of the climate trends that are of interest when assessing inland flood risk are: changes in precipitation magnitude and frequency, and changes in the intensity of short period rainfalls. Also of interest is water surplus. Water surplus is the excess remaining after the evaporation needs of the soil have been met and soil storage has been returned to the water holding capacity level. Surplus may be considered runoff.

Table 11 Richards and Daigle Projected Precipitation Changes and Water Surplus

Parameter	1980s	2020s		2050s		2080s	
	Value	Value	SD	Value	SD	Value	SD
Precipitation-annual	1212.5	1245.8	29.7	1256.1	34.5	1293.4	45.1
Winter	357.8	375.1	14.2	384.2	18.3	405.0	23.4
Spring	298.2	308.1	12.6	312.5	17.0	324.7	22.3
Summer	254.5	258.8	15.1	258.0	20.0	258.4	33.1
Autumn	302.0	305.7	13.8	305.3	14.5	312.1	33.4
Value shows the change in mm in annual average rainfall							

Table 12 Richards and Daigle Projected Water Surplus

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Water Surplus	728.0	714.7	697.3	708.3
Value shows the change in the amount of excess water				

A pattern that has emerged from recent research is that the amount of precipitation on an annual basis shows little change. However, it is expected that when rain events happen they will be more intense, in other words, more rain will fall. Trends also show a change in seasonal patterns. Annual rainfall is concentrating in the winter season. West Hants 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 and over-extend the capacity of public infrastructure that requires water-handling capacity. Intensity-duration-frequency (IDF) curves used by hydrotechnical engineers to model rainfalls events that 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 West Hants to specify that infrastructure be designed for future climate conditions.

4.3.2 Inland Flooding Mapping

West Hants' inland flooding map (Appendix B) was created using Provincial wet areas mapping (WAM), a product of research work carried out by the Forest Watershed Research Centre at the University of New Brunswick.

The Depth to Water Table categories, as seen on the map, indicate quality of drainage: the 0-0.10 m class is generally associated with poor drainage and the 0.11-0.50 m class with imperfect drainage. These areas can be used to infer where water will naturally flow and/or accumulate in the landscape. The information is also useful for showing probable connections between wet areas (i.e. by sub-surface flows, unmapped channels, and/or wetlands) (Kevin Keys, personal communication, July 29, 2013). Ideally, these interpretations would become more locally accurate by integrating information on soils.

Where imperfectly and poorly drained WAM units are related to rivers and shorelines—which is what has been mapped for West Hants—then potential flood areas may be inferred with caution. Nonetheless, the inland flooding map does detail where more detailed flood risk mapping is warranted.

Flooding occurs periodically in low-lying areas along the West Branch Avon River from Wile Settlement to Mill Section (area affected by Nova

Scotia Power's Avon Hydro System) during high precipitation events. In April of 2009, the Ashland Road washed out due to heavy spring rains and runoff. Such heavy rains and runoff events seem to be occurring more frequently. In fact, Lebreau Creek Brook frequently overtops its banks and has caused flooding of homes adjacent to the brook along Highway 1, near Panuke Road, and in Three Mile Plains (e.g., April 2009; November 2010). During fall and winter, inland flood issues are exacerbated when drainage ditches or aboiteaux become blocked with ice (Municipal Climate Adaptation Case Study Report, 2013). "The potential for more frequent and severe freshwater flooding during high precipitation events is intensified by the operations of the tide gates at the Avon River Causeway and the upstream hydroelectric dams" (Municipal Climate Adaptation Case Study Report, 2013).

A point of interest is that 80% of Falmouth storm drainage goes through two aboiteaux: one in Tregothic Marsh and one in Elderkin Marsh. When the tide is high, these areas cannot drain. As sea level rises, this issue will worsen. In fact, after any significant rainfall it can take five days for the Elderkin Marsh to drain (personal communication, Rick Sherrard, July 17, 2013). It is critical to understand where the 'pinch points' in water drainage are, and design those to a standard that not only better addresses today's flooding issues, but takes the projected increase of short intensity rainfalls into account.

4.3.3 Inland Flooding Impact Matrix

Hazard: Inland Flooding															
Flood is defined as 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.															
Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk
		Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low
Risk to Public Safety (an increased risk in terms of Emergency mgt's time to respond)	Non-specific				X		X							X	High
Displacement of Residents due to Property Damage	West Branch Avon River from Wile Settlement to Mill Section; Lebreau Creek Brook along Hwy 1, near Panuke Road; Three Mile Plains, Elderkin Marsh					X					X		X		Low
Transportation Disruption	e.g., Payzant Drive; Wentworth Road; Hwy 14; Halfway River bridge; Ashland Road, Mines Road				X		X					X			Moderate

Environmental contamination of drainage corridors in situation of sewage treatment plant overflow	Sewage Treatment Plant grainage areas					X		X				X			Low
Dyke or Dam Breach	Avon Causeway; Hydroelectric Dams	X									?			X	High
Crop/farm damage	Marshlands increasingly flooded due to ice jams (Brooklyn & Elderkin Marshes)			X							?	X			Low
Community Lifeline Damage (access to hospital)	Cut off from Hospital & Schools/Town of Windsor		X											X	Low
Flood-induced sedimentation problems in rivers and estuaries: reduction of holding capacity & increased flood potential	Pisaquid Lake			X								X		X	Low
Cyanobacteria blooms	Non-specific			X			unknown					X		Low	

4.3.4 Inland Flooding Action Items

Table 13 Action Items to Address Inland Flooding

High Priority Action Item	Impact Addressed
Assess preparedness for emergency response for inland flooding.	Risks to public safety, life and safety
*Assess if existing land use policies and development controls adequately protect wetlands and watercourses during MPS review (e.g., require retention of vegetation along watercourses, institute 'buffers' for <i>all</i> development types).	Risks to public safety, life and safety; property damage; infrastructure damage
Identify and map surface water systems in each watershed (watercourses, ponds, lakes, wetlands) in order to ensure these systems hold (store) water and drain it in natural and logical ways with topography.	Risks to public safety, life and safety; property damage; infrastructure damage
*Complete a Stormwater Master Plan and ensure the plan assesses the effects of climate change on rainfall intensity and presents a solution to the drainage bottlenecks in growth centres.	Risks to public safety, life and safety; property damage; infrastructure damage
Initiate discussions with Department of Agriculture to identify and address changes in aboiteaux heights, mechanisms or maintenance that would mitigate inland flooding.	Risks to public safety, life and safety; property damage; infrastructure damage
Partner with the Maritime Spatial Research Analysis Centre to complete a hydrodynamic model of flood risk for developed areas in and surrounding Elderkin Marsh.	Risks to public safety, life and safety; property damage; infrastructure damage
During MPS review, evaluate watercourse setbacks to ensure setbacks accommodate inland flood risk as it is understood given increased precipitation trends.	Risks to public safety, life and safety; property damage
Medium Priority Action Item	Impact Addressed
none	na
Low Priority Action Item	Impact Addressed
none	na

* links to ICSP goal(s)

4.4 Coastal Flooding / Storm Surge

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.

4.4.1 Coastal Flooding Rationale

Storm surge, sea level and tide level are three factors that combine to create conditions for flooding. Flooding from a storm surge may be combined with river flooding, thus increasing the flood severity. It is important to note that coastal flooding is different from river flooding, which is generally caused by severe precipitation (Storm Surge and Coastal Inundation).

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 14). 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 14 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). Indeed, observations confirm this, showing a doubling of global mean sea level rise in certain Atlantic Canada study sites (Forbes et al. 2010). 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).

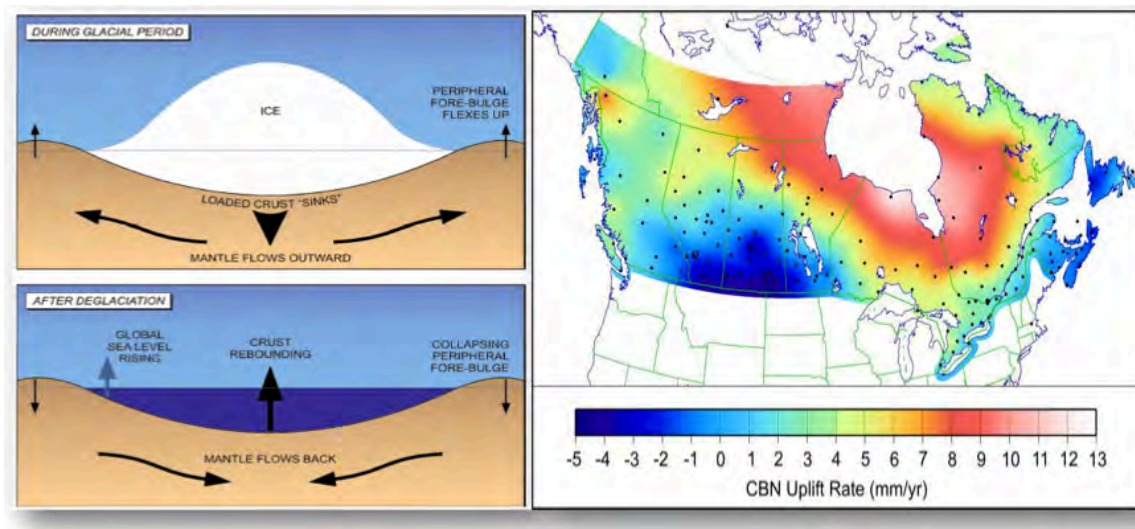


Figure 6 Glacial Isostatic Adjustment (Forbs 2009)

The geological adjustment (change) that is occurring in West Hants 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 6). 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 15).

Table 15 Water Level Scenarios for West Hants of West Hants: Richards and Daigle 2012

	2000	2025	2055	2085	2100
Total Sea Level Rise (m)		0.16 ± 0.03	0.45 ± 0.15	0.86 ± 0.36	1.10 ± 0.48
Extreme TSL - 10 Yr Ret Period	16.11 ± 0.20	16.27 ± 0.23	16.56 ± 0.35	16.97 ± 0.56	17.21 ± 0.68
Extreme TSL - 25 Yr Ret Period	16.22 ± 0.20	16.38 ± 0.23	16.67 ± 0.35	17.08 ± 0.56	17.32 ± 0.68
Extreme TSL - 50 Yr Ret Period	16.30 ± 0.20	16.46 ± 0.23	16.75 ± 0.35	17.16 ± 0.56	17.40 ± 0.68
Extreme TSL - 100 Yr Ret Period	16.39 ± 0.20	16.55 ± 0.23	16.84 ± 0.35	17.25 ± 0.56	17.49 ± 0.68

For its coastal flooding analysis, West Hants' Climate Change Committee chose to focus on Extreme Total Sea Level projections for a 1% annual exceedance probability in the 2055 time period. 2055 is the mid-decade of a three-decade period. Thus, this projection reports that in the period from 2040-2070, there is a 1% probability in any given year that water levels will reach 16.84m (± 0.35) above lowest tide level.

The primary reason West Hants chose to focus on estimates for 2055 is to align the analysis and forthcoming adaptation efforts with the Nova Scotia Department of Agriculture, which is the provincial department responsible for the maintenance of dykes. Because dykes and marshlands within West Hants play a major role in West Hants' current and future flood risk vulnerability, it is important to be in sync with the Department of Agriculture and to diligently collaborate to mitigate flood risk.

There is one phenomenon that the Richards and Daigle estimates did not incorporate: the impacts of the shortening resonant period of the Bay of Fundy—Gulf of Maine system on rising sea levels. As a result, the amplitude of the M2 tide is increasing (Greenburg et al., 2012). The effect that this would have on water levels in West Hants is that the high tide could be between 41 and 79cm higher by 2055 (Table 16). Therefore, West Hants' Climate Change Committee added the conservative end of estimate —0.41cm—to the Extreme Total Sea Level Projection of 16.84m (± 0.35) above lowest tide level. The resulting vertical reference that the Climate Change Committee used to delineate the area of increasing coastal flood risk was 17.25m Chart Datum.

Table 16 Predicted Increase in High Water Due to Tidal Changes. (Dr. Greenburg et al., 2012)

TABLE 5. The predicted increase in tidal high water in metres at selected locations for the years 2055, 2085 and 2100. The values reflect tectonic influence, ice melt, steric effects and changing M₂ tides. Maximum and minimum values are obtained from tidal runs using our estimated existing sea level trend and the extreme values of the ice and steric inputs.

Time	2055			2085			2100		
	min	mid	max	min	mid	max	min	mid	max
Boston	0.35	0.51	0.69	0.57	0.75	1.05	0.68	0.98	1.23
Portland	0.29	0.46	0.63	0.48	0.66	0.96	0.57	0.87	1.13
Saint John	0.33	0.50	0.68	0.54	0.73	1.04	0.64	0.95	1.21
Cobequid Bay	0.41	0.60	0.79	0.66	0.87	1.20	0.79	1.12	1.40
Yarmouth	0.37	0.54	0.71	0.60	0.78	1.08	0.71	1.01	1.27
Halifax	0.36	0.58	0.69	0.57	0.76	1.04	0.68	0.97	1.22

Table 11 shows "predicted increase in tidal high water in metres at selected locations for the years 2055, 2085 and 2100. The values reflect tectonic influence, ice melt, steric effects and changing M₂ tides. Maximum and minimum values are obtained from tidal runs using estimated existing sea level trend and the extreme values of the ice and steric inputs (Greenburg et al., 2012)"

As previously mentioned, Chart Datum is the plane of reference used for nautical charts. In Chart Datum, the lowest normal tide is the 'zero point'. In non-tidal waters, a low water level is adopted as datum. Because the zero point reference for Chart Datum is not the same as the zero point reference for terrain maps, the Climate Change Committee had to convert Chart Datum to Canadian Geodetic Vertical Datum (CDVD28). This conversion required subtracting an offset to account for the difference between these two mapping systems because Chart Datum is lower than CDVD28. The offset for West Hants is 7.23m. After accounting for this difference, the elevation used to delineate the area of increasing coastal flood risk in West Hants was 10m.

However, the Richards and Daigle report as well as the Atlantic Storm Prediction Centre under Environmental Canada's Meteorological Services Centre based in Dartmouth Nova Scotia, is quick to remind EMO personnel that water level scenarios do not account for wave action. Wave run up can cause significant damage. Therefore, if winds are shore facing, EMO personnel are advised to add 10% to storm surge estimates to account for the risks posed by waves.

4.4.2 Dykes in West Hants

West Hants has more than 160 km of coastline, 2,436 ha of dykelands (about two percent of the total land area of West Hants) and 30.5 km of running dyke (Municipal Climate Adaptation Case Study Report, 2013). The Nova Scotia Department of Agriculture, Land Protection Section, Agriculture and Food Advisory Service's (Land Protection Section) is responsible for the protection of agricultural land behind dykes and the maintenance of dykes which are privately owned.

Dykelands are found along the flood plains of the Avon, St. Croix, Kennetcook, Herbert and Meander Rivers. "Dykelands in West Hants fall into two categories—those protected from tidal flooding in the traditional fashion by dykes, and those upriver of the Avon River Causeway (approximately 1,214 ha or 3,000 ac) which are protected by the causeway itself, rather than by dykes" (Municipal Climate Adaptation Case Study Report, 2013).

The aboiteau controlling the Avon River (Pisiquid Lake) prevents seawater from entering during high tide and allows fresh water to exit at low tides. It is mechanical like all aboiteaux and a failure could

result in salt water flooding above the causeway. The Land Protection Section's spring maintenances schedule on the causeway aboiteau along with monitoring of weather in the watershed has prevented any major issues to date (personal communication, Craig Bauchman, August 19, 2013). However increasing sea levels increase the potential for dyke breach to occur. As well, higher sea levels mean the time which aboiteaux are closed becomes longer and this can lead to fresh water flooding during heavy run off/rain events (personal communication, Craig Bauchman, August 19, 2013).

Note that the marsh bodies have amalgamated to become Martock Marsh body (Windsor Forks, Martock and Sunny Slope), Falmouth Great Dyke Marsh body (Armstrong, Falmouth Great Dyke, Falmouth Village and Castle Frederick) (personal communication, Craig Bauchman, August 19, 2013).

The research of Dr. Danika van Proosdij and colleagues from the Department of Geography, Maritime Spatial Analysis Research Unit and Intertidal Coastal Sediment Transport Research Unit at Saint Mary's University is invaluable to those municipalities that served as case study sites under the ACAS program. The area of West Hants for which LiDAR data was available was one such study site. The results of the research, as summarized in Best Management Practices for Climate Change Adaptation in Dykelands: Recommendations for Fundy ACAS Sites (2013) included:

- A physical assessment of dykes;
- A determination of new critical elevations and associated engineering modifications;
- An assessment of current and potential future management practices (e.g. maintenance of foreshore, placement of armour rock, creek modifications); and
- Recommendations of mitigation strategies and recommendations of coastal engineering practices to protect existing foreshore marsh.

Physical stability was mapped as: highly stabilized, partially stabilized, not stabilized, unconsolidated over solid, or not applicable. As well, specific areas/points of concern were highlighted. So too were locations where the provincial Aboiteau Superintendent noted more rock should be put down. As a result of the MCCAP process, all of this data is now available to the West Hants' Planning department as a digital file (i.e., ArcGIS file format) that can easily be used for mapping by geographic information systems (GIS) technicians familiar with the

mapping software currently owned by West Hants. This information empowers West Hants to initiate or participate in discussions that determine how the dykes in West Hants are maintained, topped up, or 'let go'. Such decisions should be based on community agreement about the value of what is behind the dyke: the present and future economic and environmental worth of what a particular segment of dyke is protecting.

For those segments of dyke that protect land and/or assets of significant value, van Proosdij and Page (2012) suggest new critical elevations (Table 17) and associated engineering modifications to accommodate present day and future sea levels. Currently, dyke elevations are maintained so that their height is one to two feet (0.3–0.6 m) above predicted maximum water levels as defined in the 1960s. Local observation confirms that these levels are no longer relevant. In fact, all dykes in Nova Scotia are below where sea level is expected to be by 2055, and “most of the dykes within Fundy ACAS communities (study sites) are (currently) below the critical elevation required to stop a 1:10 year storm (0.85 m) event.” “It is important to recognize that . . . the construction elevations and design of earthen dykes within the region are not designed to protect life and property. Municipalities located behind a dyke have no control over these activities nor are they financially responsible for repairs” (van Proosdij and Page, 2012). However, because the impact of an overtopped or breached dyke is felt at the local level, it is critical that municipalities understand what is known or being planned for dyke upkeep and maintenance and engage in conversations about how to lessen vulnerabilities to dyke-related flood risks.

The Table below, created by van Proosdij and Page (2012), shows a summary of how high dykes in Hants County would need to be in order to mitigate impacts from sea level rise and a water surge associated with a storm that has a 1% annual exceedance probability. While new critical elevations are suggested for other time periods, the 2055 benchmark is of interest because it coincides with the timeframe considered for other aspects of West Hants' coastal flood analysis and mapping. Having this data at hand enables West Hants to talk with the Department of Agriculture about which dykes warrant the effort and expense of improving physical stability and height, and what standards of design ought to be met.

