MUNICIPAL CLIIMATE CHANGE ACTION PLAN

The Town of
AMHERST
"Faith in our People, Pride in our Products"

November 2013

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Purpose

The purpose of this Municipal Climate Change Action Plan (MCCAP) is to identify priorities for climate change adaptation and reduce greenhouse gas emissions.

In order to continue to receive funding under the 2010-2014 Gas Tax Agreement between the Federal Government and the Province of Nova Scotia, each municipality is required to complete a Municipal Climate Change Action Plan (MCCAP).

Structure and Methodology

Following the guide provided by the Canada – Nova Scotia Infrastructure Secretariat, this plan is divided into two main sections: adaptation and mitigation. Part one, **Adaptation,** examines the potential risks posed by current and future climate related changes on Amherst infrastructure, facilities, and services. The analysis also considers socio-economic, environmental, and cultural impacts as a result of climate change. The structure of this analysis follows a step-by-step process found in the *Municipal Climate Change Action Plan Guidebook*, provided by the Canada-Nova Scotia Infrastructure Secretariat (Fisher, 2011). The steps are as follows:

Step 1: Build a Team – plan contributors, mandate, and accountability
Step 2: Issues, Hazards and affected Locations – what will a changing climate mean for Amherst and what areas are might be affected?
Step 3: Affected Facilities and Infrastructure – how will Town assets and services be affected?
Step 4: Social, Economic, and Environmental Considerations – what other elements of the community are at risk?
Step 5: Priorities for Adaptive Action – what should be done to manage the risks?

Part two, **Mitigation,** identifies ways in which the Town has reduced its greenhouse gas emissions in the past, while identifying ways to further reduce emissions going forward. The structure of this section builds upon the 2010 Municipal Energy Audit Report in form of a UNSM Corporate Energy and Emissions Spreadsheet.

PART ONE: ADAPTATION

1.0 Step One: Build a Team

Selection of the MCCAP team was based on the premise that a small, high-level group with in-depth knowledge and decision-making authority was the most efficient way to complete the plan. These members also have the authority to involve additional staff and resources as needed throughout the process. The committee is accountable to Council, providing progress reports leading up to a final presentation of the plan for Council adoption. Principle team members include:

Andrew Fisher, Planner – project leader
Jason MacDonald, Director of Planning and Development
Ben Pitman, Director of Transportation and Public Works
Bill Crossman, Director of Emergency and Property Services

Council provided the team with the following mandate:

To develop a Municipal Climate Change Adaptation Plan, as required under the Canada – Nova Scotia Agreement on the Transfer of Federal Gas Tax Funds, through identification of potential risks posed by climate change, and to develop priorities to mitigate such risks.

Stakeholder involvement in the issues discussed throughout this plan have been ongoing prior to the commencement of the MCCAP process, and will continue into the future. It is also important to note that the Town of Amherst as a whole is an important stakeholder with respect to issues that affect the greater region around the municipality. A summary stakeholders is as follows:

Municipality of Cumberland County
Property owners along Dickey Brook and Etter's Brook
Property owners adjacent to, and near the marshlands
Nova Scotia Department of Agriculture
Nova Scotia Department of the Environment and Labour
Nova Scotia Department of Transportation and Infrastructure Renewal
Tantramar Climate Change Collaborative Working Group

Step Two: Climate Change Issues, Hazards and affected Locations

2.1 Introduction

The purpose of Step Two is to investigate the potential impacts that may pose as hazards to Amherst now and in the future. While it is difficult to predict future events, the impact of past weather events give us an indication of what to expect. The project team was provided with an overview of climate trends, the issues created or exacerbated by these trends, and the potential hazards to the community. Climate change trends include (but are not necessarily limited to): warmer temperatures and changes in precipitation patterns, sea level rise, and extreme weather events.

2.2 Temperature and Precipitation

As outlined in Table 1, over the next century projections indicate the local climate in Amherst to become warmer and wetter, and include (but may not be limited to) the following characteristics:

Temperature

- Warmer seasonal and annual mean temperatures
- Increase in hot days (over 30^0c)
- Decrease in cold days (under -10^oc)

Precipitation

- Increased precipitation in the form of rain, mostly in winter and spring
- Reduced snow levels over the long term

A warmer climate could have the following positive and negative impacts:

Positive

- Lower heating and snow removal costs in winter
- Increased tourism sector revenue from a longer season

Negative

- Increased cooling costs and health risks for people sensitive to extreme heat
- Decreased snow cover and increased chance of droughts could impact water resources, agriculture, and forest fire risk
- Stress on ecosystems sensitive to changes in climate, and threats from invasive species
- Increased risk of inland flooding due to major rain events on snow and ice cover