Table 17 Recommended elevations relative to CGVD28 datum for Fundy ACAS marshbodies.
 Table 5 in Best Management Practices for Climate Change Adaptation in Dykelands:
 Recommendations for Fundy ACAS Sites, van Proosdij and Page, 2012

NS #	Hants County Name	HWL (m)	Crit. (m)	Storm surge & return periods				Relative Sea Level Rise (m)				Combined (SLR + surge)		
				1:10 0.85	1:25 0.96	1:50 1.04	1:100 1.13	2025 0.16	2055 0.45	2085 0.85	2100 1.1	2055 & 1:100	2085 & 1:100	2100 & 1:100
14	Elderkin	7.9	8.2	8.8	8.9	8.9	9.0	8.1	8.4	8.8	9.0	9.5	9.9	10.1
27	Newport Town	7.8	8.2	8.7	8.8	8.8	8.9	8.0	8.3	8.7	8.9	9.4	9.8	10.0
38	St. Croix*	7.9	8.2	8.8	8.9	8.9	9.0	8.1	8.4	8.8	9.0	9.5	9.9	10.1
48	Centre Burlington	7.6	8.2	8.5	8.6	8.6	8.7	7.8	8.1	8.5	8.7	9.2	9.6	9.8
49	Scotch Village	8.1	8.2	9.0	9.1	9.1	9.2	8.3	8.6	9.0	9.2	9.7	10.1	10.3
50	Hebert River	7.8	8.2	8.7	8.8	8.8	8.9	8.0	8.3	8.7	8.9	9.4	9.8	10.0
61	Kennetcook	8.1	8.2	9.0	9.1	9.1	9.2	8.3	8.6	9.0	9.2	9.7	10.1	10.3
68	Tregothic	8.4	8.2	9.3	9.4	9.4	9.5	8.6	8.9	9.3	9.5	10.0	10.4	10.6
79	Chambers	7.9	8.2	8.8	8.9	8.9	9.0	8.1	8.4	8.8	9.0	9.5	9.9	10.1
85	Mantua Poplar Grove	7.9	8.2	8.8	8.9	8.9	9.0	8.1	8.4	8.8	9.0	9.5	9.9	10.1
88	Burlington	8.1	8.2	9.0	9.1	9.1	9.2	8.3	8.6	9.0	9.2	9.7	10.1	10.3
93	Greenhill	8.2	8.2	9.1	9.2	9.2	9.3	8.4	8.7	9.1	9.3	9.8	10.2	10.4
100	Wentworth	8.1	8.2	9.0	9.1	9.1	9.2	8.3	8.6	9.0	9.2	9.7	10.1	10.3
105	Belmont	8.1	8.2	9.0	9.1	9.1	9.2	8.3	8.6	9.0	9.2	9.7	10.1	10.3

In addition to suggesting critical elevations to accommodate current and future water levels, the Maritime Spatial Analysis Research Unit and Intertidal Coastal Sediment Transport Research Unit at Saint Mary’s University also recommended marshland boundaries that reflect true (contemporary) flood boundaries, as opposed to the recognized historical boundaries as delineated in the 1950s. These recommended boundaries are now available to West Hants in file formats available to be manipulated for mapping. The importance of the recommended marsh boundaries is that they provide a visual indication of where flood risk vulnerability is far greater than perceived or understood in previously planning exercises. This data can be used to guide and control development in a manner that aims to reduce exposure to the hazard of coastal flooding.

4.4.3 Coastal Flood Mapping

Using the 10m CGVD28 ‘line’ to identify the area of increased coastal flood risk is useful from both land use planning and emergency management perspectives. This line of reference—between 10m CGVD28 and low tide—defined the area for which the Climate Change Committee analyzed what areas have people, property, socially valued places or essential services that need to be protected from the level of risk associated with a 100-Year Return Period Storm.

A coastal flood map (Appendix C) was prepared to illustrate the areas of West Hants within this swath of increased risk. Essential infrastructure and watercourses are also shown on the map.

Under the ACAS program, LiDAR data was acquired for the portion of West Hants encompassing the Avon River and lowland plains (Figure 7). While this data is vital for detailed analysis of flood risk (both inland and coastal), West Hants did not allow its absence in the rest of West Hants to impede this first general analysis of flood risk. However, the Climate Change Committee acknowledges that an extension of LiDAR would create an opportunity to assess flooding from a watershed perspective, and in particular provide needed information for hydrodynamic modeling to illustrate where water would flow and why in a variety of scenarios, such as failures or additions of aboiteaux or culverts, and the overtopping or breaching of dykes.

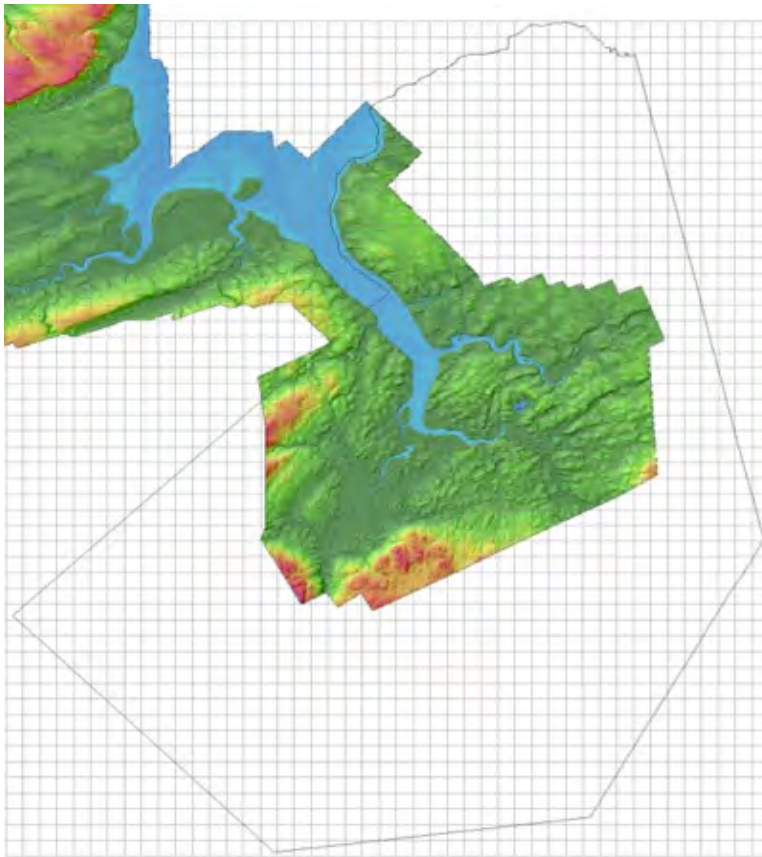


Figure 7 West Hants LiDAR Coverage

Coastal flooding is already a growing issue in West Hants. Case in point, there is concern about the flood vulnerability of the Avon River Heritage Museum in Avondale. As well, dykes overtop frequently. To

date this has been of minimal concern given it has been primarily agricultural land affected. However, residents are keenly aware that at high tide the water level appears to be near the top of the dyke. From the municipal perspective, public works is aware that there is high risk of a lift station of the Falmouth Sewage Treatment Plant flooding, and the treatment plant itself is vulnerable, particularly in terms of access. As well, there are multiple road segments that flood frequently. Given the density of roadways throughout West Hants, EMO has few concerns over isolated residents from coastal flooding. However, flooded roads can increase response times during an emergency event, so it would be prudent to identify those sections that are vulnerable.



Cheverie Bridge (Stop 10). Inadequate armouring allows overtopping by waves that continues to erode the shoulder of Highway 215. Photo: Philip Finck

4.4.4 Coastal Flooding / Storm Surge Impact Matrix

Hazard: Coastal Flooding / Storm Surge																
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).																
	Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk
			Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low
	Risks to Public Safety: life & safety	Non-specific				X						X			High	
	Damage to Infrastructure	Drainage ditches or aboiteaux; Highway 1, Falmouth; Avon River Heritage Museum, Avondale; Falmouth Sewage Treatment Plant; Avondale Wharf		X				X				X			High	
	Dyke Breach	Falmouth; St. Croix	X											X	High	
	Displacement of residents due to property damage	Coastal area (160km shoreline); St. Croix; Falmouth; Scotch Village					X				X		X	High tolerance with storm surge, but would expect low tolerance if flood caused by dyke breach	Moderate	
	Road/bridge Erosion	Hwy 215; Hwy 101; Payzant Drive; Wentworth Road		X							X			X	Moderate	
	Economic impacts (loss of farmland; business disruption)	Non-specific					X	X				X			Low	

4.4.5 Coastal Flooding Action Items

Table 18 Action Items to Address Coastal Flooding

High Priority Action Item	Impact Addressed
Assess preparedness for emergency response for coastal flooding.	Risks to public safety
*Establish a REMO protocol that uses 11m CGVD28 to the high tide line as the area indicating high risk vulnerability during a tropical storm / hurricane with an annual exceedance probability of 1% or less (i.e., a 100 year return period storm).	Risks to public safety
During the MPS review, investigate the implications of applying land use planning regulations (e.g., site controls) to require flood proofing for new coastal developments between 10m CGVD28 to the water line.	Property damage
During the MPS review, investigate amending Schedule A of the Land Use By-Law to incorporate the new recommended Marsh Boundaries as provided by the Maritime Spatial Research Analysis Centre.	Risks to public safety; property damage; infrastructure damage
**In partnership with the Maritime Spatial Research Analysis Centre, determine which salt marshes and dyke segments (if any) are candidates for realignment. As well, determine if the foreshore side of the dyke should be armoured.	Risks to public safety; property damage; infrastructure damage
Establish a policy that municipal infrastructure susceptible to flood risk given the Plausible Upper Bound water level scenario as provided in the Williams and Daigle report, be flood proofed (e.g., utilities located at or below the worst case flood elevation line).	Infrastructure damage; municipal property damage
Medium Priority Action Item	Impact Addressed
Determine how to efficiently make available to citizens investigating the development of a coastal property a one/two page brief describing what is understood about risk of overland flooding.	Risks to public safety
Seek a partnership with the Halifax office of the Insurance Bureau of Canada on a public campaign to inform residents about what flood insurance does and does not cover, and how that relates to eligibility for Disaster Financial Assistance.	Risks to public safety
Establish a joint municipal and REMO protocol to conduct post-storm analysis using a template	Risks to public safety; property damage;

provided by NS EMO and the Atlantic Storm Prediction Centre, and have REMO keep one copy for their records and send one copy to the Atlantic Storm Prediction Centre care of the Weather Preparedness Meteorologist.	infrastructure damage
Low Priority Action Item	Impact Addressed
Invite local stakeholders to a seminar to communicate what is understood about flood risk.	Risks to public safety; property damage

* Note that land use planning uses the 10m line to delineate flood risk, but this does *not* include wave action, so actual risk to safety is acknowledged by REMO as being up to 11m.)

** Managed realignment should be considered in those areas that have less than 80m of foreshore. In those cases, dykes should be re-aligned so as to provide a minimum of 100m of foreshore.

4.5 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 may be accompanied by low temperatures.

4.5.1 Winter Storm Rationale

Temperatures are increasing in every season, but the greatest increase in temperature will be experienced in winter. In other words, 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. The effects of ice on municipal infrastructure, operations or services are anticipated to be modest. Perhaps the biggest risk involves consequences of power interruption. However, from the EMO and public safety perspective, increased ice events pose serious risk on the roadways, and in cases of power failure.

4.5.2 Winter Storm Impact Matrix

Hazard: Winter Storm or Blizzard																		
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.																		
	Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk		
			Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low		
	Power Utility Disruption: Heating demand	Non-specific		X					X									Moderate
	Infrastructure Damage	Dykes & Hydroelectric system; causeway					X		X					X				Low
	Transportation: risk to public safety	Non-specific					X		X					X				Low

4.5.3 Winter Storm / Ice Event Action Ideas

There are no action ideas presented for the hazard winter storms / ice events. This is not an oversight. There are multiple reasons related action ideas did not 'make the cut'; for example, a total absence of jurisdictional control, negligible threat reduction potential, or if the idea mirrored an *existing* operational response that would happen automatically within current operating procedures.

4.6 Tropical Storm or Hurricane

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.

4.6.1 Tropical Storm or Hurricane Rationale

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. However, there are also high winds to consider.

The risks posed by high winds primarily involve public safety: felled trees, transportation disruption and increased fire risk. There may be economic impacts as well, particularly to the agricultural sector. But from the perspective of municipal operations and services, the main vulnerability of concern is power disruption as it would affect residents and the sewage pumping station. It was estimated that a power outage would become a public works problem after about "5 day time hours due to flow. This is a minor concern." (personal communication, Rick Sherrard, August 19, 2013)

4.6.2 Tropical Storm or Hurricane Impact Matrix

Hazard: Tropical Storm or Hurricane																
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.																
	Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk
			Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low
	Risk to Public Safety: felled trees	Non-specific				X		X					X			Moderate
	Power Utility Disruption: resident power and sewage pumping station	Non-specific				X		power would have to be out 5 days before an issue							X	Low
	Transportation Disruption	Municipal streets					X						X			Low
	Municipal infrastructure Damage	Signage - non-specific					X						X			Low
	Crop/farm damage	Non-specific			X			X					X			Moderate
	Community Lifeline Damage	Cut off from Hospital & Schools; Town of Windsor					X						X			Low
	Increase in wind throw to tree stand and elevated fire risk	Non-specific			X			X						X		Moderate

4.6.3 Tropical Storm / Hurricane Action Ideas

There are no action ideas presented for tropical storm / hurricanes. This is not an oversight. There are multiple reasons related action ideas did not 'make the cut'; for example, a total absence of jurisdictional control, negligible threat reduction potential, or if the idea mirrored an *existing* operational response that would happen automatically within current operating procedures.

4.7 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.

4.7.1 Coastal Erosion Rationale

West Hants has approximately 164 kilometers of shoreline with potential for exposure to sea level rise. As part of the MCCAP process, Geoscientist Philip Finck completed a high level, qualitative assessment of susceptibility to coastal erosion. The results are in hard copy and ready to be converted into a digital map.

The Climate Change Committee learned that a large extent of the high cliffs along the coastline is eroding at the high tide line. The bedrock is soft and fractured, crumbling landward quickly. There is evidence of huge rockfalls west of Walton and Clark point. Rockfalls are instantaneous events and could be devastating to life and safety, as well as infrastructure. These areas will be colour coded red on the coastal erosion susceptibility map indicating greatest areas of concern.

West Hants' low cliffs tend to be about two meters high with bedrock, and till on top of this. The 'front' of the Avon River is a good example of this. These low cliffs are also quite susceptible to erosion.

An important lesson from the erosion assessment was that living shorelines would not work in specific areas where the base of the cliff (high or low) is being undercut. In cases like this, armouring would make more sense. That being said, armouring has to be undertaken in an informed manner, otherwise it has the potential to worsen incidents of erosion in neighbouring areas. Another point about armouring is

that erosion mitigation option is not desirable in cases where the armouring would cut off the supply of sediment material needed to 'feed' the beach. West Hants, however, is characterized by mud flats, not beaches. So armouring in West Hants makes sense—again, if done well.

Coastal erosion as a result of storm surge is a concern along the entire extent of the Minas Basin coastline, from Avondale to Walton on the eastern side and from Mount Denson to Hantsport on the western side. Some areas, such as Hobart's Beach in Summerville, are believed to have lost as much as 100 feet of foreshore (Municipal Climate Adaptation Case Study Report, 2013).

During the ACAS research it was discovered that the shore along the Avon River just north of the Windsor Causeway is rapidly eroding, despite progressive armouring, as freshwater discharges from the tide gate into the narrow tidal channel. Development of the Newport bar is exacerbating the issue.

High susceptibility of erosion—indeed high rates of erosion—is causing infrastructure damage particularly to road infrastructure.



Johnson Cove. A vertical cliff typical of the entrances to small coves along the north coast of West Hants facing the Minas Basin. Photo: Philip Finck.

4.7.2 Coastal Erosion Impact Matrix

Hazard: Coastal Erosion																
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.																
	Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk
			Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low
	Displacement and/or economic impact on residents from property damage	In areas of High Susceptibility as mapped					X	Occuring continually					X			Low
	Infrastructure damage / transporation disruption	Cheverie Bridge, Bass Creek Bridge (between Cambridge and Bramber) (others ?)					X	Occuring continually						X		Low
	Loss of natural, public coastal spaces	A concern along entirety of Minas Basin, from Avondale to Walton on the eastern side and from Mount Denson to Hantsport on the western side. Some areas (e.g., Hobart's Beach) are believed to have lost as much as 100 feet of foreshore				X							X		Low	

4.7.3 Coastal Erosion Action Ideas

Table 19 Action ideas to Address Coastal Erosion

High Priority Action Item	Impact Addressed
none	na
Medium Priority Action Item	Impact Addressed
During the MPS review, assess the implications of requiring coastal erosion site assessments for development approvals in areas highly susceptible to erosion.	Property damage; infrastructure damage
Low Priority Action Item	Impact Addressed
*Determine how to efficiently make available to coastal dwelling citizens, and people investigating the purchase of a coastal property, a one/two page brief describing what is understood about susceptibility to coastal erosion.	Displacement and/or economic impact on residents due to property damage
Work with a coastal geomorphologist or geoscientist to develop a coastal erosion informational sheet in collaboration with municipal staff.	Displacement and/or economic impact on residents due to property damage
Distribute a coastal erosion informational sheet with building permit applications for properties that include shoreline.	Displacement and/or economic impact on residents due to property damage
Post a coastal erosion information sheet on the municipal website.	Displacement and/or economic impact on residents due to property damage
Organize and host a seminar on armouring the coast, targeted to those employed in this work, and property owners who have, or are considering armouring as a coastal protection option.	Displacement and/or economic impact on residents due to property damage
Request that TIR address erosion at Cheverie causeway.	Infrastructure damage; transportation disruption

*Links to ICSP goal(s)

4.8 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.

4.8.1 Extreme Heat Event Rationale

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;
- Limited awareness and knowledge of effective prevention and treatment measures; and
- Heat illnesses are probably under-recognized and under reported" (Simpson, 2013).

Table 20 Richards and Daigle Projected Changes in Heat

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Hot Days (Tmax > 30)	3.5	8.4	15.4	24.9
Very Hot Days (Tmax > 35)	0.0	0.1	0.4	1.2

While the health and wellness of West Hants' residents is of great concern, there is limited municipal jurisdiction to address health related issues, other than collaborate with provincial bodies issuing and responding to heat warnings. This effort would most likely be undertaken through REMO. REMO can also address extreme heat by planning for accessible cooling shelters in partnership with area service organizations.

The most direct link between municipal operations and services and extreme heat relates to water restrictions and utility bills. Water restrictions would result from extended extreme heat causing water capacity issues. That same heat could cause heightened utility bills. Given the nature of increasing power bills, this is not an insignificant municipal concern.

4.8.2 Extreme Heat Event Matrix

Hazard: 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 day's are defined as 30 degrees Celcius and above.																
	Potential Impacts	Susceptible Locations	Future Severity Potential					Estimated Frequency					Level of Public's Risk Tolerance			Overall Risk
			Catastrophic	Significant	Moderate	Minor	Insignificant	Once every 5 yrs or less	Likely once every 10 yrs	Might occur once every 25 yrs	Could occur once every 50 yrs	Once every 100 yrs or more	High	Medium	Low	High Moderate Low
	Power: Municipal Cooling Demand	Non-specific			X			X					X			Low
	Water Production: If capacity impacted, potential water restrictions	Water treatment facility				X		X							X	Moderate
	Cyanobacteria blooms	Non-specific		X			unknown							X	Unknown	
	Public health and safety	Non-specific				X	X						X			Moderate

4.8.3 Extreme Heat Event Action Ideas

Table 21 Action Ideas to Address Extreme Heat Events

High Priority Action Item	Impact Addressed
none	na
Medium Priority Action Item	Impact Addressed
none	na
Low Priority Action Item	Impact Addressed
*Assess preparedness for emergency response to extreme heat events.	Public health and safety
Consider creating a policy addressing the safety of municipally coordinated outdoor recreation events during hot and very hot days, defined as days that are 30°C and 35°C days respectively.	Public health and safety

*Have preparedness plan address cooling shelters / rooms (e.g., local senior's complex) and back-up generators for cooling shelters in case of power outage; assist with Message Delivery during a heat advisor, led by REMO in coordination with the Department of Health Promotion and Protection—Dr. Richard Gould, Medical Officer of Health; Inventory which fire halls / community halls have back-up generators, and make sure cooling shelters have back-up generator; confirm Windsor Elms has a cooling room or preparedness plan for extreme heat; Work with municipal partners/stakeholders to determine if and how free swim/skate hours could be offered at the Newport and District rink, and pool during extreme heat events.

4.9 Level of Preparedness for Natural Hazards and Impacts

The Municipality of West Hants is a member of a Regional Emergency Management Organization. Its REMO partners are the Town of Windsor and Hantsport. As well, Mutual Aid Agreements are in place with the Municipality of Chester, Municipality of the County of Kings, and the Municipality of the District of East Hants.

An all-hazards response plan has been prepared for REMO and was last amended in 2006. The Emergency Preparedness Plan (EPP) outlines exactly how activation would be implemented and the names and contact information for those who would be involved.

Fire, police or health services handle day-to-day incidents. These organizations could activate REMO in cases where the incident is of the

size or magnitude of consequence that it would be beyond their ability to manage it. In West Hants there are five Fire Districts: Windsor, South West, Brooklyn, Summerville, and Walton.

The organizations, agencies or groups that may be able to help in the event of a weather-related emergency, as described in the EPP, include:

- Police, RCMP, and Fire Districts
- Partnering REMO Municipalities
- Mutual Aid partners
- Municipal Administrators, Public Works and Planning Departments
- Hants Community Hospital
- Medical Officer of Health
- Emergency Health Services (EHS)
- Community Services
- Nova Scotia Department of Natural Resources
- Nova Scotia Department of Agriculture
- Nova Scotia Department of Environment
- Nova Scotia Department of Transportation and Infrastructure Renewal

Understandably, the all-hazards plan is a comprehensive EPP that primarily focuses on response procedures. It lists, though doesn't describe, potential emergencies in order of perceived probability as determined by the REMO Planning Committee. It also lists REMO Planning Priorities (Table 22). Interestingly, five of the natural hazards analyzed by the Climate Change Committee were *not* included in the EPP: flooding (inland or coastal), hurricane, drought, erosion, and extreme heat events. Therefore, one of the action items included in the Committee's list of adaptation action priorities is an update of REMO's EPP.

Table 22 REMO Potential Emergencies and Planning Priorities, 2006

Potential emergencies	Planning priorities
Blizzard or Massive Snow Storm	Forest / Brush Fire
Major Frost / Freeze	Chemical Spill / Contamination
Chemical Spill / Contamination	Plane Crash
Plane Crash	Massive Automobile Wreck
Electric Power Blackout (24 hrs)	Freezing Ice Storm
Freezing Ice Storm	Blizzard or Massive Snow Storm
Massive Automobile Wreck	Electric Power Blackout (24 hrs)
Forest / Brush Fire	<i>left blank intentionally</i>

Despite these omissions, the Climate Change Committee, which included the Regional Emergency Management Organization Coordinator, his Alternate, as well as municipal administrative staff that would be engaged if the REMO was activated, believed West Hants' level of emergency preparedness to be good. 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 exist naturally.

The only issue that came up during MCCAP development for which there was questionable response readiness was the potential for chemical spills. The link between chemical spills and climate change is one of extreme weather events: events that cause conditions (e.g., flash floods, high winds) that 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 role of West Hants given the financial realities of response-readiness for chemical spills is to encourage First Responders within West Hants to consider the problem and ensure there is an up-to-date procedure that identifies who First Responders call during an incident. They need to consider how long it will take for trained hazardous material teams to arrive at the site of the problem, and what they could do to protect their own safety and safety of others before a team arrived. For example, it may mean that the municipality would have to do large-scale evacuations while waiting for teams because of long (4 hour plus) arrival times.

4.10 Positive Climate Change Impacts

The most obvious potential climate change impact within West Hants is the anticipated extension of the growing season. This is discussed in section 7.2, Climate Change Opportunities in Agriculture. Other 'opportunities' are less direct, and may stem more from what will *not* happen as opposed to what will. For example, Windsor, Ontario already experiences over twenty days a year over 30°C, and western

provinces throughout the continent are experiencing water shortages. Although West Hants is not immune to climate change impacts, relatively speaking the province is beautifully positioned as a place of abundance (i.e., arable land and space) that may not experience the severe heat and drought that will completely change communities, and nations around the world. If resources are used increasingly mindfully, and attention is paid to our most concerning social and environmental issues (including priority climate impacts), the province ought to be promoting Nova Scotia as a great place to live to families concerned about their children's future.

4.11 Information Required to Improve Adaptation Efforts

West Hants would like to better understand groundwater. It is difficult to assess the degree to which drought would impact West Hants' residents or the local economy without understanding characteristics such as quantity, patterns of flow and needs for recharge. It is presumed that the Nova Scotia Department of Natural Resources has either the information or the expertise to collect the information that would provide a better understanding of groundwater conditions. Therefore, West Hants, as is the case with many municipalities, would benefit from the Province's leadership and guidance in determining what climate change impacts would be to private wells, an area of provincial jurisdiction, but a locally felt impact.

West Hants would benefit from provincial mapping that indicates areas of susceptibility to the transport of metals in the environment, or, a provincial program that makes it financially affordable to obtain this information. For example, if departments (Environment, Health, Natural Resources) partnered to cost-share the expenses of mapping arsenic susceptibility, municipalities with susceptible areas could partner with the province by helping distribute information on water testing and arsenic mitigation to residents in at risk areas.

West Hants, like many 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 in West Hants. Similarly, West Hants 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.

There are multiple opportunities for the Province to provide needed leadership to mitigate the consequences of natural hazards exacerbated by climate change. Such opportunities include, but are not limited to:

- Working 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;
- Developing a program to track incidents of dry private wells;
- Developing a program to better track incidents of seawater intrusion; and
- Working inter-departmentally and with federal departments, such as Department of Fisheries and Oceans, to capitalize on opportunities to gather and/or share LiDAR data at reduced rates.

Additional opportunities for provincial leadership were identified in a Bay of Fundy Ecosystem Partnership Report (2013) on its 2012-2013 Climate Change Project. The ideas presented which resonate with West Hants include:

- Develop and distribute directly to municipalities mapping protocol so that municipal mapping done in the context of climate change action planning can be assimilated into a larger provincial database and used seamlessly for subject analysis to inform provincial climate change efforts (i.e., identify data gaps, municipal needs, and areas of priority action to ensure public safety and opportunities for community wealth);
- Budgetary support (i.e., staff and operational) for the Nova Scotia Department of Natural Resources for the production of vulnerability and risk assessment products and tools for land use and emergency planning and response;
- Increased partnership with academic institutions to lead and/or support municipal-public conversations about flood risk, flood risk tolerance, and flood mitigation options in coastal marshlands;
- Program support within Service Nova Scotia Municipal Relations and Nova Scotia Environment for the training of

newly elected officials on climate change trends and projections, and the role of adaptive capacity and adaptation strategy; and

- Program support within Service Nova Scotia Municipal Relations and Nova Scotia Environment Climate Change Unit in the form of a framework for climate change action plan implementation and monitoring.

4.12 Analysis of Social and Organizational 'Hazards'

The collaborative hazard analysis process used by West Hants' Climate Change Committee revealed some circumstances that, if not addressed, would undermine other adaptation efforts. In other words, the circumstances could *impact* West Hants' ability to cope with and respond to natural disasters. In this regard, these circumstances could be considered hazards because, if not addressed, they could exacerbate potential damage, harm or adverse effects. As these circumstances/hazards were brought to light, they were grouped into three new hazard categories:

1. Constrained REMO—reduced capabilities to mitigate, respond to and recover from a natural hazard;
2. Organizational Adaptive Capacity—inability to effectively manage and make decisions during natural disasters of extreme weather events; and
3. Social Vulnerabilities and Cohesiveness—inability to cope with disasters and challenges without collapsing into a different state.

5. Facilities and Infrastructure

The three maps that were produced as part of the MCCAP process that indicate areas of increased risk of geological hazards in the context of climate change are the coastal flooding map, the inland flooding map, and the map of coastal erosion susceptibility. In all of these maps, attributes of essential infrastructure and roadways are included. Generally speaking, transportation infrastructure and the Falmouth Sewage Treatment facility are the infrastructure most at risk from flooding both now and into the near future (2055). Transportation infrastructure is also currently susceptible to erosion in certain locations, as identified in the erosion hazard impact matrix. This situation is only expected to get more concerning. Other climate issues that will affect infrastructure and key facilities (e.g., drought, wildland fire, high winds, ice events, extreme heat) are summarized in section 4, Hazard Analysis.

5.1 Essential Facilities and Infrastructure

The following list highlights essential infrastructure in West Hants:

- Falmouth Sewage Treatment Plant
- Falmouth Water Treatment Plant
- Falmouth Booster Station
- Standpipe (tower)
- Low lift Building
- Dyke Road
- Mountain Road – in Three Mile Plains
- Municipal Building and Emergency Operations Centre
- Hwy 14
- Hwy 1 – Panuke Road
- 101 Causeway
- Power utility infrastructure
- Secondary roadways
- Bridges
- Avon River hydro system
- St. Croix Dams
- Hospital
- Schools

Although water supply areas and watersheds are not considered infrastructure, they are essential to municipal operations and services. West Hants has “three municipal drinking water supply watersheds within its boundaries, all of which rely on surface water. French Mill Brook, located west of Falmouth, consists of 1,139 ha (2,814 ac) designated as a Protected Water Area (PWA) under the Nova Scotia Environment Act. It provides treated water to the Falmouth Growth Centre. Mill Lakes, covering 1,778 ha (4,393 ac) south of Martock, also a designated PWA, supplies water to the Town of Windsor and the Three Mile Plains Growth Centre. The Town of Hantsport’s water supply is Davidson Lake, just west of French Mill Brook. Although not currently protected under the Environment Act, Hantsport is in the process of seeking the designation” (Municipal Climate Adaptation Case Study Report, 2013).

Essential to the functioning and well-being of West Hants are a variety of socially valued assets, including (but not limited to):

- Civic Center in Brooklyn
- Community Halls
- Churches

- Elementary Schools (Brooklyn, Summerville, Newport, Falmouth, Windsor Forks)
- West Hants Middle School
- Avonview High School
- Windsor Elms Village
- Provincial Parks located within West Hants
- Municipally maintained parks:
 - Ste. Croix Recreation Site
 - Eldridge Road Recreation Site
 - Irishman's Road Recreation Site
 - Halewood Drive (small parcel of parkland)
 - Falmouth Mini Park
 - Armstrong Lake (small parcel of parkland)
 - Quarry Pond Recreation Site
 - Hobarts Recreation Site
- Avondale Wharf / Museum
- Commercial Districts such as in Brooklyn
- Town of Windsor, particularly its grocery stores
- Avon Valley Golf Course
- French Mill Brook Watershed (recreational site)

5.2 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.

- West Hants' Municipal Office Building, as it serves as the primary Emergency Operations Centre (EOC) for REMO. The alternate EOC is in the Town of Windsor's Administration Building;
- The fire halls associated with the municipality's Fire Districts: Windsor, South West, Brooklyn, Summerville, and Walton;
- Major roadways (e.g., Hwy 101, Hwy 1, Hwy 14) and secondary roadways important to evacuation routes as identified in emergency preparedness plans;
- The Hospital, which is in the Town of Windsor, and access roads to the hospital;
- Falmouth Water Treatment Plant;
- Falmouth Booster Station; and
- Standpipe (tower).

5.3 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, can be found in Appendix D.

6. Determining Vulnerability

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 8).

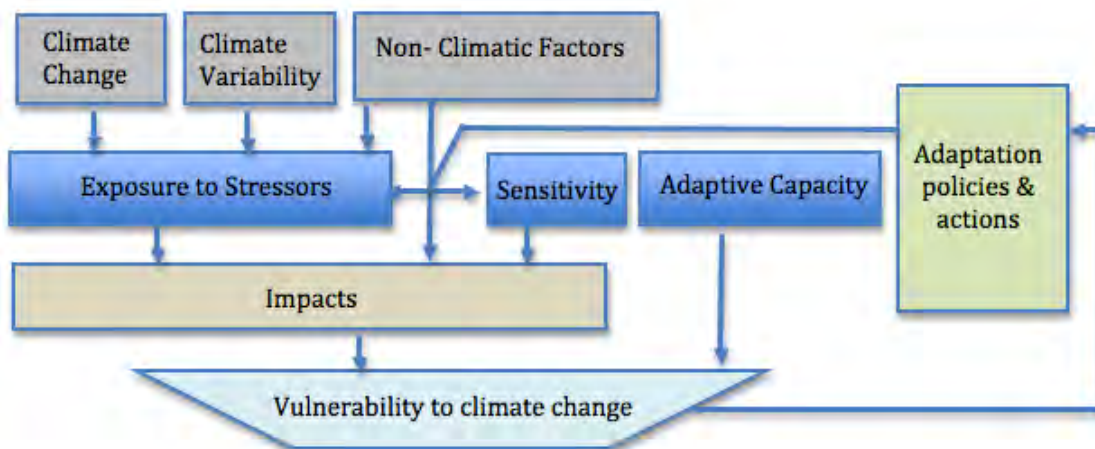


Figure 8 Adapted from Fuessel and Klein, 2006

6.1 Vulnerability Due to Exposure

When undertaking hazard risk vulnerability assessments, emergency management professionals are mostly interested in exposure: the number of people potentially affected and the resources needed to ensure their safety during and after an event. For example, when assessing flood risk, EMO will first look to see what areas are exposed (if the hazard is spatial) and if and where populations might be isolated, due to roads becoming impassable. EMO is also concerned with the risk vulnerability of infrastructure where that infrastructure, if damaged, could exacerbate the endangerment of citizens. For example, EMO would be concerned with the interruption of municipal services only in cases where that interruption may trigger an

emergency response, such as the unavailability for potable drinking water for an extended period of time” (Warburton and MacKenzie-Carey, 2013).

To answer the question of exposure (i.e., vulnerability due to location), West Hants’ Climate Change Committee used its coastal flooding map, the inland flooding map, and the identified areas of high susceptibility to coastal erosion. These maps, which were created as part of the MCCAP process, address key natural hazards that are exacerbated by changing climate conditions.

West Hants recognizes it would also benefit from maps indicating exposure / susceptibility to sinkholes and metals in the environment (e.g., arsenic). As well, West Hants is mindful of seawater intrusion. It was determined that municipal mapping for seawater intrusion is not currently needed because only two incidents of seawater intrusion have been reported, the Department of Natural Resources has already created a relative vulnerability map using a GIS approach and available chemistry data (Appendix E), and development patterns are not anticipated to be dense enough to heighten withdrawal rates to the extent that seawater intrusion will be triggered. This is, however, an issue that West Hants will pay attention to going forward. Should the number of reported incidents increase, or a dense development in a susceptible area (as identified in the Provincial seawater vulnerability map) be proposed, West Hants will work with the DNR to understand what needs to be known or done in order to mitigate seawater intrusion.

6.2 Vulnerability Due to Sensitivity

“Sensitivity can confound (or ameliorate) the social and economic effects of climate exposure” (Cinnear et. al, 2013). Therefore, there is a need to consider both social and environmental aspects of sensitivity.

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. Children are particularly vulnerable during extreme weather events or natural disasters. Their vulnerability can only be mitigated through compassionate, wise efforts of the adults in their communities to mitigate risk through precautionary land use planning and development control, and efficient emergency

preparedness and response. Older adults are also considered at higher risk if health (i.e., physical or mental) issues are involved. As is the case with children, collaborative leadership between municipalities, health organizations at all levels of government, and emergency professionals can mitigate this population's risk vulnerability. However, it is acknowledged that social vulnerability of people of any age is inherently tied to the strength and resilience of social systems that support a family's access to health care, education for *all* ages, and policy and program assistance with energy and food security.

From the municipal perspective, as an organizational system, economic, political, cultural and institutional factors are going to influence the degree to which the municipality is buffered from or pays attention to climatic changes. For example, social systems are more likely to be sensitive to climate change if they are highly dependent on a climate-vulnerable natural resource. (Cinnear et. al, 2013)
Environmental sensitivity measures one's physiological ability to cope with physical and chemical changes in the environment (e.g. extreme temperatures).

Within municipal climate change planning, the question begs to be asked is to what extent can a municipality know the sensitivity of its citizenry? What scale of analysis makes sense? While municipal partners / stakeholders in the health and social services professions have some understanding of types of social vulnerabilities in the area (e.g., trends for drug dependency, number of people on home oxygen tanks, rates of homelessness) the information itself is ever-changing. One lesson learned during the MCCAP process is that when older adults need help during times of emergency, they will call their home health professional (e.g., Victorian Order of Nurses) or a family member before they call any branch of emergency services.

6.3 Interpreting Socioeconomic Vulnerability

Ms. Kyla Milne, of the Nova Scotia Department of Environment Climate Change Unit, is trying to better understand and assess how socioeconomic factors and socioeconomic change affect community vulnerability, adaptive capacity and resilience to climate change. In a recent research document stemming from that effort, it was stated that:

Given otherwise analogous community descriptors (e.g., size, location, and exposure to climate impacts), communities may exhibit a widely

divergent ability to respond and adapt to stresses or crises based on their overall socioeconomic circumstance and patterns. There is substantive agreement internationally that certain socioeconomic circumstances and patterns lead to more adaptive community attributes. These circumstances and patterns include 'harder' dimensions such as economic and employment diversity and growth (as captured in economic scenarios), and 'softer' dimensions such as trust, communication, community health and collaboration. Researchers have found that climate assessments that look only at climate scenarios (i.e., climate trends and projections) and do not consider relevant socioeconomic conditions, or assume that they will remain static, are less complete and useful as a basis for effective adaptation planning (Stantec, 2013).