Table 1 – Amherst Projected Temperature and Precipitation

Parameter		Historical 1980s	Projected 2020s	Projected 2050s	Projected 2080s
Temperature (^{0}C)	Annual	5.8	6.9	8.2	9.4
	Winter	-6.0	-4.7	-3.3	-1.9
	Spring	3.9	5.0	6.1	7.2
	Summer	17.1	18.2	19.3	20.5
	Autumn	8.2	9.3	10.5	11.8
Precipitation (mm)	Annual	1174.8	1207.1	1217.1	1253.2
	Winter	319.6	335.2	343.2	361.9
	Spring	285.0	294.4	298.7	310.7
	Summer	262.5	266.9	266.0	266.4
	Autumn	307.7	311.4	311.0	318.0
Heating Degree Days		4516.7	4167.2	3797.1	3439.6
Cooling Degree Days		85.7	140.8	222.6	322.9
Hot Days (Tmax > 30)		0.6	2.7	6.8	14.6
Very Hot Days (Tmax > 35)		0.0	0.0	0.0	0.1
Cold Days (Tmax < -10)		8.4	7.0	4.9	2.9
Very Cold Days (Tmax < -20)		0.1	0.1	0.0	0.0
Growing Degree Days > 5		1713.5	1929.5	2187.7	2471.0
Growing Degree Days > 10		860.1	1017.0	1206.9	1414.3
Growing Season Length (days)		166.7	176.6	194.2	211.2
Corn Heat Units (CHU)		2468.5	2775.2	3140.5	3501.0
Corn Season Length (days)		136.9	146.0	159.1	170.2
Freeze Free Season (days)		197.3	221.7	241.5	257.0
Days With Rain		124.4	136.3	140.3	144.4
Days With Snow		41.3	50.6	42.7	36.9
Freeze-Thaw Cycles - Annual		95.5	89.1	79.7	72.6
Winter		33.8	35.2	37.6	38.7
Spring		38.3	34.1	26.8	21.6
Summer		0.4	0.3	0.1	0.0
Autumn		23.0	19.6	15.3	12.2
Water Surplus (mm)		708.3	689.3	688.7	694.9
Water Deficit (mm)		43.0	47.9	57.6	68.1
Change in Sort Period Rainfall (%)		0	5	9	16

Source: W. Richards Climate Consulting, August 2011

2.3 Storm Severity and Intensity

Although difficult to predict and quantify, there is a consensus in the climate change literature that climate change will result in more intense and severe storm events in Atlantic Canada (Webster et al 2011). Furthermore, there is growing evidence that other extreme weather related events such as storm surges, droughts, heat/cold waves, and thunderstorms are increasing (Richards, 2011 and Vasseur, 2007). Severe storm events come with various impacts such as:

- Runoff and drainage issues
- Localized flooding, washouts and erosion
- Heavy precipitation, strong winds, and sever lightning storms

These impacts can result in hazards such as:

- Damage to structures, property and infrastructure
- Public safety concerns, transportation system interruption, first responder delays
- Interruptions in power supply
- Economic implications

2.4 Storm Surge

Low pressure systems that accompany more frequent and intense storms will result in higher risk of storm surges. Storm surge is basically the excess water level above regular predicted tide. The total storm surge level is highly influenced by wind speed and direction, wave energy, as well as, the shape and orientation of the coastline. Storm surge and sea level rise are interrelated, so the hazards associated with storm surge are addressed with sea level rise below.

2.5 Sea Level Rise

Global sea level rise is the result of the water expansion due to warmer global temperatures combined with the melting of glaciers and polar ice caps. Predicting the amount of sea level rise on a global and local scale involves many complex factors and continuously evolving information; however, it is certain that some increase in sea level will occur. Historically, sea level has increased 0.32 m in the last 100-150 years (Webster et al. 2012). By the end of this century, the studies referenced in this report rely on "Rahmstorf 2007 Median Sea-Level Rise Estimates," that predict between 50-130 cm rise with a median value of 90 cm by 2100 (Richards 2011).

Additional factors that affect sea level include tidal amplitude and crustal subsidence. Due to the shape and dynamics of the Bay of Fundy, tidal amplitude is expected to increase with sea level rise (Webster et al, 2011). Crustal subsidence is a geological process caused by the rebounding of the earth's crust following the last ice age. The rate of subsidence in Nova Scotia is estimated at about 15 cm per century (Forbes et al., 2009). The cumulative effect of crustal subsidence and tidal amplitude with sea level rise is known as relative sea level rise. Relative sea level rise is estimated to be 1.05+/- 0.48 metres by 2100 (Richards 2011). This research supports earlier statements by Natural Resources Canada that identify the upper Bay of Fundy along the Chignecto Isthmus as being highly vulnerable to sea level rise (Vasseur, 2007).

The hazards associated with storm surge are well known to Nova Scotians. Extremely high water levels often accompanied by high winds and strong wave forces can cause severe damage to land and structures along coastal areas. As mentioned above, low lying coastal areas such as the marshlands protected by dykes are particularly vulnerable. Rising sea levels reduce the amount of storm surge required to overtop dykes, thus increasing the risk in these areas.

2.6 Climate Issues and Hazards Already Experienced in Amherst

After considering the potential impacts and hazards outlined above, the MCCAP team identified major storm events that caused issues for the community in the past. The Saxby Gale (1869) storm event produced an estimated 1.5 to 2 m storm surge overtopping all dykes on the Chignecto Isthmus by 0.9-1.2 m. The storm caused extensive flooding, widespread damage, and killed several people along the North Atlantic seaboard. The 1:150 year event took place during the peak of the 18-year Saros cycle creating extremely high astronomical tides. The Saxby Gale is considered the regional benchmark of what is possible when extreme high tides and storm surge combine.

The team also identified heavy rainfall events, such as the September 1999 storm where Amherst received 145mm of rain in 24 hours, almost 50% more than the average rainfall for the entire month of September (Environment Canada). This event caused localized flooding, which temporally cut off the most direct access between Amherst and the hospital (Cumberland Regional Health Centre). Connection to the Town's water source was also cut off for several days due to a culvert being washed away.

Figure 1: September 1999 storm destroyed a large culvert and severed Amherst's wellfield connection.

Subsequently, other significant rain events on September 8, 2008 (71 mm in 24 hours), and September 18, 2012 (118 mm in 24 hours) led to minor localized flooding of private property. A recent assessment that analyzed the localized flooding issue noted that records indicate severe rainfall events (> 50 mm in 24 hours) have significantly increased over the last 12 years when compared to the previous 50 years (McCullough 2012).

2.7 Preparedness

It could be argued that Amherst and the Tantramar Marsh region was not prepared for the extremely rare Saxby Gale storm surge in 1869. In fact, a Saxby Gale level event would cause significantly more damage to the increased development and value of infrastructure that exists on the Isthmus today. The September 1999 event required the Town's reservoir and backup supply wells to operate, but the team felt that Amherst was fairly well prepared to respond to the loss of connection to the Tyndal Wellfield. The backup systems supplied water until a temporary water main connection was installed. However, the team acknowledged that this circumstance was not anticipated. Localized flooding was considered temporary with no significant damage to property or structures.

2.8 Future Issues,Hazards and Affected Locations

After taking the above information into consideration, the team identified issues and hazards that could cause problems in the future, and the areas that are most likely to be affected. A description of these issues is as follows:

Extreme Weather

The team acknowledged that extreme weather events with severe and intense precipitation, winds, and lighting are certain to happen in the future. In general, the Town's facilities, infrastructure, and services have become increasingly resilient to such events. While the Town's EMO Plan is in place to deal with the various potential hazards associated with extreme weather, localized flooding could cause problems. Consequently, maintenance and upgrading of stormwater infrastructure will require ongoing action over time.

In terms affected locations, Amherst is fortunate to be located on well-draining Tormentine soils; however, localized flooding sometimes occurs along Dickey Brook. The brook is the Town's only water course and main surface drainage channel. The brook drains a watershed encompassing over 33% of the Town's area. The brook flows from east to west and discharges in Etter's Brook on the Amherst Marsh, draining approximately 1,100 acres of land. The remaining lands to the north and south drain to marshland. During heavy rain events the water level rises considerably and has in the past overflowed onto adjacent streets and residential properties, particularly along Terrace Street.

Figure 2: The Dickey Brook watershed (Ekistics).

Flooding issues related to Dickey and Etter's Brook is an issue the Town is addressing. A rehabilitation plan (Ekistics 2011) identified ways manage flow and stormwater retention upstream. An assessment of flooding along Terrace Street identified insufficient capacity in the brook to handle a 1:5 year or greater rainfall, as well as, the ability of the brook to flow during high tide in the Bay of Fundy. The brook ultimately flows onto the marsh and into the LaPlanche River, which in turn flows to the Bay via an aboiteaux. When peak runoff coincides with a high tide (aboiteaux is closed) the brook will back up and potentially flood adjacent properties (McCullough 2013). Conversely, a failure of the aboiteaux would allow water from the Bay of Fundy to flow freely into marshlands behind the dykes, potentially flooding the LaPlanche River and consequently Dickey and Etter's Brook.

The LaPlanche River aboiteaux, located adjacent to the Amherst Waste water Treatment Facility, was constructed in the 1950s and is in need of replacement. An attempt to replace the wooden structure with a new aboiteaux in 2007 failed within a short time frame. Subsequently, the Department of Agriculture have commissioned an engineering study looking into the dyke and aboiteaux system, but to date, no immediate plan to replace or update the aboiteaux has been released publically.

Major Dyke Failure and Marsh Flooding

Amherst is bordered to the north and west by former marshlands that are protected from the Bay of Fundy by approximately 1.2 km of dykes that extend across the isthmus. The dyke system is currently maintained by the Nova Scotia Department of Agriculture under the Marshland Reclamation Act (1989) and the Agricultural Marshland Conservation Act (c22, s.1, amended 2004). Under this legislation, the principal purpose of the dykes is to protect agricultural uses, not the substantial non-agricultural development that has located on the marshlands over the years. See Van Proosdij (2012) and Webster et al (2012) for in-depth information about dyke construction, vulnerability, and adaptation in relation to sea level rise and storm surge.

Over the past 300+ years the area has flooded several times: 1758, 1869 (Saxby Gale), 1887, 1958, and 1969 (Webster et al., 2012). Dyke height is established for dykes near Chignecto by the higher high water large tide (HHWLT) level, plus about 0.5m of freeboard depending on conditions specific to the dyke location (bay exposure versus up river).

Table 2 – Current and Projected Storm Surge Water Levels Relative to Dyke Height

				Storm surge & return periods				Relative Sea Level Rise (m)				Combined (SLR + surge)		
NS #	Cumberland County Name	HWL (m)	Crit. (m)	1:10 0.85	1:25 0.96	1:50 1.04	1:100 1.13	2025 0.15	2055 0.42	2085 0.82	2100 1.05	2055 & 1:100	2085 & 1:100	2100 & 1:100
42	Amherst Point	7.6	8.1	8.5	8.6	8.7	8.8	7.8	8.0	8.4	8.7	9.2	9.6	9.8
44	Converse	7.9	8.1	8.8	8.9	9.0	9.1	8.1	8.3	8.7	9.0	9.5	9.9	10.1
45	Barronsfield	8.1	8.1	8.9	9.0	9.1	9.2	8.2	8.5	8.9	9.1	9.6	10.0	10.3
46	River Herbert	8.0	8.1	8.9	9.0	9.0	9.1	8.2	8.4	8.8	9.1	9.6	10.0	10.2
53	John Lusby	7.8	8.1	8.6	8.7	8.8	8.9	7.9	8.2	8.6	8.8	9.3	9.7	10.0
54	Minudie	8.1	8.1	8.9	9.0	9.1	9.2	8.2	8.5	8.9	9.1	9.6	10.0	10.3
55	Seaman	8.1	8.1	9.0	9.1	9.2	9.3	8.3	8.6	9.0	9.2	9.7	10.1	10.3
63	Maccan	8.1	8.1	9.0	9.1	9.1	9.2	8.3	8.5	8.9	9.2	9.7	10.1	10.3
78	Athol	7.6	8.1	8.5	8.6	8.7	8.8	7.8	8.0	8.4	8.7	9.2	9.6	9.8
87	Chignecto	8.0	8.1	8.9	9.0	9.0	9.1	8.2	8.4	8.8	9.1	9.6	10.0	10.2
115	Nappan-Maccan	7.9	8.1	8.8	8.9	9.0	9.1	8.1	8.3	8.7	9.0	9.5	9.9	10.1
119	Upper-Maccan	8.1	8.1	9.0	9.1	9.1	9.2	8.3	8.5	8.9	9.2	9.7	10.1	10.3

Recommended elevations relative to CGVD28 datum for Fundy ACAS marshbodies. Storm surge and sea level rise estimates derived from Richards and Daigle, 2011. HWL determined form NSDA marsh plans with the exception for Cumberland County where HWL value is based on HHWLT at CHS Joggins site and transformed to CGVD28 at Fort Beausejour by Ollerhead et al. 2011. Standard error for SLR estimates for 2025 and 2055 is 0.1 m, 2085 is 0.2 and 2100 0.4.