When evaluating and ranking the severity of a climate impact (i.e., natural hazard), West Hants' Climate Change Committee first examined the type and financial worth of infrastructure potentially affected, and number of properties and facilities physically exposed to the hazard. The committee then pondered if anything within the community's socioeconomic circumstance or patterns implied that sensitivity to an impact might be worse or less than initially presumed. To guide this exploration, the Committee drew from a draft document called, "A Guide for Incorporating Socioeconomic Information into Municipal Climate Adaptation Strategy Development" (Warburton, 2013). The research document presents ten theme areas, each with its own set of indicators. The theme areas are:

1. Health
2. Education
3. Demographics
4. Sense of Community
5. Governance
6. Safety & Preparedness
7. Infrastructure
8. Local Economy
9. Macro Economy
10. Technology

The themes and associated indicators were used by the Committee as a platform for an honest evaluation of the municipality's existing

vulnerability and adaptive capacity. MCCAP consultant, Elemental Sustainability Consulting, posed questions from each of the theme areas to provoke conversation around where West Hants lies on a continuum of adaptive capacity. As a point of reference, the continuum consisted of four story lines: four community characterizations that wove together plausible circumstances within each of the ten socioeconomic theme areas. The community characterizations were not meant to project how West Hants would fare in the future, but rather to establish reference points to reach a general understanding of what different degrees of vulnerability, adaptive capacity, and resilience might look like in relationship to a range of possibilities (Warburton, 2013). The four community characterizations were: a thriving, adaptive community; a stable and moderately adapted community; a declining and insufficiently adapted community; and a community in crisis. Once a question was posed, Committee members would individually evaluate which of the characterizations best reflected their perception of West Hants' current reality. This group exercise served to reveal hidden assumptions as well as topics for which more information was needed (e.g., the public works people could see when there was limited understanding of infrastructure capacity). It also prompted the sharing of ideas and information that resulted in a more cohesive and adaptive Committee.

The socioeconomic exercise and conversations had by the Committee served two functions. First, the information was used to evaluate the accuracy of impact severity rankings. In other words, the Committee reviewed the rankings previously assigned to impacts in the hazard impact matrices to ensure the rankings appropriately reflected the community's vulnerability due to socioeconomic sensitivities. The Committee considered whether or not the rankings were appropriate given demographic and development patterns found within West Hants. Patterns of interest based on the 2006 census included:

- Almost 45 percent of West Hants residents were over the age of 44, with 14% of the population being over 65 years or older;
- 7.6% of the West Hants families had low-income status, compared to the 10.3% provincial average;
- Only 12% of West Hants employed labour force worked within the municipality. There was (and is) a very high percentage of commuters;
- 90% of the dwellings were owned rather than rented, 90.8% of which were single detached dwellings. This pattern comes into play in terms of disaster response: specifically, potential

- insurance coverage and eligibility for disaster financial assistance; and
- Resource based industries such as agriculture accounted for only 7.8% of the labour force.

Secondly, the socioeconomic conversations were used to gain insight into the municipality's organizational adaptive capacity, the municipality's 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 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 were all discussed as key factors of adaptive capacity.

6.4. Review of EPPs to Identify Social Vulnerabilities

The documents listed below were examined to see if, and to what extent, they took into consideration the natural hazards identified during the MCCAP process, as explained in section 4.9. They were also reviewed for their identification of *who* would be affected during emergency events. The documents reviewed were:

1. The REMO Emergency Preparedness Plan
2. The Davidson Lake Source Water Protection Plan (2013), Emergency Response and Contingency Plan
3. The EPP for Mill Lakes and Fall Brook Reservoir Water Supply System, Town of Windsor
4. The Town of Windsor Water Utility Emergency Response and Contingency Plan
5. Finding Solutions—Tidal Flow Control on the Halfway River and Flooding at Hantsport (2013)

Few of the emergency plans reviewed highlight distinct populations that may be particularly vulnerable in an emergency event, or where those populations are located. The practicality is that EPPs note the presence and location of institutions such as health care facilities or schools, and provide contact information for notification of events or evacuation. However, water utility contingency plans, notably the Davidson Lake Source Water Protection Plan, list neighbourhoods that are vulnerable in contamination events due to their proximity to the water body. Therefore, the EPPs were not particularly helpful in understanding who might be vulnerable during emergency events. The

Committee did not see this as a weakness of the EPPs, but instead a reflection of the complexity of determining who is 'susceptible' to what.

7. Economic Loss versus Opportunity

West Hants is economically diverse with not only a resource-based sector, but also retail, health, construction services, tourism, and finance rounding out the forms of wealth generation in the Municipality. Its strong economic interdependence with two of Nova Scotia's key economic growth centres—the Halifax Regional Municipality and the Annapolis Valley—offers both challenges and opportunities. Projected changes in climate may disadvantage some of West Hants' economic sectors yet bolster others. Unraveling climate change trends, within an economic context, has illuminated the need for intentional, regionally integrated economic decision-making that will sustain wealth creation into the future.

With a population just under 14,000, West Hants is one of four Municipalities that make up the larger region of Hants County with 42,000 people and the production of \$1 billion in goods and services annually (Community Counts). West Hants experienced population growth on par with the Provincial average of .6% between 2001-2006. Although an overall provincial decline is expected from 2012-2038 due to a number of factors including an aging population: 45% of the West Hants' population is over 44 years old (Municipal Climate Adaptation Case Study, 2006 data), West Hants "has continued to see new residential development and modest growth in population, unlike many other areas of Nova Scotia" (Municipal Climate Adaptation Case Study Report, 2013). West Hants is primarily rural with two urbanized "Growth Centres"—Three Mile Plains and Falmouth. Planning documents adopted in 2008 encourage the majority of growth to occur in these two Growth Centres, with "rural development to be focused in village and hamlet designations, while resource land, particularly agricultural land, is protected" (Municipal Climate Adaptation Case Study Report, 2013).

West Hants' economic breakdown by labor force participation is as follows: construction sector (13%), retail trade (11%), manufacturing (11%), health care and social services (10.2%), agriculture and other resource-based industries (7.4%), educational services (6.2%), wholesale trade (4.3%) and finance/real estate (3.5%) (Municipal Climate Adaptation Case Study Report, 2013). With 30% of these workers commuting to HRM, a key economic component in regards to

climate change is West Hants' position as an economic corridor (Municipal Climate Adaptation Case Study Report, 2013).

7.1 West Hants as a Corridor and "Gateway to the Valley"

When exploring economic realities and opportunities within West Hants, it is important to note that the boundaries between "local" and "regional" and "natural vs. economic" are not always easily definable and that present and future economic wealth is inextricably tied to the wider region. For example, the small population and its proximity to both HRM and the Annapolis Valley create an interesting economic scenario in which West Hants is closely tied to and in many ways dependent upon the economic vitality of its neighboring economies. Its "proximity to Halifax and the relatively lower cost of housing have contributed to the attractiveness of the area as a bedroom community for commuters who work in the Halifax Metro area" (Municipal Climate Adaptation Case Study Report, 2013). Conversely, West Hants is strategically important to key economic growth centres within the Province, providing not only a geographic corridor for the local, national, and international distribution of goods, but as a link in a chain of suppliers and manufacturers.

Highway 101 was twinned in 2010 and is the vital transport link from West Hants to HRM. Disruptions to the route caused by severe weather conditions could prove devastating to both the local and regional economy as the transport of goods and services grinds to a halt. Furthermore, 30% of West Hants' residents commute to HRM for work, thus further disruption could occur with the closure of the highway.

One option for building resiliency around road closures and delays is to collaborate closely with the Department of Transportation and Infrastructure Renewal and appropriate emergency professionals (e.g., RCMP, REMO) so that a joint effort can be made around clearing, managing, and communicating any future disruptions. Simply acknowledging the interdependent nature of West Hants' economy as it relates to West Hants' position as a transportation corridor is an important step in starting conversations that will build collaborative capacity for the region. As well, West Hants advocates that planning and design standards for infrastructure development, repair or upgrades are climate-wise, in other words, designed to accommodate an increase in intense short period rainfalls, more frequent storm surge flooding, and a potential for an increased number of ice events.

7.2 Climate Change Opportunities in Agriculture

A second important economic driver within the context of climate change is agriculture. There are 164 farms in West Hants, occupying approximately 11% of West Hants' land area, with gross farm receipts totaling \$17.5 million annually (Municipal Climate Adaptation Case Study Report, 2013). West Hants is home to Class 2 & 3 agricultural land. There is no Class 1 land in Nova Scotia, which is the highest quality arable land in the Province. As acknowledged in West Hants' planning documents, agricultural land is socially and economically significant and requires protection.

Not only is the protection of prime agricultural land, as it is known today, an important step in preparing for climate change, but the mapping of agricultural land with respect to coastal and inland flooding projections is critical in preserving land that will be most productive in the future. Using flood maps to make decisions about development patterns for the continued protection of agricultural land will help to ensure that West Hants' agricultural tradition will continue to thrive.

One of the biggest opportunities for potential growth within the context of climate change is in the agricultural sector. The climate indices of growing season length and freeze free season length (Table 23) indicate that the growing season will increase by one to two months by the end of the century (Richards and Daigle, 2013). Although there are predictions that an increase in pests may be a negative side effect of this warming trend, related changes in the freeze-thaw cycle may negatively affect the winter survival of some plants (e.g., strawberries) and increased extreme weather events, a longer growing season with rising temperatures could produce some positive economic outcomes like a higher variety of crops, an increase in high-heat crops, and an opportunity to grow cash crops (e.g. soy, corn). The most important effort the agricultural sector can make to position itself to capitalize on climate change opportunities is to enact wise water management. The projected increase in water deficit will need to be addressed through choices in crops, crop management, and watershed management informed by natural drainage patterns and capacity for retention and aquifer recharge.

Table 23 Richards and Daigle Climate Projections for Growing Season, the Kentville Climate Station

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Growing Degree Days >5	1906.3	2134.8	2406.8	2704.1

Growing Degree Days >10	1001.9	1169.3	1370.2	1589.7
Growing Season Length (days)	184.4	200.9	214.2	233.1
Corn Heat Units (CHU)	2318.9	2583.2	2878.8	3189.3
Corn Season Length (days)	152.9	165.0	173.9	188.2
Freeze Free Season (days)	180.6	201.5	217.9	233.0

A key adaptation option for determining how agricultural land could best be adapted to changing climate conditions is for West Hants to connect its agricultural constituents with organizations that are involved in climate change research, such as Perennia, a bio-food and agri-resource company, and the Faculty of Agriculture at Dalhousie University. West Hants can provide the communication component to making meaningful connections between the latest research and the 225 farm and livestock operators within West Hants by announcing workshops, public meetings, and providing contact information. Proactively harnessing the opportunities that could arise from changing weather patterns will not only ensure stability within the agricultural sector and secure the Province’s local food supply, but could increase economic prosperity for West Hants.

7.3 Climate Change Opportunities & Challenges to Municipal Operations

There are a handful of ways in which climate change may directly affect municipal operations: shifts in utility bills, additional challenges to managing water quality and quantity, influence on decisions pertaining to recreation, and influence on choices made in the maintenance and upkeep of municipally owned or maintained property.

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 24). 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) may offset financial savings from the winters.

Table 24 Richards and Daigle Climate Projections, Degree Days, for the Kentville Climate Station

Parameter	1980s	2020s	2050s	2080s
	Value	Value	Value	Value
Heating Degree Days	4163.1	3825.3	3466.7	3120.5

Cooling Degree Days	146.9	213.6	307.0	418.5
Hot Days (Tmax>30)	3.5	8.4	15.4	24.9
Very Hot Days (Tmax>35)	0.0	0.0	0.0	0.0
Cold Days (Tmax<-10)	1001.9	1169.3	1370.2	1589.7
Very Cold Days (Tmax<-20)	0.0	0.0	0.0	0.0
Freeze-Thaw Cycles-Annual	87.8	80.6	70.3	61.7
Freeze-Thaw Cycles-Winter	36.7	37.9	37.8	37.7
Freeze-Thaw Cycles-Spring	33.2	29.1	22.6	17.2
Freeze-Thaw Cycles-Summer	0.0	0.0	0.0	0.0
Freeze-Thaw Cycles-Fall	18.0	13.7	10.0	6.8

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 24); 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, potholes).

Table 25 Climate Challenges to Water Utilities. (US EPA, 2012)

Challenges by Group		Drinking Water	Wastewater
Drought	Reduced groundwater recharge	●	
	Lower lake / reservoir levels	●	
	Changes in seasonal runoff & loss of snowpack	●	
Water Quality Degradation	Low flow conditions & altered water supply		●
	Seawater intrusion into aquifers	●	
	Altered surface water quality	●	●
Floods	High flow events & flooding	●	●
	Flooding from coastal storm surges	●	●
Ecosystem Changes	Loss of coastal landforms/wetlands	●	●
	Increased fire risk & altered vegetation	●	●
Service	Volume & temperature	●	●

Demand & Use	challenges	●	●
	Changes in agricultural water demand	●	
	Changes in energy sector needs	●	
	Changes in energy needs of utilities	●	●

Climate Change will pose relatively new, but not unknown challenges to water utilities. The United States Environmental Protection Agency (EPA) created an Adaptation Strategies Guide for Water Utilities (2012) that summarizes the climate challenges as seen in Table 25. All of the challenges listed are of interest to West Hants. The Committee specifically discussed the challenges in the highlighted rows. The cost implications of addressing these challenges will vary based on level of efforts and costs required in implementation. The EPA document summarized relative costs of adaptation options as follows:

\$ Many utilities will try to cope with change by assessing their options to expand operational flexibility to meet the changed operating parameters driven by the climate threat. Costs associated with adaptation options may be minimal.

\$\$ Some systems can operate beyond design or current capacity without making large changes to the system. Operations and maintenance costs may increase, but would remain less costly than making infrastructure changes.

\$\$\$ After the existing system has reached the limit of its capacity to absorb climate impacts, it becomes necessary to augment or optimize capacity through adoption of new practices and resources. This typically involves a higher level of capital investment.

At present, flooding and heavy rainfalls are key causes of water quality contamination in West Hants. These weather events can, fortunately, be addressed through planning strategies and operational changes (Table 26). Should adaptation options in these categories not be implemented, it is likely West Hants will inevitably face the need to invest in high-cost capital/infrastructure strategies.

Table 26 Categories of Adaptation Options (US EPA, 2013)

Categories of Adaptation Options	
Planning Strategies	include use of models, research, training, supply and demand planning, natural resource management, land use planning, and collaboration at watershed and community scales
Operational Strategies	include efficiency improvements, monitoring, inspections, conservation, demand management, flexible operations, and sustainable strategies
Capital / Infrastructure Strategies	include construction, water resource diversification, repairs and retrofits, upgrades, phased construction, new technology adoption, and green infrastructure

Trends for an increased length of the growing season and freeze free season may influence (increase) the number of user-days and maintenance requirements of parks, playing fields and other outdoor recreation facilities. Unfortunately, this shift in winter conditions will negatively affect winter recreational activities reliant on snow. Area businesses (e.g., Martock Ski Hill) will face increasingly challenging conditions.

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 used a determinant of appropriate plant varieties for a given area. A shift in the growing degree days within West Hants will factor into choices about what is financially and ecologically appropriate to plant. Landscaping and maintenance choices should also take into consideration increased water deficits and fire risk. Prudent property maintenance should, by design, require little to zero irrigation. To manage fire risk, the location of plantings, stand thinning, and choices about *what* to plant are all critical. The Alberta Fire Smart program details guidelines for managing fire risk that could easily be employed by West Hants.

8. Environmental Considerations

8.1 Natural Stresses on Natural Systems

The pastoral nature of West Hants is its defining character. Residents value West Hants' arable land, coastline, and lakes and rivers. Past weather events have posed minor environmental problems in the past. Notably, weather events such as heavy rainfalls or storms causing surge have altered the quality of freshwater habitats, to the extent that opportunities for recreational fishing have diminished over time. As well, it is believed that saltwater marshes have also diminished in some locations. Storms and sea level rise may have played a part in this, along with development that impinges on the wetlands ability to migrate. The ACAS report, *Best Practices for Climate Change Adaptation in Dykelands*, suggests that saltmarshes with less than 80m of foreshore be considered for realignment. A minimum of 100m of foreshore is recommended.

Within West Hants, the effects of habitat loss on flora and fauna are a concern, as is the case all over the province. Climate stresses such as shifts in temperature, too much or too little water, and increased ranges of insects all play a part in exacerbating the stress plants and animals are under. For this reason, West Hants will remain attentive to sensitive habitats, ecosystems, wildlife and endangered species. A provincial map identifying significant areas for wildlife is found in Appendix F. As well, the municipality will assist the Province, however practical and possible, in the protection of Parks, Protected Areas and Sites of Ecological Interest including:

- Panuke Lake Nature Reserve: 150.9 ha (373 ac) including 47 ha (116 ac) of old growth eastern hemlock-red spruce forest
- St. Croix River International Biological Program Site: mixed forest on karst topography; rare flora including Ram's-head Lady Slipper (species listed as Endangered in the Nova Scotia Species at Risk Act).
- Akin Marsh: Eastern Habitat Joint Venture Site, Mount Denson.
- Falls Lake Provincial Park: 4.86 ha (12 ac) on Falls Lake, Vaughan.
- Smiley's Provincial Park: 40.47 ha (100 ac) on Meander River, McKay Section.
- Cheverie Creek Salt Marsh Restoration Project: Highway 215, Cheverie

Additionally, West Hants will strive to maintain natural drainage, material and nutrient flows in the parks maintained by the municipality, which are:

- St. Croix Recreation Site
- Eldridge Road Recreation Site
- Irishman's Road Recreation Site
- Halewood Drive (small parcel of parkland)
- Falmouth Mini Park
- Armstrong Lake (small parcel of parkland)
- Quarry Pond Recreation Site
- Hobarts Recreation Site

8.2 Unnatural Stresses on Natural Systems

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."

As discussed in section 4.9, the release of hazardous substances is an omnipresent concern, potentially made more probable by extreme weather events. West Hants acknowledges that there is only anecdotal understanding of where hazardous materials are kept, and this information is not mapped. It is also understood that nearly every single household has substances listed in Schedule A of Nova Scotia's Environmental Emergency Regulations. Therefore, at this time the Committee aims to support the efforts of local fire districts and other emergency personnel in efforts to ensure there are appropriate response procedures in place until fully equipped and trained hazardous material teams arrive on the scene of an incident.

9. Priorities for Adaptation

9.1 Hazard and Impact Priorities

The natural hazard analysis done for MCCAP development revealed that the natural hazards most warranting municipal attention and adaptive action in the near-term (prior to 2055) are coastal flooding, inland flooding, and drought.

As described in section four, Analysis of Hazards and Impacts, 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. For these reasons, coastal flooding, inland flooding and drought are considered high priority hazards (Table 27).