However, unlike other places in the world (ex. British Columbia, The Netherlands) potential storm surge is not formally taken into account when determining critical dyke height in Nova Scotia. Currently, 7.2% of the dyke protecting the Amherst marsh body is below the recommended critical dyke height (Van Proosdij 2012). As the highlighted row of the chart above indicates, even a relatively small storm surge with a 1:10 year return period (10% chance of happening any given year) during a large tide could overtop the dyke by 0.8 m. Figure 3 below shows the elevation of such a flood that could overtop the rail line and inundate properties in Amherst that border the marshlands. This level of flooding could reach the outer perimeter of the Tyndall Wellfeild recharge area. It is estimated that a major flood of this scale would risk damage to approximately $70 million in assets located behind the dykes, including the Town's waste water treatment facility. A storm surge with a 1:100 year return period during a large tide would overtop the Trans-Canada Highway. As the note on the map indicates, this extent of flooding does not take into account how the water would flow over the marshlands, or how long water would have to overtop the dykes to reach this level.

Figure 3: Flood model showing 0.9 m storm surge during a very high 8 m tide. The missing sections of the Trans-Canada Highway represent bridges, not overtopping of the highway.

Figure 4 models a storm surge with a 1:100 year return period by 75 years (2085). The water height is projected to be 10 m, and would further cover the Trans-Canada Highway. It should be emphasized that any disruption to the transportation corridor threatens over $50 million per day in interprovincial trade (based on $10 billion / year) Webster and Pett 2012).

Figure 4: By 2085, a 1:100 year storm surge flood model at 10 m.

Drier Summers

As mentioned previously, a warmer climate increases the risk of drought. Long-term drought conditions can not only harm agricultural output but also diminish drinking water resources. The team recognized that drought conditions could impact the agricultural sector in the region, diminish local food sources, and increase the risk of forest fires. However, the team felt that these issues were relatively low risk. The agricultural sector represents a very small portion of the town's economy (>5%), and only 1% of the Town's water comes from the surface. The biggest potential impact recognized by the team is the increased risk of forest fires.

Although not heavily forested within its boundaries, the Town's well field is located under a protected wilderness area. While a fire in this area would not affect the underground infrastructure, nitrogen loading from the ash could pose a risk to long term water quality. If such an event occurred additional water treatment may be required. This risk is addressed and mitigated within the *North Tyndall Wellfield Groundwater Management and Protection Strategy* through restrictions around land use, open fires, and responsible forestry practices.

Wetter Winters

The potential impact of more precipitation (rain) in winter months includes increased threat of localized flooding, particularly in the areas around Dickey and Etter's Book. The hazards associated with localized flooding are addressed in the Extreme weather section above.

Threats to Amherst's Future

Although varying in range of severity, the team did not feel the hazards discussed above threaten the future viability of the community. Inland flooding due to extreme precipitation is likely to be localized, and actions to mitigate flooding hazards are already being evaluated. In terms of a worst-case scenario storm surge that floods the marsh, this would be considered a major disaster for Amherst and the region; however, the majority of property within town limits would not be directly impacted.

Stakeholder Involvement

The dyke and potential marsh flooding is a complex issue involving many stakeholders, from senior levels of government to large corporations (CN Rail), to individual land owners. Located in the Municipality of Cumberland County approximately 4 km from the Town border, the dykes are managed by the Nova Scotia Department of Agriculture. As such, Amherst does not have any control over the dykes, but must remain engaged as a stakeholder to ensure the proper attention is given to this issue.

There has been significant stakeholder involvement in dealing with flooding issues around Dickey Brook. The Dickey Brook: Rehabilitation Master Plan by Ekistics Planning & Design completed in 2011 addressed stormwater management issues, and included widespread public input. In August 2013, stakeholder meetings with residents adjacent to the brook, and representatives from the Nova Scotia Department of the Environment and Labour have taken place to address flooding issues. At this meeting several action items were identified to better understand the relevant issues in the hopes of finding solutions to the intermittent flooding.

Step Three: Facilities and Infrastructure

3.1 *A description of key facilities and infrastructure.*

A brief description of key facilities and infrastructure relevant to the Town of Amherst is as follows:

- Streets and sidewalks – approximately 78 km of streets and 35 km of sidewalks.
- Water supply – water is supplied by the North Tyndal Well field, located 6 km north of town commissioned in 2003. The 79 km distribution network services all properties within town limits, as well as, 192 properties in Cumberland County, for a total of 3,561 customers. The system includes a reservoir (approximately 3 day supply), and back up pumps and wells that are centrally controlled. The wellfeild is protected by the *North Tyndall Wellfield Groundwater Management and Protection Strategy*, which controls uses in the recharge zone covering 2,100 ha.
- Sanitary Sewer – All properties within town limits are connected to this system, which is predominantly gravity forced with 6 lift stations. Sanitary sewer is treated at a new facility (commissioned in 2012) located on marshlands 1.5 km outside town limits. The top of berm height around the facility are 9.8 m above sea level, approximately 1.8 m above the current height of the nearby dykes. Treated waste water is discharged into the LaPlanche River, which flows to the Bay of Fundy.
- Storm Sewer – As discussed previously, over one third of Amherst stormwater is channeled to Dicky Brook. The remaining areas are drained to various outflows that eventually reach the marshlands to the north, west and south.
- Key Facilities – As shown on the map below, key facilities include: Town Hall, Public Works Garage, Wastewater Treatment Facility, Fire Hall, Amherst Police, RCMP barracks, Emergency Health Services (Ambulance), and the Cumberland Regional Health Care Centre.

Figure 5 below shows the location of key facilities and infrastructure.

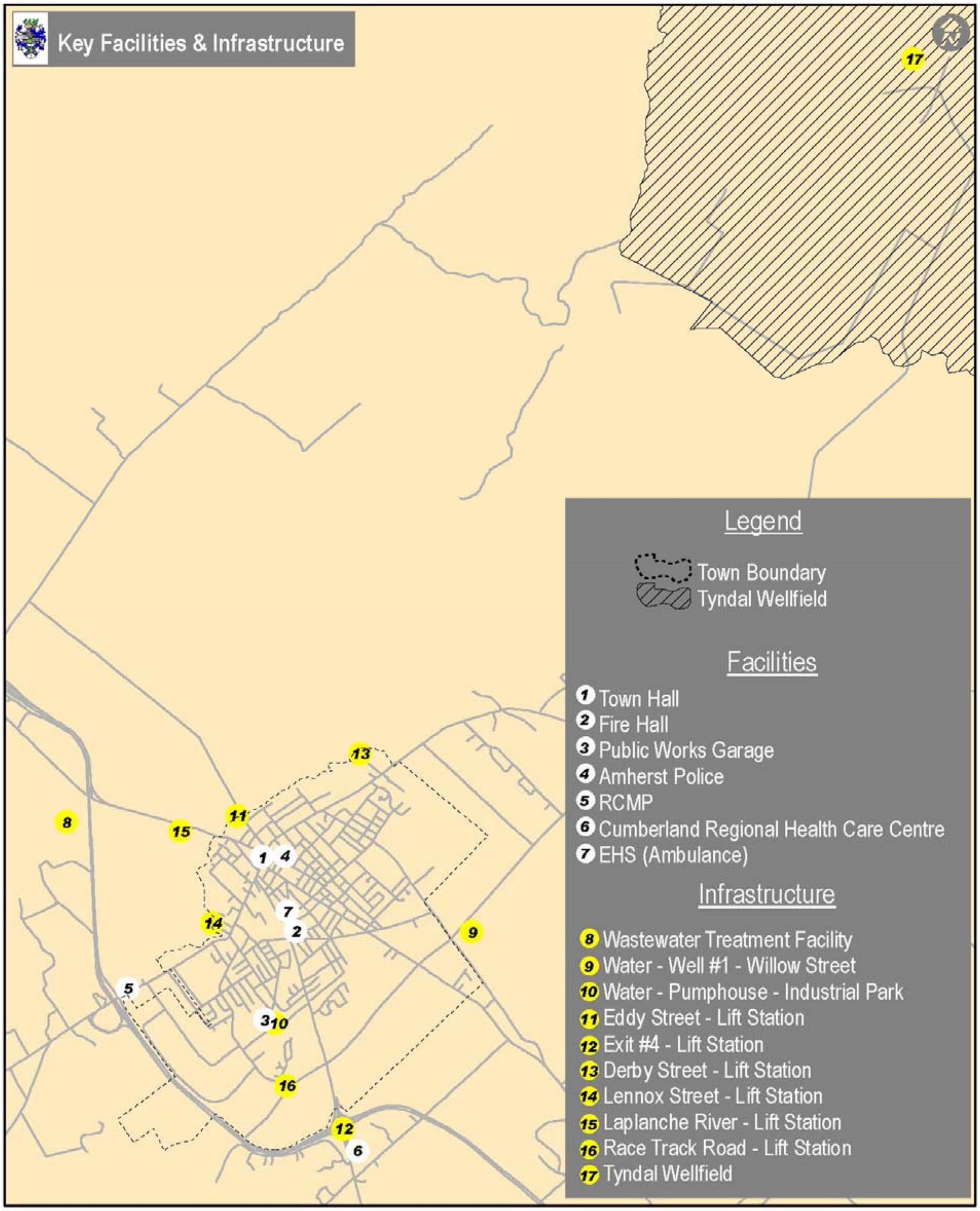

Figure 5: Town of Amherst key facilities and infrastructure.