Although coastal and inland flooding and drought are recognized as priorities because of their associated severity of impacts and probability of occurrence, 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.

Table 27 Level of priority for hazards and impacts

HIGH RISK	
Hazard	Impact
Drought	Water supply: quantity & quality
Drought	Increased solubility of metals in the environment (e.g., arsenic)
Inland Flooding	Risk to Public Safety (but an increased risk in terms of Emergency mgt's time to respond)
Inland Flooding	Dyke or Dam Breach
Coastal Flooding	Risks to Public Safety: life & safety
Coastal Flooding	Damage to Infrastructure
Coastal Flooding	Dyke Breach
MODERATE RISK	
Hazard	Impact
Extreme heat	Water Production: If capacity impacted, potential water restrictions
Drought	Crop / farm damage
Wildland Fire	Risks to public safety: life & safety
Wildland Fire	Displacement of Residents due to Property Damage/threat
Wildland Fire	Power Utility Disruption
Wildland Fire	Water Utility Disruption
Wildland Fire	Transportation Disruption: roads and bridges
Tropical Storm	Risk to Public Safety: felled trees
Tropical Storm	Crop/farm damage
Winter Storm	Power Utility Disruption: Heating demand
Winter Storm	Infrastructure Damage
Winter Storm	Transportation: risk to public safety

Inland Flooding	Transportation Disruption
Coastal Flooding	Displacement of residents due to property damage
Coastal Flooding	Road/bridge Erosion
LOW RISK	
Hazard	Impact
Extreme heat	Power: Municipal Cooling Demand
Drought	Pest infestation/ wildlife disease-economic
Drought	Increase in sinkholes
Wildland Fire	Crop/farm damage
Wildland Fire	Long-term environmental damage: e.g., effect on water table, and socially valued trails/places
Tropical Storm	Community Lifeline Damage
Inland Flooding	Displacement of Residents due to Property Damage
Inland Flooding	Environmental contamination of drainage corridors in situation of sewage treatment plant overflow
Inland Flooding	Crop/farm damage
Inland Flooding	Community Lifeline Damage (access to hospital)
Inland Flooding	Flood-induced sedimentation problems in rivers and estuaries: reduction of holding capacity & increased flood potential
Inland Flooding	Cyanobacteria blooms
Coastal Flooding	Economic impacts (loss of farmland; business disruption)
Coastal Erosion	Displacement of Residents due to Property Damage
Coastal Erosion	Infrastructure Damage / transportation disruption
Tropical Storm	Power Utility Disruption: resident power and sewage pumping station
UNKNOWN RISK	
Hazard	Impact
Extreme heat	Cyanobacteria blooms
Tropical Storm	Transportation Disruption
Tropical Storm	Municipal infrastructure Damage

9.2 Adaptive Actions Underway

West Hants has undertaken five specific actions that will help the municipality adapt to changing climate conditions and extreme

weather events. First, West Hants has severely restricted development on dykelands since 2001. This measure helps to mitigate coastal flood impacts. Lynn Davis, Planning Director for West Hants explained in the Municipal Climate Adaptation Case Study Report (2013) that:

The continuation of the historical development pattern—with roads and buildings following the Minas Basin coastline and the tidal rivers—means that a considerable amount of infrastructure is exposed to potential flooding as a result of sea level rise. To some extent, though, West Hants has been able to avoid the sort of large-scale residential and commercial development on dykeland that has taken place in other parts of Nova Scotia. This is in part related to the historical value of this land for agriculture and its ongoing use for crop production. In the late 1990s, however, with development pressure growing, some dykeland began to be converted to residential use. To counteract this trend, in March 2001, Municipal Council approved changes to the planning documents that prohibited the construction of new main buildings on this land. As a result, no development has occurred on dykeland since that time. Of the 2,436 ha (6,000 ac) of dykeland in West Hants, only about 64 ha (based on GIS calculation of the area that has received a variance or been exempted from the development provisions of the Agricultural Marshland Conservation Act) has been used for non-farm development. Development has taken place, however, close to the identified boundaries of the dykelands, making that development also vulnerable to flooding as a result of sea level rise or storm surge. In addition, dykeland flooding outside the municipal boundaries has the potential to affect West Hants residents, many of whom rely on facilities and services in the neighbouring town of Windsor. Of particular concern is the potential for road access to the hospital and high school to be cut off in the event of severe flooding.

Secondly, agricultural land in West Hants has received a relatively high level of protection, recognizing that arable land is an invaluable asset to future food security and municipal resilience. Protection of

agricultural land has a great deal of support from West Hants residents. Planner Jeanne Bourque explains that, “there is no Class 1 soil in West Hants, and quite a lot of class 2 and 3, which has high potential for agricultural production. After the Prime Agriculture zone, the second most controlled category of agricultural lands (in West Hants) is AR-2, and for the most part, that zoning has been applied to active farms as well as districts where Class 2 and 3 soils are. AR-3 is the zone used in areas where there are Class 2 and 3 soils, but where growth is expected, such as the Growth Centres and Hamlets such as Ardoise” (personal communication, Jeanne Bourque, 2013).

Third, the preparation of a Stormwater Master Plan is currently in the West Hants’ capital budget. The completion of this plan is necessary to address drainage bottlenecks in growth centres. Support for the plans completion is listed as an MCCAP action item because it became apparent in the MCCAP process that there needs to be an explicit requirement that the Plan incorporate climate projections for increased rainfall intensities.

Fourth, as part of the MCCAP process, West Hants coordinated with Professional Geoscientist, Philip Finck, to do a ‘phase one’ assessment of coastal erosion. Having taken this initiative, West Hants is now in a position to incorporate coastal erosion risk into the upcoming review of the Municipal Planning Strategy.

Fifth, Council and staff have recognized the importance of continuing the Climate Change Committee into 2014 to ensure and guide implementation of the action items put forth in this MCCAP. They will further refine the action ideas and assign a timeline for the completion.

9.3 Adaptive Actions Under Consideration

As explained in section 3.2, Bridging Impacts to Implementation, West Hants ranked impacts and actions. This was completed in order to position the municipality for successful mitigation of unwanted climate change impacts, as well as a strengthening of community resilience.

It is important to remember that the prioritization process used to evaluate action items (explained in Section 3.2) represents a marriage between the significance of the impact and the nature of the effort municipal staff would have to invest to achieve the actions intent. For example, if the effort falls outside the normal scope of familiar activity, accessible capital or existing skill sets, but achieving the action would substantially lessen the municipality’s risk, then the action is a high

priority. Comparatively, if it would be rather straightforward for municipal staff to achieve the actions intent but the action itself did not reduce the threat, the actions priority ranking is going to be low.

In many cases, there are action ideas that provide an appropriate response to an impact once the threat/hazard is experienced. These are completely legitimate actions to include in the MCCAP because they are important to the municipality's ability to respond to or recover from an event. In essence, their institution contributes to the municipality's resilience. However, these actions were ranked low priorities because they do not prevent damage or harm from happening. Therefore, it is important to remember that low priority does not mean low importance.

During the process of generating potential action ideas, ideas came forth that were not hazard-specific, but instead fell within two overarching themes:

- ideas to strengthen emergency preparedness and response, and
- efforts to improve organizational adaptive capacity.

Therefore, in addition to action ideas for specific natural hazards, action ideas are also presented for these two themes.

Table 28 Action Items to Address Emergency Preparedness and Response

High Priority Action Item
Update REMO's Emergency Preparedness Plan, and in doing so include consideration of all hazards identified in the MCCAP.
*Build mapping capabilities (staff and technology) and create redundancy for Emergency Preparedness Planning and use in the Emergency Operations Centre (EOC) in collaboration with all REMO members.
Collaborate with REMO members to provide a computer with appropriate mapping software in the EOC and alternate EOC with access to appropriate municipal databases/GIS data and a plotter.
Medium Priority Action Item
Pursue funding for a summer student from COGs to update mapping that relates to REMO emergency preparedness planning.
Low Priority Action Item
Make available in municipal buildings and other frequently visited locations, provincial and/or federal Emergency Preparedness Guides.
Visit with HAM radio operators to provide information on natural hazards in

the context of changing climate conditions, and discuss their potential contribution during times of extreme weather events, as well as the need for their help to build a historical record of local weather events.

*There is currently only one person available for mapping within REMO and this person is not sufficiently trained to use the municipality’s mapping software. This person and an alternate both need to be trained to use the mapping software for real-time applications.

Table 29 Action Items to Improve Organizational Adaptive Capacity

High Priority Action Item
none
Medium Priority Action Item
*Participate in the Nova Scotia Geomatics Centre large-scale mapping program to get LiDAR data for that portion of the municipality for which LiDAR is currently not available.
Revisit natural hazard analysis in the context of changing climate conditions in 2020, drawing from updated municipal efforts in watershed planning, potential new mapping capacities (e.g., additional LiDAR data) and updated findings regarding sea level rise, shifts in return period storms, Bay of Fundy tidal levels, projections for precipitation, provincial information/mapping resources for groundwater quantity and quality, etc.
Low Priority Action Item
Meet with Town of Windsor and Town of Hantsport to compare MCCAP action items and identify areas for collaboration.

*Would provide needed data for watershed mapping that would enhance inland flood mitigation efforts. Also would help identify areas of karst terrain. The deliverables are: digital orthophotography mosaics, 2metre contour, LiDAR LAS files (all hits and bare earth classification), bare earth digital elevation mapping, and an annotation data set. The deliverables are clipped into 1:2000 sheet tiles. As of August 2013, the cost is \$1,500 per map tile and is split 50/50 so the cost to the municipality would be \$750.

It is safe to say that all action items listed in the MCCAP are important, for each action item presented survived critical discussions about its appropriateness to the municipality’s circumstance.

In total, the MCCAP identifies 47 potential action items. Twenty actions were ranked as high priorities in both value and capacity to implement. Twelve were identified as medium priority actions. Fifteen were listed as lower priority actions indicating that while it may be straightforward for municipal staff to achieve the action’s intent, the action itself does not reduce the threat.

There are no action ideas presented for the hazards of tropical storms / hurricanes, and winter storms / ice events. This is not an oversight. There are multiple reasons initial action ideas did not 'make the cut'; for example, a total absence of jurisdictional control, negligible threat reduction potential, or if the action(s) was a shift in operations that would happen automatically within current operating procedures.

As stated in the MCCAP Guidebook, there are three key areas of municipal influence where adaptation can begin (2012):

- a) Licensing and Regulation – Municipalities can use their powers to set the local regulatory environment in conjunction with their ability to enforce regulations, to implement and enforce adaptive policies.
- b) Facilitation, Advocacy, Leadership and Public Education – Municipalities can use their close contact and relationship with community organizations, businesses, residents and other stakeholders at the local level to develop a shared understanding of the issues and to develop collaborative responses to climate change.
- c) Service Delivery, Community Development and Civic Engagement – Many of the services provided by municipalities for businesses and residents can be reviewed in light of adaptive climate change initiatives.

For each action idea listed in Tables 20-22, there is indication of whether or not it intends to provide information or a deeper analysis of a hazard, or province influence in the key areas listed above.

9.3.1 High Priority Adaptation Actions

Table 30 High Priority Adaptation Actions

	High Priority Action Items	Hazard / Theme Area	Lead Dept./Agency	Area of Influence
1	Support the completion of the drought impacts analysis and public works preparedness plan.	Drought	REMO	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
2	When undertaking the MPS review, incorporate integrated water resource management concepts/approach.	Drought	Planning	Information for Deeper Analysis; Planning, licensing and regulation
3	Partner with local industry, stakeholders and DNR to acquire mapping of karst terrain to build knowledge about sinkhole susceptibility.	Drought	Planning	Information for Deeper Analysis; Planning, licensing and regulation
4	During the MPS review, consider creating a policy to regulate the development of municipal infrastructure and facilities in areas known to be highly susceptible to	Drought	Public Works	Planning, licensing and regulation; Service Delivery,

	sinkholes.			Community Development and Civic Engagement
5	Assess preparedness for emergency response for inland flooding.	Inland Flooding	REMO	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
6	Assess if existing land use policies and development controls adequately protect wetlands and watercourses during MPS review (e.g., require retention of vegetation along watercourses, institute 'buffers' for <i>all</i> development types).	Inland Flooding	Planning	Planning, licensing and regulation
7	Identify and map surface water systems in each watershed (watercourses, ponds, lakes, wetlands) in order to ensure these systems hold (store) water and drain it in natural and logical ways with topography.	Inland Flooding	Planning	Information for Deeper Analysis; Planning, licensing and regulation
8	Complete a Stormwater Master Plan and ensure the plan assesses the effects of climate change on rainfall intensity and presents a solution to the drainage bottlenecks in growth	Inland Flooding	Public Works	Information for Deeper Analysis; Service Delivery,

	centres.			Community Development and Civic Engagement
9	Initiate discussions with Department of Agriculture to identify and address changes in aboiteaux heights, mechanisms or maintenance that would mitigate inland flooding.	Inland Flooding	Council and Planning	Information for Deeper Analysis
10	Partner with the Maritime Spatial Research Analysis Centre to complete a hydrodynamic model of flood risk for developed areas in and surrounding Elderkin Marsh.	Inland Flooding	Planning or Public Works	Information for Deeper Analysis
11	During MPS review, evaluate watercourse setbacks to ensure setbacks accommodate inland flood risk as it is understood given increased precipitation trends.	Inland Flooding	Planning	Planning, licensing and regulation
12	Assess preparedness for emergency response for coastal flooding.	Coastal Flooding	REMO	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
13	Establish a REMO protocol that uses 11m CGVD28 to the high tide line as the area indicating high risk vulnerability during a tropical storm /	Coastal Flooding	REMO	Service Delivery, Community Development

	hurricane with an annual exceedance probability of 1% or less (i.e., a 100 year return period storm).			and Civic Engagement
14	During the MPS review, investigate the implications of applying land use planning regulations (e.g., site controls) to require flood proofing for new coastal developments between 10m CGVD28 to the water line.	Coastal Flooding	Planning	Planning, licensing and regulation
15	During the MPS review, investigate amending Schedule A of the Land Use By-Law to incorporate the new recommended Marsh Boundaries as provided by the Maritime Spatial Research Analysis Centre.	Coastal Flooding	Planning	Planning, licensing and regulation
16	In partnership with the Maritime Spatial Research Analysis Centre, determine which salt marshes and dyke segments (if any) are candidates for realignment. As well, determine if the foreshore side of the dyke should be armoured.	Coastal Flooding	Planning / Council	Information for Deeper Analysis
17	Establish a policy that municipal infrastructure susceptible to flood risk given the Plausible Upper Bound water level scenario as provided in the Williams and Daigle report, be flood proofed (e.g., utilities located at or below the worst case flood elevation line).	Coastal Flooding	Planning / Public Works	Planning, licensing and regulation
18	Update REMO's Emergency Preparedness Plan, and in doing so	Emergency Preparedness	REMO	Information for Deeper

	include consideration of all hazards identified in the MCCAP.	and Response		Analysis; Service Delivery, Community Development and Civic Engagement
19	Build mapping capabilities (staff and technology) and create redundancy for Emergency Preparedness Planning and use in the Emergency Operations Centre (EOC) in collaboration with all REMO members.	Emergency Preparedness and Response	REMO	Service Delivery, Community Development and Civic Engagement
20	Collaborate with REMO members to provide a computer with appropriate mapping software in the EOC and alternate EOC with access to appropriate municipal databases/GIS data and a plotter.	Emergency Preparedness and Response	REMO	Service Delivery, Community Development and Civic Engagement

9.3.2 Medium Priority Adaptation Actions

Table 31 Medium Priority Adaptation Actions

	Medium Priority Action Items	Hazard / Theme Area	Lead Dept./Agency	Area of Influence
1	During the MPS review, consider drafting a Water Conservation By-law that allows for a conservation order restricting water use on the public works water system, depending on withdrawal amounts and recharge rates.	Drought	Public Works	Service delivery, community development and civic engagement
2	* Investigate how to make well water testing as accessible / convenient as possible for citizens in coordination with a local company located in the Windsor/West Hants Industrial Park.	Drought	Planning (or REMO)	Facilitation, advocacy, leadership, public education
3	Investigate the implications of instituting an increasing block rate to consumption rates for water charges.	Drought	Public Works	Service delivery, community development and civic engagement
4	Provide information and/or a public education campaign targeted to private citizens and/or citizen organizations about fuel loading and landscape-level fire risk.	Wildland Fire	Planning	Facilitation, advocacy, leadership, public education
5	Work with DNR to improve communications and understanding	Wildland Fire	REMO	Facilitation, advocacy,

	about local fire risk.			leadership, public education
6	Determine how to efficiently make available to citizens investigating the development of a coastal property a one/two page brief describing what is understood about risk of overland flooding.	Coastal Flooding	Planning	Facilitation, advocacy, leadership, public education
7	Seek a partnership with the Halifax office of the Insurance Bureau of Canada on a public campaign to inform residents about what flood insurance does and does not cover, and how that relates to eligibility for Disaster Financial Assistance.	Coastal Flooding	Planning	Facilitation, advocacy, leadership, public education
8	Establish a joint municipal and REMO protocol to conduct post-storm analysis using a template provided by NS EMO and the Atlantic Storm Prediction Centre, and have REMO keep one copy for their records and send one copy to the Atlantic Storm Prediction Centre care of the Weather Preparedness Meteorologist.	Coastal Flooding	REMO	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
9	During the MPS review, assess the implications of requiring coastal erosion site assessments for development approvals in areas highly susceptible to erosion.	Coastal Erosion	Planning	Planning, Licensing & Regulation
10	Pursue funding for a summer student from COGs to create and/or update REMO related geographic data needs	Emergency Preparedness and Response	REMO	Information for Deeper Analysis;

	and mapping, including the creation of a map with essential infrastructure and comfort stations.			Service Delivery, Community Development and Civic Engagement
11	*Participate in the Nova Scotia Geomatics Centre large-scale mapping program to get LiDAR data for that portion of the municipality for which LiDAR is currently not available.	Organizational Adaptive Capacity	Planning	Information for Deeper Analysis
12	Revisit natural hazard analysis in the context of changing climate conditions in 2020, drawing from updated municipal efforts in watershed planning, potential new mapping capacities (e.g., additional LiDAR data) and updated findings regarding sea level rise, shifts in return period storms, Bay of Fundy tidal levels, projections for precipitation, provincial information/mapping resources for groundwater quantity and quality, etc.	Organizational Adaptive Capacity	Planning & Council	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement

9.3.3 Low Priority Adaptation Actions

Table 32 Low Priority Adaptation Actions

	Low Priority Action Items	Hazard / Theme Area	Lead Dept./Agency	Area of Influence
1	Assess preparedness for Emergency Response to drought	Drought	REMO	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
2	Explore partnerships to disseminate an education and engagement program about water conservation.	Drought	Planning or Public Works	Facilitation, advocacy, leadership, public education
3	Introduce a fire risk reduction program for municipally owned property (e.g. plant only low fire risk species).	Wildland Fire	Planning / Council	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
4	Invite local stakeholders to a seminar to communicate what is understood about flood risk.	Coastal Flooding	Planning	Facilitation, advocacy, leadership, public education