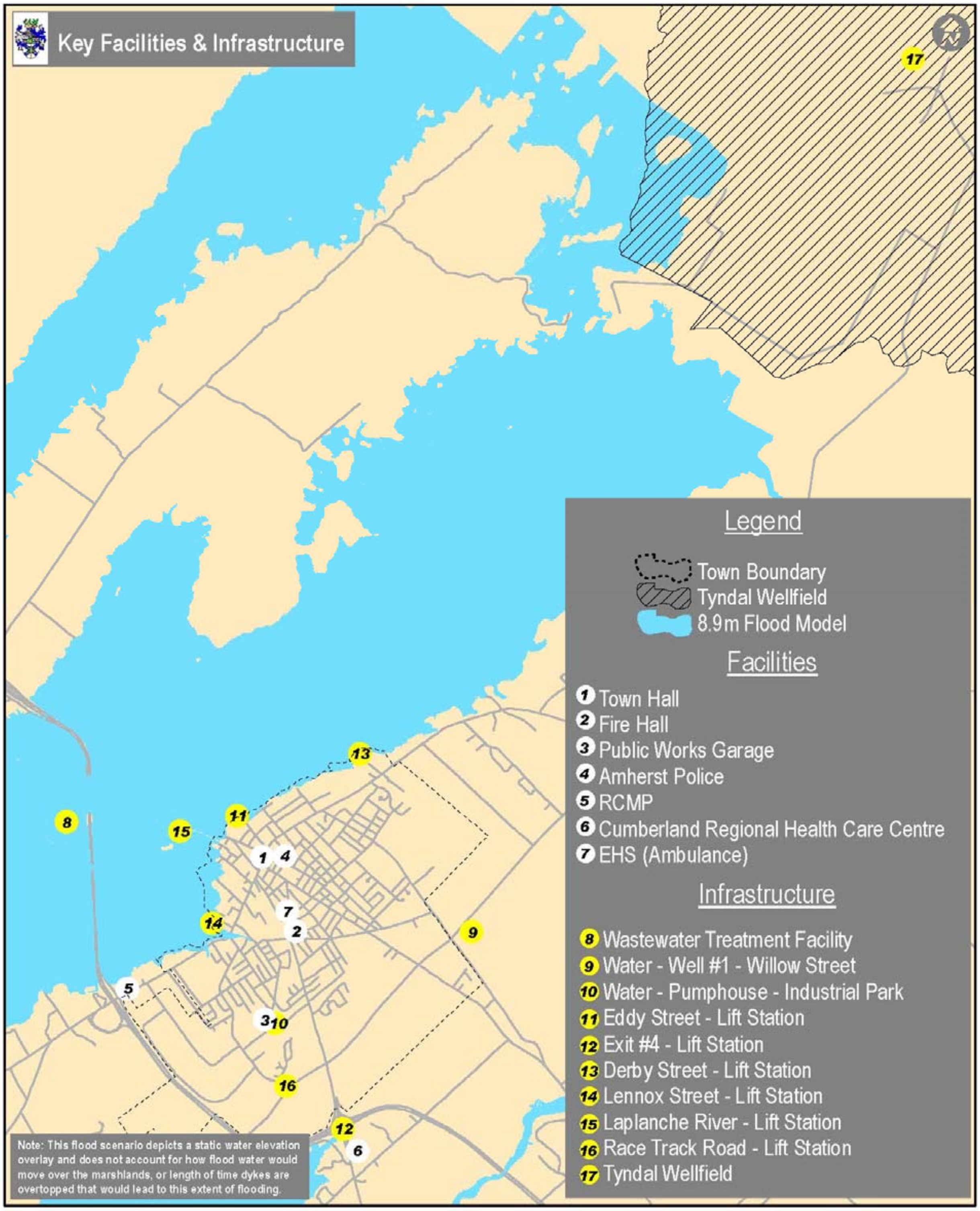

Figure 6: Key facilities and infrastructure within the flood risk area.

3.2 Key Facilities and Infrastructure that may be at Risk

The team considered the two main hazards that could affect key facilities and infrastructure. Firstly, severe precipitation events can cause temporary localized flooding and overwhelm the storm sewer system. This is particularly the case along Dickey Brook; however, the floodplain zone (in the Land Use Bylaw) delineates this area, limiting potential damage to infrastructure and facilities that may be nearby.

The second and potentially more serious issue is aboiteaux failure or dyke overtopping caused by storm surge. Figure 6 above shows the areas and key facilities and infrastructure that would be flooded. While key facilities required to respond during an emergency (ex. fire, police, ambulance) would not be impacted, the waste water treatment facility, streets near the marshlands, and 4 lift stations would be affected. Affected streets may be temporarily impassable during a flood event, but damage is not likely to be severe. If flooding overwhelmed or otherwise rendered lift stations inoperable, overflow valves would release waste water into the marshlands allowing the system to continue to function. While not ideal, release of the untreated waste water onto the marshlands would be diluted and eventually flushed into the Bay of Fundy as flood waters recede. It should be noted that until the waste water treatment facility was made operable in 2012, untreated waste water was discharged into the LaPlanche River in the same fashion.

Amherst's newly constructed waste water treatment facility is the Town's most valuable asset on the marshlands. Its location is due in large part for the requirement that treated outflow be discharged directly into a salt water body. The elevation of the facility is 9.8 m above sea level, 0.7 m above a storm surge at extreme high tide with a 1:100 year return period storm surge. In approximately 70 years, projected sea level rise will raise the same storm surge (1:100) to 10 m, overtopping the treatment facility berms and potentially flooding the associated building. While this may not cause immediate alarm, a smaller surge (1:10 year surge today) that overtops the dyke system could undermine or damage the perimeter berms and cut off access to the facility. Given the high value of the asset and its proximity to the dyke system, the team acknowledged that a more in-depth assessment of the level of vulnerability of treatment facility and lift stations within the flood zones as a priority for action.

As shown on Figure 6, a static 8.9 m flood model indicates that a marshland flood would reach the outer recharge zone of the Tyndall Wellfield. While this circumstance is possible, the risk to the wellfield is relatively low. Only about 1% of the recharge area is supplied by surface water, and approximately 10 m of overburden and several layers of impermeable clays exist over the aquifer. A greater risk is the possibility of flooding at the well head, which could infiltrate the aquifer and damage equipment. If this did happen, the equipment would be replaced, the aquifer would be flushed until fresh water is achieved, and the operation could continue. However, the team acknowledged that given the critical importance of the town's watersource, an investigation into the vulnerability of the wellfield infrastructure is warranted. To mitigate the risk of salt water intrusion through the wellhead, the Town will look to ensure that all water sampling wells are water tight and future upgrades to well pits may involve raising the wellhead elevations.

3.3 Important Infrastructure and Facilities during an Emergency

The team identified the following facilities and infrastructure as being important during an emergency situation:

Facilities

- Police Station (21 Acadia Street)
- EHS (43 Albion Street)
- Cumberland Regional Health Care Centre (Hwy #2)
- Fire Station (70 South Albion Street)
- RCMP Detachment (West Victoria Street)
- Public Works Garage (14 McCully Street)

Infrastructure

- Transportation network
- Stormwater drainage system
- Emergency Communication System
- Water reservoir and backup systems

Step 4: Who Will be Affected

4.1: Vulnerable People and Places

Within the Town's borders, the team identified those who may be vulnerable to the hazards associated with climate change. In general, those with mobility issues and the elderly may be vulnerable during a major storm event that causes power failure over the course of several days. Intense precipitation could cause flooding along Dickey and Etter's Brook. In this circumstance the impact is likely limited to some property damage only; however, in any flooding situation there is increased risk to public safety. This risk increases with the extent of the flooding. A major marsh flood increases the affected area to properties located along the marshlands, and include (but may not be limited to) the following Town streets:

- Terrace Street
- Lennox Avenue
- Russell Street
- Copp Avenue
- Brownell
- West Victoria Street
- Haliburton Street
- Redland Street
- Foundry Street
- Lamy Street

The team also looked at the location of schools and properties containing seniors. As shown on Figure 7, none of these facilities are located within areas at risk of flooding.

Emergency Management Plan

The Town of Amherst *Emergency Management Plan* (EMO Plan) contains an analysis and response to potential emergencies and disasters given its geographical location, types of local industries, and other contributing factors. The EMO Plan addresses the characteristics, critical issues, prioritized actions, responsible Town departments, and community services organizations in the case of the following emergencies:

- Winter storm event
- Chemical/dangerous materials spill
- Hurricane/violent winds
- Epidemic/pandemic
- Flooding
- Power failure
- Train derailment

The plan also identifies those able to offer assistance during an emergency and what their role in the response would be. Depending on the type of emergency, the plan identifies the following responders:

- Town Operational Services (Public Works)
- Local radio & amateur Radio Club
- Nova Scotia Power
- Amherst Fire Service
- N.S. Department of Agriculture
- N.S. Department of Community Services
- Emergency Health Services
- Amherst Police Services and RCMP
- Red Cross
- CN Rail
- N.S. Department of Environment
- Heavy equipment contractors
- Cumberland Health Authority
- Cumberland Snowmobile Club

While the EMO Plan comprehensively details a response to the above emergencies, the team acknowledged that the plan should be updated to reflect newly identified hazards and vulnerabilities as a result of climate change. In particular, the EMO Plan should be reviewed with respect to a major flood of the isthmus that could require an organized response involving multiple entities on a regional scale.

4.2: Economic Considerations

The team considered the potential impacts climate change might have on the local and regional economy. The three largest employment sectors in the Amherst economy are manufacturing, retail trade, and private sector services. Combined, these sectors employ just under 70% of the total workforce. Strength in these sectors is partly due to the Town's central location within the Maritime Provinces and easy access to transportation links, as well as, its central location for retail services within the North Cumberland County region. It should be noted that agricultural and resource-based industries employ only 2.5% of the total workforce, and while at first glance one might consider this sector to be the most vulnerable to climate change, the team acknowledged that the transportation routes across the isthmus are critical to the local and regional economy.

As discussed previously, the dyke system protects approximately $70 million in assets, and allows about $10 billion in trade to move across the Chignecto isthmus annually (Webster and Pett, 2012). Any disruption to rail or road transport by flooding would have a significant negative economic impact on the Province. The impact would also be felt at the local level, as only a small percentage of local manufacturing output services the local economy. Moreover, a serious marshland flood could destroy small local businesses that are located within the marshlands, and damage to Town infrastructure such as the waste water treatment facility could cost Town significantly. It is therefore in the Town's best interest to continue to advocate for a comprehensive dyke system management plan that takes climate change and vulnerable assets into account. The risk of marshland flooding to the health of the local economy is also a risk to Provincial economy.

On the other hand, warmer temperatures may potentially have a positive economic impact in some sectors. For example, a warmer and longer 'tourist' season could result in more visitors staying longer in the area. Similarly, a longer summer season may extend the growing season, which might benefit the agricultural sector.

4.3: Environmental Issues

Within its boundaries, Amherst does not contain a significant amount of undeveloped area, sensitive habitat, or endangered species populations. However, important ecosystems exist throughout the Chignecto isthmus, including a National Wildlife Area (Lusby Marsh), inshore wetlands, and the Chignecto Isthmus Wilderness Area. This wilderness area not only protects the Town's drinking water, but is also recognized as an important wildlife corridor between Nova Scotia and mainland North America.

The team considered sea level rise and increased risk of flooding within the isthmus as the most significant environmental issue facing Amherst and the isthmus. Although it is difficult to predict what impact climate change could have on ecosystems in the area, the introduction of sea water by a major storm surge from the Bay of Fundy to the south or from Baie Verte from the north would definitely have an immediate negative impact.

In terms of hazardous materials, there are several properties that have onsite storage of hazardous materials, from petroleum to chemicals used in agriculture and manufacturing. Figure 7 below shows the locations where hazardous materials are stored. In addition to regulations specific to the type of material (ex. petroleum management is regulated under the N.S. Environment Act), all hazardous material storage is reported to, and given approval by, the Director of Emergency and Property Services. This information is provided to the Town of Amherst Hazmat Response Unit in the case of a fire or spill. Beyond the immediate Hazmat Response Unit, the Emergency Management Plan further provides prioritized actions, responsible Town departments, and organizations that would carry out those actions in response to such an event. This includes a coordinated response to the derailment of a train carrying hazardous materials.