5	Determine how to efficiently make available to coastal dwelling citizens, and people investigating the purchase of a coastal property a one/two page brief describing what is understood about susceptibility to coastal erosion.	Coastal Erosion	Planning	Facilitation, advocacy, leadership, public education
6	Work with a coastal geomorphologist or geoscientist to develop a coastal erosion informational sheet in collaboration with municipal staff.	Coastal Erosion	Planning	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
7	Distribute a coastal erosion informational sheet with building permit applications for properties that include shoreline.	Coastal Erosion	Planning	Facilitation, advocacy, leadership, public education
8	Post a coastal erosion information sheet on the municipal website.	Coastal Erosion	Planning	Facilitation, advocacy, leadership, public education
9	Organize and host a seminar on armouring the coast, targeted to those employed in this work, and property owners who have, or are considering armouring as a coastal protection option.	Coastal Erosion	Planning	Facilitation, advocacy, leadership, public education
10	Request that TIR address erosion at Cheverie causeway.	Coastal Erosion	Council	Information for Deeper

				Analysis; Service Delivery, Community Development and Civic Engagement
11	Assess preparedness for emergency response to extreme heat events.	Extreme Heat Events	REMO	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement
12	Consider creating a policy addressing the safety of municipally coordinated outdoor recreation events during hot and very hot days, defined as days that are 30°C and 35°C days respectively.	Extreme Heat Events	Recreation	Facilitation, advocacy, leadership, public education
13	Make available in municipal buildings and other frequently visited locations, provincial and/or federal Emergency Preparedness Guides.	Emergency Preparedness and Response	REMO	Facilitation, advocacy, leadership, public education
14	Visit with HAM radio operators to provide information on natural hazards in the context of changing climate conditions, and discuss their potential contribution during times of extreme weather events, as well as	Emergency Preparedness and Response	REMO	Facilitation, advocacy, leadership, public education

	the need for their help to build a historical record of local weather events.			
15	Meet with Town of Windsor and Town of Hantsport to compare MCCAP action items and identify areas for collaboration.	Organizational Adaptive Capacity	Planning & Council	Information for Deeper Analysis; Service Delivery, Community Development and Civic Engagement

10. Mitigating Greenhouse Gas Emissions

10.1 Energy and Emissions Information

West Hants has been tracking GHG emissions using the Union of Nova Scotia Municipalities spreadsheet since 2008-2009 fiscal year. The waste numbers being tracked represents community waste (sourced from residential, commercial, institutional and construction) disposed at the West Hants WM Landfill and not corporate waste, which would include only waste generated by municipal operations. As a result, the GHG emissions reported are significantly higher than would be expected for a municipality of this size under the UNSM/Stantec approach. However, because West Hants has been tracking emissions for a period of time using the same method, it is reasonable to maintain this approach. The first year of data is 2008-2009 and this has been treated as the baseline year. Note that updated emissions factors were used to calculate the 2012-2013 totals. See Appendix G for details.

The Partners for Climate Protection recommends that municipalities include GHG emissions from community waste if they operate or have substantial control over the landfill facility (See: Partners for Climate Protection. *Achieving Milestone 1: Technical guidance for BC Local Governments. Federation of Canadian Municipalities*). West Hants does not own the facility but is engaged in a lease to own arrangement.

Table 33 Historical GHG emissions

	West Hants GHG emissions (tCO ₂ e)				
	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013 ¹
Buildings	624	697	909	854	878
Vehicle fleet	37	34	31	31	34
Street and area lights	8	9	9	9	8
Water and sewer	204	197	178	186	148
Community waste	1,920	1,968	1,866	1,762	1,231
Total	2,793	2,905	2,992	2,842	2,299
% change over 2008-2009	100%	104%	107%	102%	82%

Overall GHG emissions increased between 2008 and 2011 before curving downwards between 2011 and 2013. Overall reduction of GHG emissions in 2012-2013 was an 18% reduction over 2008-2009. The reduction was due to a significant decrease in solid waste (45%) over 2008-2009. The reason for the decrease is a policy change that required all waste go into clear bags, resulting in a significant increase in amount of recyclable material collected. Emissions from buildings have climbed 41% over 2008-2009 and increased by 2.8% over 2011-2012; the major increase was likely due to the addition of Brooklyn Firehall and an increased heating load due to a colder winter and/or an improper setting of the geothermal system in the Municipal Office. Emissions from water and sewer decreased by 27% over 2008-2009, but increased in 2011-2012 due to the upgrade and expansion of the Falmouth sewer treatment plant. Emissions from vehicles and streetlights were relatively constant over the comparison period.

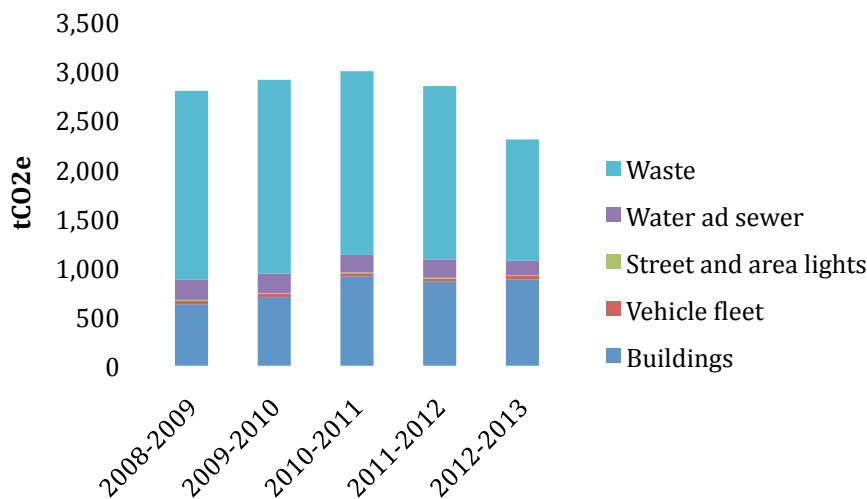


Figure 9 Municipality of West Hants of West Hants (2013). West Hants Municipal Energy Emissions for 2012-2013.

The emissions factor for electricity has been falling in Nova Scotia since 2007 as more and more renewable energy comes online (Environment Canada, 2013). This means that while electricity consumption may remain constant or increase, GHG emissions still fall (Figure 10).

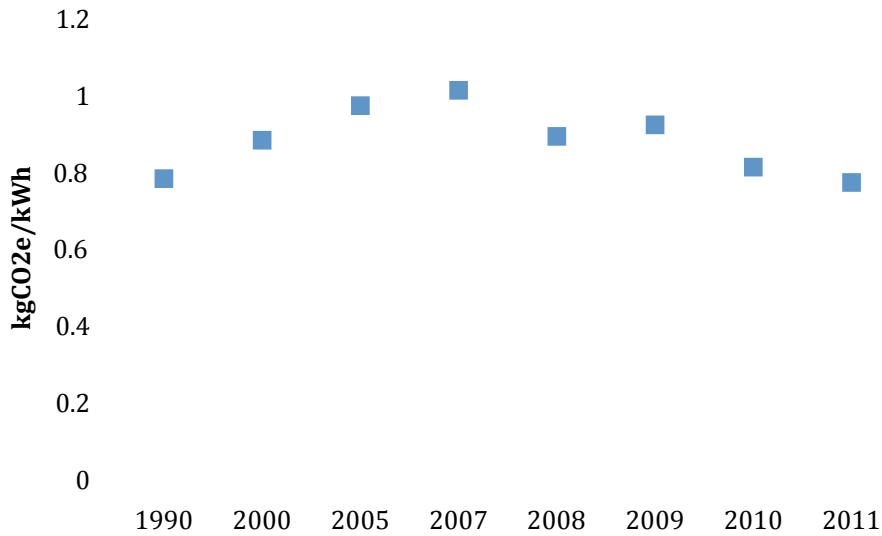


Figure 10 Emissions factor for electricity generation, Nova Scotia

Based on 2012-2013 data, two buildings account for 60% of the building-related energy consumption, the Water Plant (27%) and the Falmouth Sewer Treatment Plant (33%). The Brooklyn Fire Station and the Municipal building represent 18% and 17% of the energy consumption respectively, with the remaining two buildings, the Courthouse and Recreation Centres accounting for 3%.

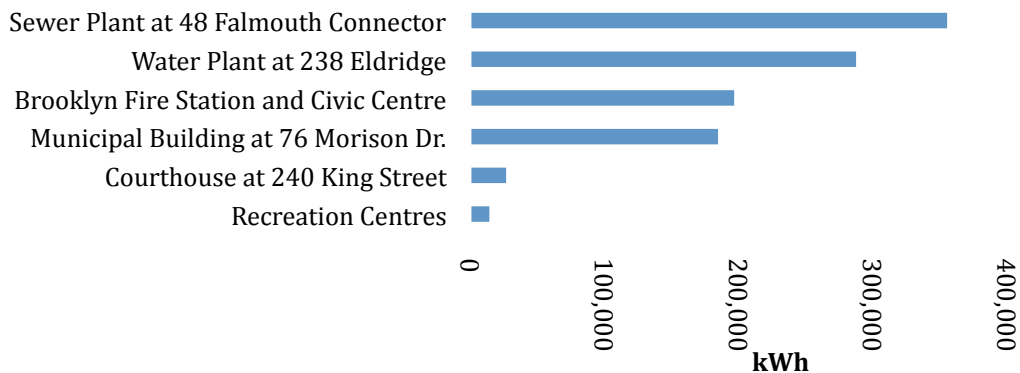


Figure 11 West Hants Building energy Consumption 2012-2013

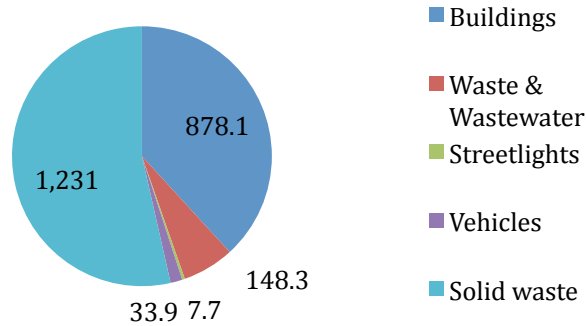
10.2 Energy and Emissions Inventory Table

The UNSM Corporate Energy and Emissions Spreadsheet was completed by the Municipality of West Hants for 2012-2013. Based on this data, the Energy and Emissions Summary Inventory Table was completed (Table 34). Note that some modifications were made to reflect updates to emissions factors not captured by the UNSM spreadsheet.

Table 34 Energy and Emissions Summary Inventory - 2012-2013

Emissions Category	Energy type	Energy consumption	Units	GJ	Cost (\$)	Emissions factor	Unit	Emissions (tCO2e)
Buildings	Electricity	1,060,234	kWh	3,817	\$97,252	0.770	kgCO2e/kWh	816.4
	Fuel Oil	22,091	L	857	\$21,540	67.7	kgCO2e/GJ	58.0
	Diesel	1,381	L	53	\$1,289	70.0	kgCO2e/GJ	3.7
Waste & Wastewater	Electricity	192,597	kWh	693	\$20,009	0.8	kgCO2e/kWh	148.3
Streetlights	Electricity	10,053	kWh	36	\$2,166	0.8	kgCO2e/kWh	7.7
Vehicles	Gasoline	14,054	L	492	\$16,074	2.4	kgCO2e/L	33.2
	Diesel	267	L	10	\$307	2.7	kgCO2e/L	0.7
Community solid waste	Waste	2,556	T	0	\$-	0.4817	tCO2e/t waste	1,231
Total					\$158,638			2299.0

Figure XX: West Hants Municipal Operations- GHG emissions- 2012-13



The majority of the emissions are derived from community waste and buildings, 53% and 28%, respectively. If the focus were on corporate waste, the vast majority of emissions would be derived from buildings.

Total energy costs were approximately \$158,000, or just over 1% of the annual budget of West Hants. While this is not a significant cost for the municipality it does represent an outflow of dollars from the community and any additional opportunities for savings will accumulate over time.

10.3 Emission Reduction Projects To Date

The Municipality of West Hants has undertaken a number of actions to reduce GHG emissions including energy audits, the incorporation of energy savings measures into Brooklyn Fire Station and energy efficiency improvements of the Municipal Office Building. When the Falmouth sewer treatment plant was recently upgraded and expanded, variable frequency drives were added on motors at the plant to ensure that the pumps could adjust the power required according to the size of the load, an energy saving measure.

10.4 Emission Reduction Projects Under Consideration

10.4.1 Corporate Climate Action Policy Statement

As an MCCAP action item that addresses the reduction of GHG emissions, West Hants will consider adopting a policy statement that signals the intent to continue reducing energy consumption and GHG emissions. A draft Corporate Climate Action Policy Statement is:

The Municipality of West Hants will conduct its operations with the objectives of:

- a) improving energy efficiency,
- b) maintaining fiscally responsible operations,
- c) contributing to the growth of a local green economy, and
- d) continually reducing GHG emissions.

10.4.2 Targets for GHG Emission Reductions

Table 35 Sample Targets

Target	Organization
33% reduction over 2007 by 2020; 80% reduction over 2007 by 2050	Government of BC
10% below 1990 levels by 2020	Government of Nova Scotia
6% below 1990 levels by 2014; 15% below 1990 levels by 2020; and 80% below 1990 levels by 2050.	Government of Ontario
20% below 2002 levels by 2012 (not achieved)	Halifax
15% by 2020 over 2007 levels	Town of Shelburne
17% by 2020 over 2007	Town of Lockeport
20% by 2020 over 2007	Municipality of Shelburne
50% to 80% by 2050 over 2000	Intergovernmental Panel on Climate Change

The following considerations are important in establishing a GHG target for a community:

- rate of population growth or decline as this is an indication as to whether or not community services will be expanding or contracting
- future infrastructure plans such as the replacement of aging buildings or equipment or the provision of additional infrastructure
- targets established by peers (similar-sized communities)
- targets recommended by scientists to stabilize the climate at a safe level
- capacity of the community to make financial investments in energy efficiency and low carbon projects, and
- level of community support.

Given that Nova Scotia is committed to reducing the GHG emissions associated with electricity and West Hants achieved a reduction of 18% over 2008-2009 in 2012-2013, West Hants is considering the following targets:

>30% reduction over 2008-2009 baseline year by 2020.

>45% reduction over 2008-2009 baseline year by 2030.

The basis for the target is described in Table 36.

Table 36 Targeted GHG reductions by 2030 over 2008.

Action	2020		2030	
	% change	GHG reduction (tCo2e)	% reduction	GHG reduction (tCo2e)
Eliminate diesel and fuel oil in buildings	100% reduction	-62	100% reduction	-62
Emissions factor improvements in electricity generation	15% cleaner	-141	30% cleaner	-291
Building efficiency improvements	10% energy savings	-70	20% energy savings	-114
Improved efficiency of pumps for water and wastewater	10% energy savings	-25	20% energy savings	-30
Reductions from fuel efficiency/electric vehicles	10% energy savings	-3	20% energy savings	-7
Reductions from reduced waste production	27% waste reduction over 2008	-537	40% waste reduction over 2008	-762
Total reduction		-838		-1,266
Total emissions in 2030		1,955		1,527
Total savings over base year: 2008-2009		30%		45%
Total savings over last year: 2011-2012		15%		34%

10.4.3 Actions to Achieve Emission Reduction Targets

Activities have been identified that set West Hants on the course to achieving these emission reduction targets. Note that these actions alone are not likely to be enough but they do provide the foundation.

Table 37 Proposed Emission Reduction Actions

#	Action	Justification	Priority	Cost implications	Category
1	Join Federation of Canadian Municipalities' Partners for Climate Protection'.	Partners for Climate Protection (PCP) is a peer to peer program that provides a framework and support. (Note that this report qualifies for 3 of 5 milestones on the corporate side of the PCP program).	High	No cost.	Corporate leadership
2	Coordinate a staff education day on climate action.	Staff can become community ambassadors on emissions reduction.	High	\$1,000 for a facilitator.	Energy
3	Create a revolving loan fund to finance energy efficiency.	Revolving loan funds continuously recycle savings into new efficiency projects.	High	Staff time to design the fund.	Corporate leadership
4	Implement an energy efficiency purchasing policy.	Ensure products purchased are the most efficient possible.	High	Staff time to draft a policy.	Corporate leadership

5	Investigate options for upgrading or selling the Court House.	The Court House is a difficult building to heat and uses heating oil, a GHG intensive fuel.	High	\$6,000 for a detailed energy audit.	Buildings
6	Continue to support waste reduction initiatives.	Waste reduction drives substantial GHG emission reductions for the municipality.	High	No cost.	Waste
7	Track building energy consumption in Energy Star Portfolio Manager.	Allows staff to identify anomalies in building energy consumption.	High	Free program; two to three hours of staff training.	Buildings
8	Re-commission the Brooklyn Firehall and the Municipal Office.	Ensure that the heating and cooling systems are functioning according to their design.	High	\$10,000 for recommissioning. Energy savings of 5% to 15% possible.	Buildings
9	Energy audit for pumping stations.	Pumping stations use \$20,000 in electricity per year.	Medium	\$6,000 for a detailed energy audit.	Water and wastewater
10	Participate in a driver training program.	A driver training program can help reduce gasoline consumption.	Medium	Clean Nova Scotia offers a free program.	Energy
11	Consider purchasing a hybrid or electric vehicle.	A hybrid can be useful for many of the purposes required by a municipality such as	Medium	High capital cost for operational savings.	Vehicles

		building inspection.			
12	Investigate a newsletter that includes a section on climate action.	Communication of efforts will build support for future activities.	Low	Staff time, mailing and printing costs.	Corporate leadership
13	Investigate a composting system that generates biogas or compost.	A composting collection system for areas with a concentrated population can reduce waste GHG emissions.	Medium	Feasibility study cost \$20-40,000.	Waste
14	Investigate the COMFIT program.	Discuss with other municipalities such as Pictou and New Glasgow that are installing turbines.	Low	Staff time.	Energy
15	Consider a tree planting program with community businesses.	While not part of the official inventory, trees store carbon from the atmosphere.	Low	Staff time.	Corporate leadership
16	Continue the annual report on corporate GHG emissions	(see below)	High	Staff time	Corporate leadership

Monitoring and evaluation is critical for climate change mitigation and energy savings. As West Hants gains more experience as to what works and does not work, staff and Council can adjust the action plan to reflect this experience. No new actions are required to track progress on this front as monitoring is already in progress. This is a useful update to Council and enables the municipality to track GHG

emissions and identify any irregularities. However, future updates will need to include a review of the 16 emission reduction actions proposed in this report: whether they have been implemented and their impacts. As well, West Hants will update the UNSM spreadsheet with the latest emissions factors for electricity and ensure the correct emissions factor for waste (Table 38).

Table 38 Emission Factors

Energy type	Emissions factor	Unit	Notes
Electricity	0.770	kgCO2e/kWh	Canada's National Inventory Report, 2013
Fuel Oil	67.7	kgCO2e/GJ	BC's Best Practice Method for Quantifying Greenhouse Gas Emissions 2013
Diesel	70.0	kgCO2e/GJ	BC's Best Practice Method for Quantifying Greenhouse Gas Emissions 2013
Electricity	0.8	kgCO2e/kWh	Canada's National Inventory Report, 2013
Electricity	0.8	kgCO2e/kWh	Canada's National Inventory Report, 2013
Gasoline	2.4	kgCO2e/L	BC's Best Practice Method for Quantifying Greenhouse Gas Emissions 2013
Diesel	2.7	kgCO2e/L	BC's Best Practice Method for Quantifying Greenhouse Gas Emissions 2013
Waste	0.4817	tCO2e/t waste	UNSM Corporate Energy and Emissions Spreadsheet

11 References

- Adger et al., (2007). Assessment of adaptation practices, options, constraints and capacity. In: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E. (Eds.), *Climate Change 2007, Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge UK, pp. 433
- Adger, W.N., & Vincent, K. (2005). Uncertainty in Adaptive Capacity. 2005. *C. R. Geoscience*, 337: 399-410
- Adger, W.N. et al. (2004). New Indicators of Vulnerability and Adaptive Capacity. Tyndall Centre for Climate Change Research Technical Report 7, 1-128
- Adger, W.N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography*, 79(4): 387-404
- Brown, K. & Westaway, E. (2011) Agency, Capacity, and Resilience to Environmental Change: Lessons from Human Development, Well-being, and Disasters. *Annual Review of Environment and Resources*, 36: 321 -342
- Canada. Environment Canada. Threats to Water Availability in Canada. 2013. Print. <<http://www.ec.gc.ca/inre-nwri/default.asp?lang=En&n=OCD66675-1&xml=OCD66675-AD25-4B23-892C-5396F7876F65&offset=8&toc=show>>.
- Chabot, D., Gu nette, S., and Stortini, C., (2013). Fisheries and Oceans Canada. Bedford Institute of Oceanography. Review of the Physiological Susceptibility of Commercial Species of Fish and Crustaceans of the Northwest Atlantic to Changes in Water Temperature, Dissolved Oxygen, pH and Salinity. Print.
- Cinner JE, Huchery C, Darling ES, Humphries AT, Graham NAJ, et al. (2013) Evaluating Social and Ecological Vulnerability of Coral Reef Fisheries to Climate Change. *PLoS ONE* 8(9): e74321. doi:10.1371/journal.pone.0074321
- Colville, D., and Reiger W. (2012). South West Nova Scotia Temperature and Solar Radiation Study Project Summary.
- Department of Fisheries and Oceans Canada (DFO). 2012. Preliminary Summary of Trends and Projections for the Atlantic Large Aquatic Basin, for Use in I&V and S&E Preparations for the Atlantic LAB Risk Assessment. Bedford Institute of Oceanography, Dartmouth, Nova Scotia.
- Environment Canada (2013). National Inventory Report: 1990-2011 Part 3. Government of Canada.
- Forbes, D. L., Manson, G. K., Charles, J., Thompson, K. R. and Taylor, R. B. (2009). Halifax Harbour Extreme Water Levels in the Context of Climate Change:

- Scenarios for a 100-Year Planning Horizon. Geological Survey of Canada Open File 6346, iv+ 22p.
- Füssel, H. M. and Klein R. J. T. (2006). Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change*, 75: 301–329.
- Galbraith. 2012. Trends and variability in Eastern Canada Sea-Surface Ocean Temperatures. Can. Tech. Rep. Hydrogr. Ocean. Sci. 17pp.
- Goodwin, T.A., Parker, L., Fisher, B.E., and Dummer, T.J. 2010. Toenails, Tap Water and You: The Arsenic Connection. In Mineral Resources Branch, Report of Activities 2009. Nova Scotia Department of Natural Resources, Report ME 2010-1, pp. 41-44.
- Gornitz, V. (2005). Rising Seas: A View from New York City. Goddard Institute for Space Studies. Retrieved from: http://www.giss.nasa.gov/research/briefs/gornitz_05 (accessed August 5, 2013).
- Greenberg, D.A., Blanchard, W., Smith, B., and Barrow, E. (2012). Climate Change, Mean Sea Level and High Tides in the Bay of Fundy, *Atmosphere-Ocean, Circulation and Hydrography of Canada's Coastal and Inland Waters* (Special Issue 50 (3): 261-276. Retrieved from: <http://dx.doi.org/10.1080/07055900.2012.668670>. (accessed March 28, 2013).
- Guo L. (2012). The Impacts of Climate Change on the Autumn North Atlantic Wave Climate. Can. Tech. Rep. Hydrogr. Ocean. Sci. 37 pp
- Hanson, R.L., 1991, Evapotranspiration and Droughts, in Paulson, R.W., Chase, E.B., Roberts, R.S., and Moody, D.W., Compilers, National Water Summary 1988-89--Hydrologic Events and Floods and Droughts: U.S. Geological Survey Water-Supply Paper 2375, p. 99-104. Retrieved from: <http://geochange.er.usgs.gov/sw/changes/natural/drought/> (accessed Sept 16, 2013).
- IPCC (2001). In: McCarthy, J., Canziani, O., Leary N., Dokken, D., and White, K. (Eds.). *Climate change 2001: Impacts, Adaptation, and Vulnerability*. Cambridge: Cambridge University Press
- Langsdale, Stacy, Allyson Beall, Jeff Carmichael, Stewart Cohen, and Craig Forster. "An Exploration of Water Resources Futures under Climate Change Using System Dynamics Modeling." *Integrated Assessment Journal*. 7.1 (2007): 51-79. Print.
- National Weather Service, Flagstaff Weather Forecast Office, U.S. Department of Commerce. National Atmospheric and Oceanic Administration. What is Meant by the Term Drought. 2013. Print. <<http://www.wrh.noaa.gov/fgz/science/drought.php?wfo=fgz> >.

- Nova Scotia Commission on Building Our New Economy. (2013). *One Nova Scotia; Shaping Our New Economy Together*. Print. <<http://onens.ca/wp-content/uploads/2013/05/OneNS-Interim-Report.pdf>>.
- Perrie, W., Guo, L., Long, Z. (2012). Wave Climate Trends and Projections – GCM and RCM Results. Can. Tech. Rep. Hydrogr. Ocean. Sci. 9 pp
- Posey, J. (2009). The determinants of vulnerability and adaptive capacity at the municipal level: Evidence from floodplain management programs in the United States. *Global Environmental Change*, 19: 482-493
- Province of Nova Scotia. Canada Nova Scotia Infrastructure Secretariat. Gas Tax Fund. 2013. Web. <<http://www.nsinfrastructure.ca/>>.
- Province of Nova Scotia. 2011. Municipal Climate Change Action Plan Guidebook: Canada-Nova Scotia Agreement on the Transfer of Federal Gas Tax Funds. Service Nova Scotia and Municipal Relations, Canada-Nova Scotia Infrastructure Secretariat, Halifax, Nova Scotia. 31pp. Retrieved from: <http://www.nsinfrastructure.ca/uploads/MCCAP%20Guidebook-final%20draft%202011.pdf> (accessed April 3, 2013).
- Richards, W. and Daigle, R. (2011). Scenarios and Guidance for Adaptation to Climate Change and Sea-Level Rise-NS and PEI Municipalities. Atlantic Climate Solutions Association (ACASA), Halifax, Nova Scotia. Retrieved from: <http://atlanticadaptation.ca/reports> (accessed March 28, 2013).
- Simpson, Christina. (2013). "Helping Canadians Adapt to a Changing Climate: Overview of Health Impacts from Extreme Heat." EMO Webinar. Climate Change and Health Office, Health Canada. 4 Jun 2013. Address.
- Stantec. (2012). Nova Scotia Environment Climate Change Unit. *Tools for Community Climate Change Adaptation in Nova Scotia: Socio-economic Indicators & Scenario Planning*. Print.
- Stea, R. R. and Fowler, J. H. (1979). Minor and trace element variations in Wisconsinian tills, Eastern Shore Region, Nova Scotia. Nova Scotia Department of Mines and Energy, Paper ME 1979- 4, pp. 1-30. Retrieved from: <http://www.gov.ns.ca/natr/meb/data/pubs/79paper04/79paper04.pdf> (accessed April 3, 2013).
- Storm Surge and Coastal Inundation. National Oceanic and Atmospheric Administration. National Oceanic and Atmospheric Administration. Web. 20 September 2013. <http://www.stormsurge.noaa.gov/overview_causes.html>.
- The Municipality of West Hants. Planning Department. Municipal Climate Adaptation Case Study Report. 2012. Print.
- United States Environmental Protection Agency. (2012). Adaptation Strategies Guide for Water Utilities. Retrieved from:

<http://water.epa.gov/infrastructure/watersecurity/climate/upload/epa817k11003.pdf> (accessed August 12, 2013).

United States. National Ocean Service, National Oceanic and Atmospheric Administration, Department of Commerce. Storm Surge and Coastal Inundation. Retrieved from:
http://www.stormsurge.noaa.gov/overview_causes.html (accessed September 10, 2013).

van Proosdj, D., and CBWES Inc. (2011). Dykelands: Climate Change Adaptation. Atlantic Climate Adaptation Solutions Association (ACASA). Retrieved from:
<http://atlanticadaptation.ca/sites/discoveryspace.upei.ca.acasa/files/Dykelands%20Climate%20Change%20Adaptation.pdf> (accessed April 3, 2013).

van Proosdij, D. and Page, S. (2012). Best Management Practices for Climate Change Adaptation in Dykelands: Recommendations for Fundy ACAS Sites. Prepared for the Atlantic Climate Solutions Association (ACASA). Retrieved from:
http://atlanticadaptation.ca/sites/discoveryspace.upei.ca.acasa/files/Best%20Management%20Practices%20for%20Climate%20Change%20Adaptation%20in%20Dykelands._0.pdf. (accessed March 28, 2013).

van Proosdij, D., and Peitersma-Perrott, B. (2012). Shore Zone Characterization for Climate Change Adaptation in the Bay of Fundy. Prepared for the Atlantic Climate Solutions Association (ACASA). Retrieved from:
http://atlanticadaptation.ca/sites/discoveryspace.upei.ca.acasa/files/ACAS%20Shorezone%20Classification_0.pdf (accessed March 28, 2013.)

Walker, B.H. et al. (2004). Resilience, adaptability, and transformability in social-ecological systems. *Ecology and Society*, 9(2): 5

Warburton, A. (2013). Bay of Fundy Ecosystem Partnership Climate Change Project 2012-2013. Prepared for Bay of Fundy Ecosystem Partnership, Nova Scotia. Retrieved from: http://www.bofep.org/wpbofep/wp-content/uploads/2013/06/2013_climatechange_workshops_finalreport.pdf (accessed June, 2013).

Warburton, A. (2013). Guide for Incorporating Socioeconomic Information into Municipal Climate Adaptation Strategy Development. Prepared for Nova Scotia Environment Climate Change Unit, 2013. Print.

Warburton, A. (2012). The Municipal Climate Change Action Plan Assistant: Learning From Others. Prepared for Service Nova Scotia and Municipal Relations, Halifax, Nova Scotia. Retrieved from:
<http://www.gov.ns.ca/snsmr/municipal/planning/climate-change.asp>. (accessed March 28, 2013).

Warburton, A., and MacKenzie-Carey, H. (2013). Province of Nova Scotia. Nova Scotia Environment Climate Change Unit. Using an EMO-Based Hazard Risk Vulnerability Assessment Process for Municipal Climate Change Action Plan Development. Print.

- Whitman, E., Rapaport, E., and Sherren, K. (March 29, 2013). Future Wildfire Risk in the HRM Wildland Urban Interface Under Climate Change. Dalhousie University.
- Woodman, K. K., Duncan, D. R., Graves, R. M., Hudgins, A. B. and Rogers, P. K. 1994: Compilation of Seabright Resources Inc. till and soil geochemical data, Nova Scotia.
- Xu F., Perrie, W. (2011). Wave Modeling in Halifax Harbour and its Use in Estimating the Vulnerability of Harbour-front Properties during Extreme Weather Events. ACAS Research, Wave Modeling in Halifax Harbour and its Use in Estimating the Vulnerability of Harbour-front Properties during Extreme Weather Events. <http://atlanticadaptation.ca/node/179>
- Yin, J. (2012). Century to Multi-Century Sea Level Rise Projections from CMIP5 Models. Geophysical Research Letters. Vol. 39. 7 pp.

Appendix A: The Municipality of West Hants Climate Change Committee's Terms of Reference



MUNICIPALITY OF THE DISTRICT OF WEST HANTS

Climate Change Adaptation Committee Terms of Reference

Purpose

The purpose of the Climate Change Adaptation Committee is to act as an advisory committee to the Council of the Municipality of the District of West Hants on the development of the West Hants Municipal Climate Change Action Plan (MCCAP).

Mandate

The Adaptation Committee shall be responsible for developing the West Hants MCCAP and accountable to Service Nova Scotia and Municipal Relations in regard to any elements of the plan which require explanation, elaboration for Gas Tax purposes, revisions, or requirements regarding its development or implementation.

In fulfilling its mandate, the Adaptation Committee shall:

- 1) Oversee and direct the work of consultants and staff;
- 2) Review and provide comments on information material and presentations related to climate change and the ongoing development of the MCCAP;
- 3) Review and provide comments on drafts of the MCCAP;
- 4) Keep Council fully informed on the progress of MCCAP development through monthly reports or updates;
- 5) Present a final draft of the MCCAP to Committee of the Whole not later than December 3, 2013.

Membership

Committee membership shall include the following eight (8) members:

- 1) Three Councillors, being Jennifer Daniels, Victor Swinamer and Randy Matheson (appointed by Council December 11, 2012);
- 2) Chief Administrative Officer;
- 3) One representative from each of the Planning, Public Works and Recreation Departments; and
- 4) Regional Emergency Management Organization (REMO) Coordinator.

Meetings

- 1) The Committee shall meet as needed until the acceptance of the MCCAP by Council.
- 2) A Chair and Vice-Chair shall be elected by the members at the first Committee meeting.

- 3) A majority of the total number of members of the Committee is a quorum.
- 4) Decisions of the Committee shall be made by a majority vote of those members present at the meeting.
- 5) Interested and knowledgeable members of the public, representatives from provincial or federal government departments, and experts in particular subject areas, may be invited to meetings, as needed, to provide specific advice and input to the Committee.
- 6) Committee meetings shall be open to the public, except where in camera meetings are authorized by the *Municipal Government Act*.
- 7) Minutes of Committee meetings and information material concerning climate change and other items as may be identified, will be made available by the Committee to the public through the Municipality's website.

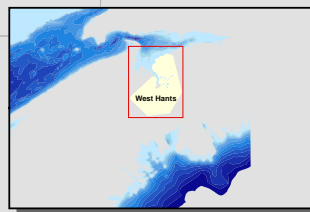
Resources

Administrative support for the Committee including preparation and distribution of agendas and minutes shall be provided by staff of the Planning Department.

Appendix B: Areas Susceptible to Inland Flooding Based on Wet Areas Mapping

MUNICIPALITY OF WEST HANTS Inland Flooding

- Town of Windsor
- Roads
- Flow Accumulation
- Depth to Water Table**
- Depth (metres)**
- 0 - 0.10m
- 0.11 - 0.50m
- Buildings
- Emergency Services - Paramedic
- Fire Department
- Hospital
- Municipal Building
- Pumping Station
- Rural RCMP
- Town of Windsor/RCMP
- Water Treatment Plant
- Variance
- Watersheds
- Municipality of West Hants



Scale 1:55,000

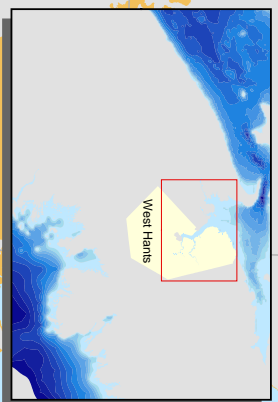
0 1,250 2,500 5,000 Metres

Projection: UTM Zone 20N

August 2013

Appendix C: Coastal Flooding / Storm Surge Map

MUNICIPALITY OF WEST HANTS Sea Level Modeling - Coastal Flooding



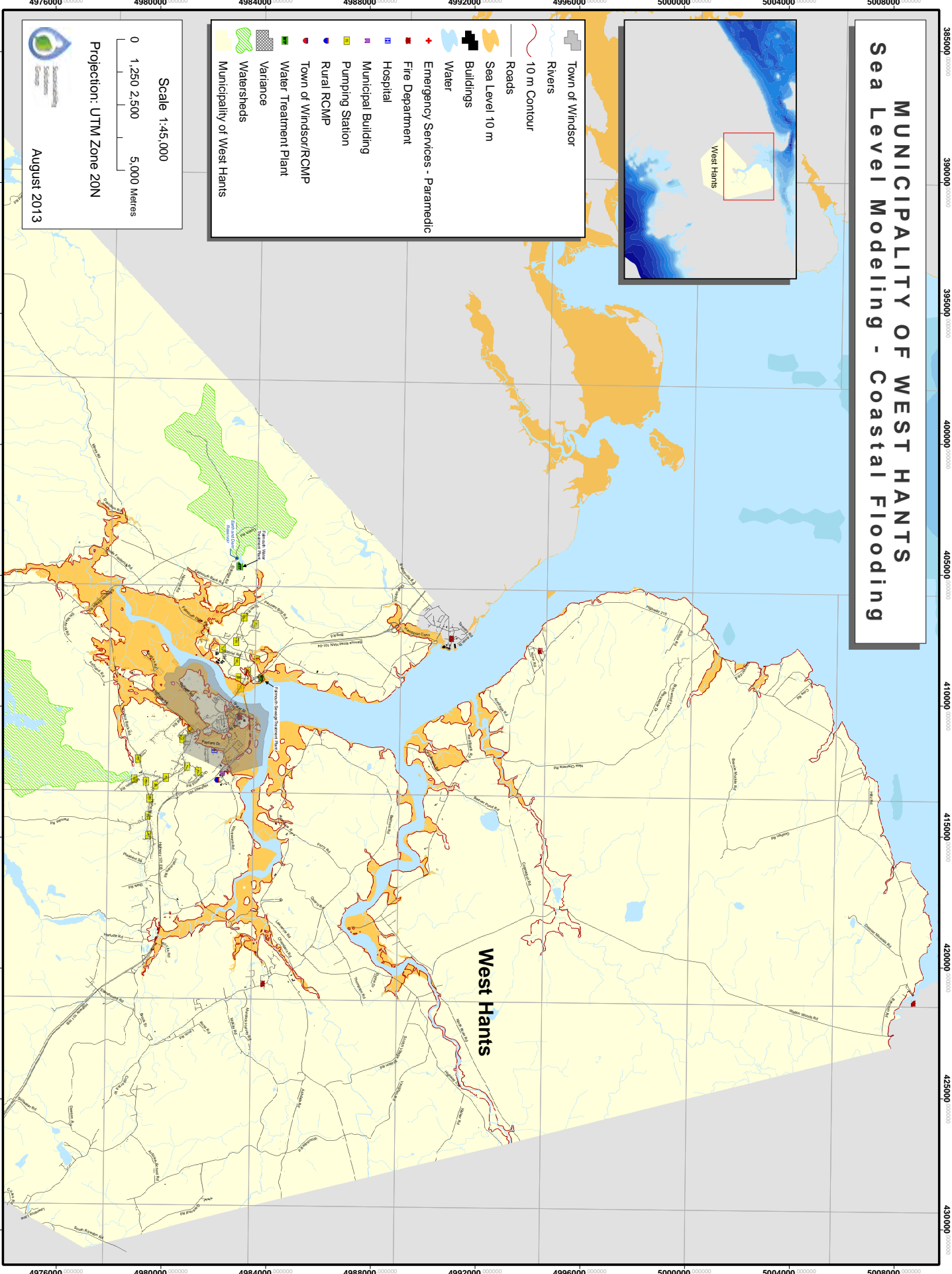
	Town of Windsor
	Rivers
	10 m Contour
	Roads
	Sea Level 10 m
	Buildings
	Water
	Emergency Services - Paramedic
	Fire Department
	Hospital
	Municipal Building
	Pumping Station
	Rural RCMP
	Town of Windsor/RCMP
	Water Treatment Plant
	Variance
	Watersheds
	Municipality of West Hants

Scale 1:45,000

0 1,250 2,500 5,000 Metres

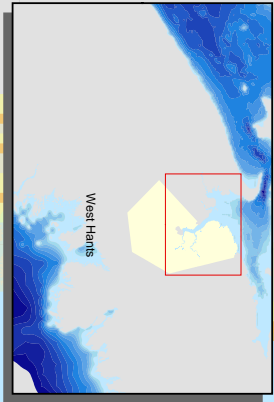
Projection: UTM Zone 20N

August 2013



Appendix D: Seawater Intrusion Map

MUNICIPALITY OF WEST HANTS Seawater Intrusion



Seawater Intrusion Vulnerability

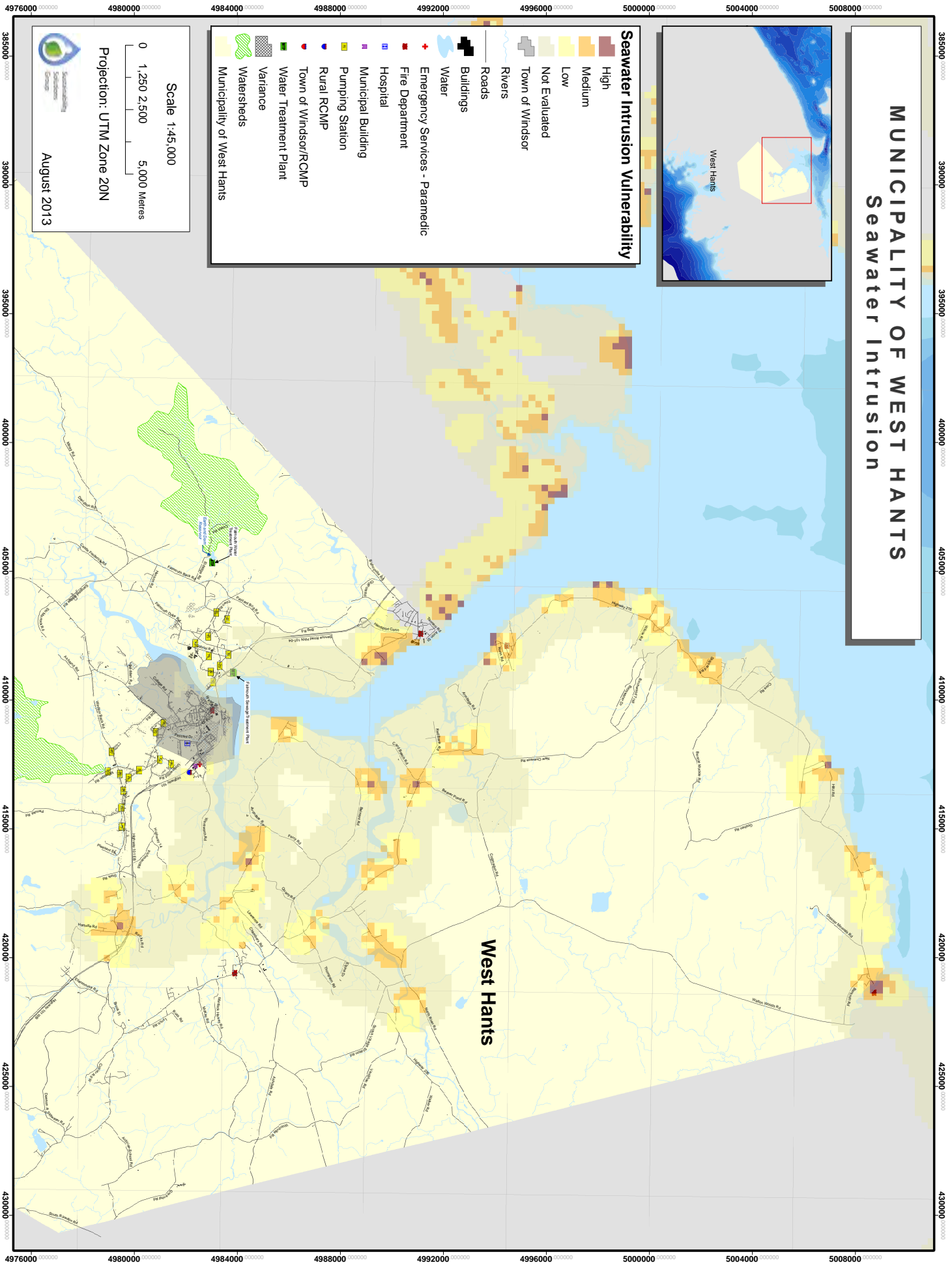
- High
- Medium
- Low
- Not Evaluated
- Town of Windsor
- Rivers
- Roads
- Buildings
- Water
- Emergency Services - Paramedic
- Fire Department
- Hospital
- Municipal Building
- Pumping Station
- Rural RCMP
- Town of Windsor/RCMP
- Water Treatment Plant
- Variance
- Watersheds
- Municipality of West Hants

Scale 1:45,000

0 1,250 2,500 5,000 Metres

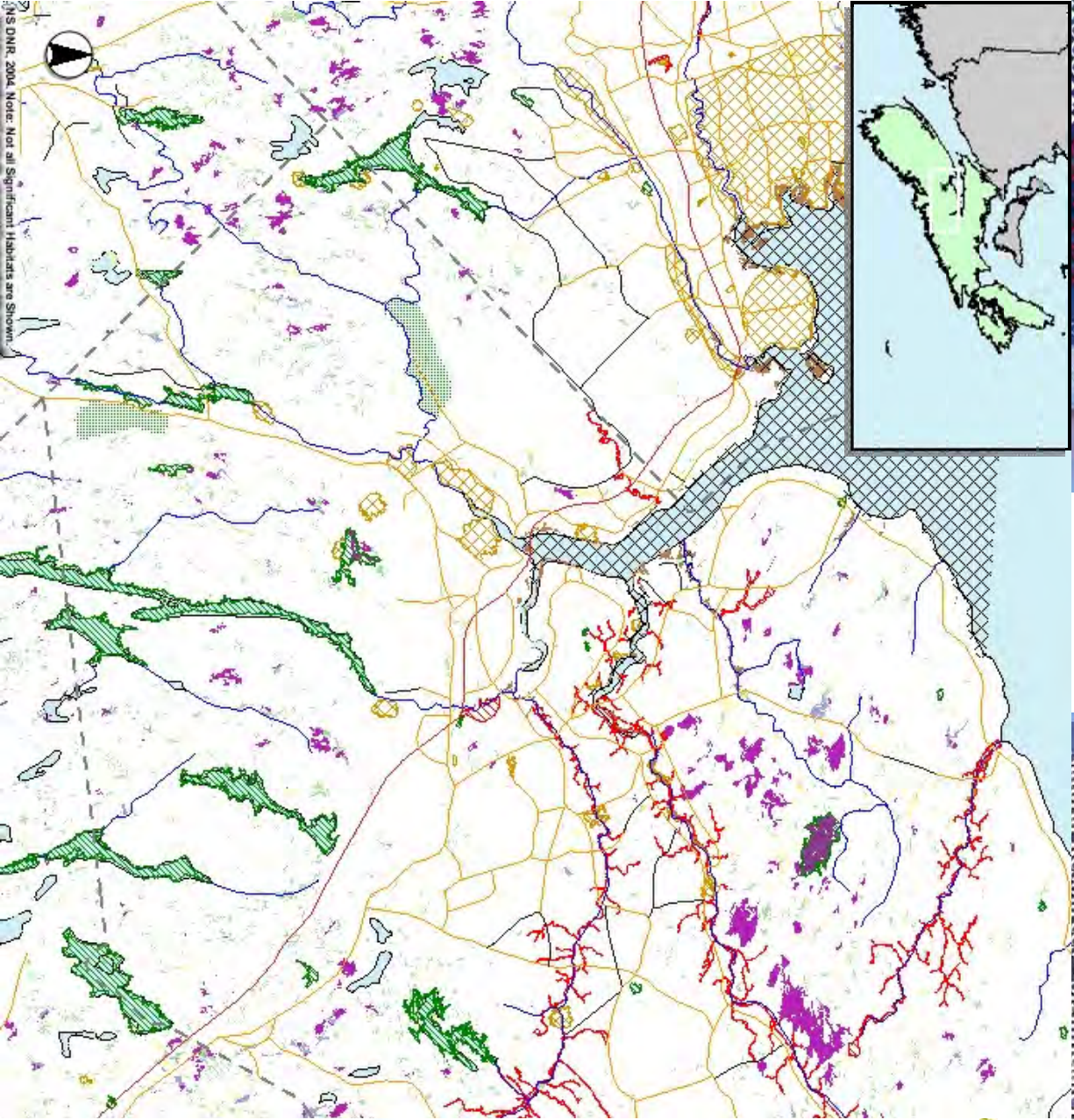
Projection: UTM Zone 20N

August 2013



West Hants

Appendix E: Significant Habitats Map



HELP!

LAYERS

- All Layers
- Places
 - Places
 - Gazetteer
- Base Map
 - County Boundaries
 - Roads and Utilities
 - Streams (10k)
 - Lakes (10k)
 - Contours (50k)
 - Contours (250k)
 - Streams (250k)
 - Roads (250k)
 - Roads (500k)
 - Lakes (500k)
 - Streams (500k)
 - Lakes (500k)
- Significant Wildlife
 - Species at Risk
 - Species of Conservation
 - Deer Wintering
 - Migratory Bird
 - Moose Wintering
 - Other Habitat
- Significant Wildlife Lands
 - Lynx Manage
 - Martin Managen
- Wetlands and Vegetation
 - Wetlands
 - Wetlands
 - Blag or Fen
 - Fen
 - Marsh
 - Salt Marsh
 - Swamp
 - Open Water
- Vegetation
 - Aquatic Vegetation
 - Exposed
 - Garnnhold
 - Lichen
 - Low Shrub
 - Salt Marsh
 - Sphagnum
 - Tall Shrub
 - Treed
 - Water

NS DNR, 2004. Note: Not all Significant Habitats are Shown.

Appendix F: Canada-Nova Scotia Infrastructure Secretariat's Preliminary Risk Assessment Spreadsheet

Climate Change Adaptation Plan

Municipal Asset	Sea Level Rise		Precipitation (extreme event)		Extreme Wind	Flooding	Temperature		Erosion	Earthquake	Total	Risk
			Snow	Rain			High	Low				

Water System

Water Source (Wells, Surface Water, Other)	N	0	L	1	M	2	L	1	L	1	M	2	N	0	M	2	N	0	9	L
Water Treatment Plant	N	0	N	0	N	0	L	1	N	0	N	0	N	0	N	0	N	0	1	L
Water Storage Facilities	N	0	N	0	N	0	M	2	N	0	N	0	L	1	L	1	N	0	4	L
Water Pumping Facilities	N	0	N	0	N	0	M	2	N	0	N	0	N	0	L	1	N	0	3	L
Water Distribution System	L	1	N	0	N	0	L	1	L	1	N	0	L	1	L	1	N	0	5	L
Individual Water Service Lines	N	0	N	0	N	0	N	0	N	0	N	0	L	1	N	0	N	0	1	L
Total	1		1		2		7		2		3		5		0		23			

Sanitary Sewer System

Wastewater Treatment Plant	L	1	N	0	N	0	L	1	N	0	N	0	L	1	N	0	N	0	3	L
Buildings	N	0	N	0	N	0	N	0	L	1	N	0	N	0	N	0	N	0	1	L
Wastewater Gravity Sewer	L	1	N	0	M	2	N	0	M	2	N	0	N	0	N	0	N	0	5	L
Wastewater Pressure Sewer (Forcemain)	N	0	N	0	M	2	N	0	N	0	N	0	N	0	N	0	N	0	2	L
Pumping Stations	L	1	N	0	M	2	M	2	H	3	N	0	N	0	N	0	N	0	8	L
Total	3		0		6		3		6		0		1		0		0		19	

Municipal Asset	Sea Level Rise		Precipitation (extreme event)				Extreme Wind	Flooding	Temperature				Erosion	Earthquake	Total	Risk
			Snow		Rain				High		Low					

Storm Sewer System

Catchbasins	N	0	N	0	L	1	N	0	L	1	N	0	N	0	N	0	N	0	2	L
Manholes	N	0	N	0	L	1	N	0	L	1	N	0	N	0	N	0	N	0	2	L
Pipes	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Total	0		0		2		0		2		0		0		0		0		4	

Municipal Buildings

Buildings	N	0	N	0	N	0	L	1	N	0	N	0	L	1	N	0	N	0	2	L
Total	0		0		0		1		0		0		1		0		0		2	

Landfills/Solid Waste Facilities

Flooding	N	0	L	1	L	1	N	0	L	1	N	0	N	0	L	1	N	0	4	L
Access Road	N	0	L	1	L	1	N	0	N	0	N	0	N	0	L	1	N	0	3	L
Leachate Collection	N	0	L	1	M	2	N	0	N	0	N	0	N	0	L	1	N	0	4	L
Leachate Treatment	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Buildings	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Total	0		3		4		0		1		0		0		3		0		11	

Dams

Flooding	N	0	L	1	M	2	L	1	L	1	N	0	L	1	L	1	N	0	7	L
Control Gates	N	0	L	1	M	2	L	1	L	1	N	0	L	1	L	1	N	0	7	L
Access Road	N	0	L	1	L	1	L	1	N	0	N	0	N	0	L	1	N	0	4	L
Fish Passage	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Total	0		3		5		3		2		0		2		3		0		18	

Municipal Asset	Sea Level Rise		Precipitation (extreme event)				Extreme Wind	Flooding	Temperature				Erosion	Earthquake	Total	Risk
			Snow	Rain	High	Low										

Roads																				
Bridges	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Traffic Signals	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Street Lighting	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Signs	N	0	L	1	N	0	L	1	N	0	N	0	N	0	L	1	N	0	3	L
Culverts	N	0	L	1	L	1	N	0	L	1	N	0	L	1	L	1	N	0	5	L
Sidewalks	N	0	L	1	N	0	N	0	L	1	N	0	N	0	N	0	N	0	2	L
Local Roads	N	0	L	1	N	0	N	0	L	1	N	0	N	0	L	1	N	0	3	L
Collectors	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	N	0	0	L
Total	0		4		1		1		3		0		1		3		0		13	

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

Appendix G: Partners for Climate Protection Fact Sheet

About PCP

The Partners for Climate Protection (PCP) program is a results-oriented network of Canadian municipal governments that have committed to reducing greenhouse gases (GHGs) and acting on climate change.

By participating in the program, municipalities commit to taking action on climate change, and work to achieve a series of five milestones to reduce their GHG emissions.

PCP is managed through a partnership between FCM and ICLEI – Local Governments for Sustainability. The program receives financial support from FCM's Green Municipal Fund™.

Background

Municipalities have direct or indirect control over approximately 44 per cent of Canada's GHG emissions. While all levels of government need to work together to reduce Canada's GHGs, municipalities can and are taking effective action themselves.

In 1994, FCM started an initiative called the 20% Club to build political support for federal action on climate change while promoting and recognizing municipal action.

The 20% Club became the PCP program in 1998 after merging into the Canadian component of ICLEI's Cities for Climate Protection (CCP) network, which involves more than 1,000 communities worldwide. The CCP's five-milestone framework forms the basis for the program.

PCP milestones

PCP is based on a five-milestone framework that guides municipalities to reduce GHG emissions from corporate and community sources.

- Corporate sources include municipal government facilities and operations, such as buildings, street lighting, water and wastewater treatment, municipal fleets and corporate solid waste.

- Community sources include industrial, commercial, and institutional (ICI) operations, transportation and residential waste.

The five-milestone framework is a flexible performance-based model in which each milestone provides an opportunity for municipalities to build their capacity to reduce GHGs. The five milestones are:

1. Milestone One: Create a GHG emissions inventory and forecast.
2. Milestone Two: Set an emissions reductions target.
3. Milestone Three: Develop a local action plan.
4. Milestone Four: Implement the local action plan or a set of activities.
5. Milestone Five: Monitor progress and report results.

PCP membership and achievements

Municipalities join PCP by passing a council resolution. Membership is free. A model council resolution is available on FCM's [website](#).

More than 230 municipalities in Canada are PCP members, representing over 80 per cent of the population.

Municipalities can achieve milestones in any order. Most municipalities are in the process of completing milestones One, Two and Three. Almost 20 municipalities have achieved milestones Four or Five.

Municipalities often achieve the milestones for their corporate emissions before their community emissions to demonstrate leadership and build their capacity to reduce GHGs in the community.

Membership support

FCM and ICLEI provide PCP members with the tools and resources they need to complete the milestones, including case studies, newsletters, webinars and templates, as well as valuable networking opportunities.

FCM recognizes municipalities that have achieved PCP milestones and reduced emissions through recognition letters to council, milestone recognition events, an annual measures report and webinars showcasing their successes.

ICLEI – Local Governments for Sustainability provides free technical support to PCP members.

Through its Green Municipal Fund™, FCM provides grants of up to 50 per cent of costs to a maximum of \$175,000 toward the completion of milestones One, Two and Three for PCP members. FCM also offers grants for feasibility studies, as well as grants and below-market loans for capital projects to implement actions in Milestone Four.

Impacts

As of March 2013, PCP members have reduced GHG emissions by more than 1.8 million tonnes through more than 800 green projects or measures. Together, these initiatives represent nearly \$2.3 billion of investment in mitigation activities.

FCM and ICLEI are continually working to improve the methodology for measuring emission reductions, investments and cost savings, as these are estimated to be considerably higher than reported.