Figure 7: Location of hazardous material storage in relation to a major marsh flood scenario

Step Five: Priorities for Action

Based on the analysis of the potential issues and hazards discussed above, the team identified the following priorities for action:

ISSUE 1: **Marshland Flooding** (high priority)

Currently, dykes along the Chignecto Isthmus would be overtopped if a 1:10 year storm surge occurred in the Bay of Fundy during an extreme high tide. In addition, the LaPlanche River aboiteaux is over 50 years old, and is in need of replacement. Failure of the aboiteaux or overtopping of the dykes could potentially cause widespread damage to property and high value infrastructure, and even threaten the vital transportation corridor linking Nova Scotia to New Brunswick. While the Town of Amherst has no direct control over these systems, there are several actions that can be undertaken to mitigate the risk.

Action 1: **Be an engaged stakeholder**

Advocate at the Provincial and Federal government level for a long term management plan that not only addresses current vulnerabilities, but also involves a long term plan that accounts for the potential impacts of climate change (sea level rise, increased storm events). The management plan should include a cost benefit analysis of the assets protected by the dyke system to determine the level of acceptable risk, which would then dictate dyke height.

Action 2: **Develop a flood contingency plan for vulnerable infrastructure**

While the risk of marshland flooding is dependent upon the dyke system, a review of the treatment facility, lift stations, and Tyndall Wellfeild should be undertaken to fully anticipate a flood event. The review would identify vulnerabilities that could be corrected or mitigated.

Action 3: **Community Engagement**

Although the risk of marshland flooding has not significantly changed, property owners within the projected flood zone should understand what the risks are.

Action 4: **Update the Emergency Management Plan**

The EMO Plan should be reviewed and possibly updated to account for a large-scale flood of the marshlands. This review should also consider protocols for hazardous material spill due to a train derailments within Town, and a bulk fuel carrier accident in or around the Tyndall Wellfield.

Action 5: **Review Development Regulations**

Policies within the Municipal Planning Strategy and the Land Use Bylaw do not account for potential flooding within the marshlands. A review of these documents should be undertaken to determine if regulatory changes are needed to appropriately protect property and development that is located in areas vulnerable to flooding along the marhslands.

ISSUE 2: **Inland Flooding** (Medium priority)

It is anticipated that climate change will result in more extreme weather events that will put added pressure on stormwater infrastructure.

Action 1: **Dickey Brook Stormwater Management**
Over 1/3 of the Town's land area drains into Dickey and Etter's Brook. While the brooks run over private land, Town infrastructure (culverts) influences the rate of flow. Changes to culvert size and other upstream inputs into the brooks must take its capacity into account.

Action 2: **Stormwater Infrastructure Design Specifications**
The Subdivision Bylaw requires that all new subdivision developments include a stormwater drainage system to accommodate a 1:100 return period storm. A review of the design standards under the Subdivision Bylaw should be conducted to ensure adequate capacity. Similarly, an analysis of built systems should be conducted and upgrades should be planned for where deficiencies are identified.

Land Use Policy Influenced by Climate Change

Amherst's Municipal Planning Strategy (MPS), Land Use Bylaw (LUB), and Subdivision Bylaw the Town's land use policies and regulations. This policy framework is one of the primary municipal tools for dealing with climate change adaptation and mitigation. Although perhaps not explicitly stated in the current documents, there are several policies that speak to climate change mitigation through its built form. Residential policies include the encouragement of efficient use of land through infill, and contiguous residential development. Minimum lot size and frontage requirements have been reduced to allow greater density in single-family home developments. These policies help to keep the community more compact and walkable, reducing vehicle travel distances, which reduces emissions. Other recent changes in the MPS are aimed at strengthening policies around development in the downtown to encourage residential uses above ground floor commercial, and require that the traditional downtown commercial character is preserved. These policies, along with significant capital investment in public spaces, are directed at increasing active forms of transportation (walking and cycling), and reducing vehicle trips. Reduced vehicular use translates into lower emissions overall for the community.

In terms of adaptation to climate change, existing land use policies already address some the issues and hazards identified in this plan, while other issues need to be incorporated into policy. The MPS and LUB includes a Flood Plain Zone along Dickey Brook that prohibits main buildings and severely restricts accessory buildings. The Subdivision Bylaw includes provisions for stormwater system design to accommodate a 1:100 year storm, as well as, the requirement that new development not increase peak flow into Dickey Brook. However, there are climate change issues that are not addressed sufficiently or at all.

Stormwater management, especially as it relates to Dickey Brook requires a holistic approach. With so many upstream inputs into the Brook, it could be argued that peak flow has increased over time. With increased intensity of precipitation due to climate change, this peak could become an increasing problem over time. However, increasing capacity through larger pipes and culverts will likely cause problems downstream around Etter's Brook. As such, any changes to the Stormwater system must be looked on with the view of reducing peak flow and/or increasing retention capacity upstream. This issue should be addressed within the land use policies, particularly in new subdivision design.

The second climate change issue that should be addressed in the land use policies is the potential flooding of property near the marshlands. In general, the properties in this area are moderate, low-density residential uses, with very little new development. Potential approaches to land use policy that would address this flood risk include: restricting new development in this area, requiring flood proofing, and establishing minimum building elevations. However, it must be emphasized that any approach must start with consulting the land owners in this area to ensure they understand the risk.

Part 2: Mitigation

Greenhouse gases (GHGs) generated by human activity have risen sharply as the world's population expands, industrialization spreads and the consumption of resources accelerates. The inevitable consequence of this growth is an increase in greenhouse gas emissions, leading to a rise in average global temperature, the disruption of climate patterns and the irreversible alteration of the ecological balance of our planet (Fisher 2011).

Canadian municipalities contribute, directly or indirectly, to approximately 44 % of total GHG emissions in Canada (EnviroEconomics 2009). As such, municipalities big and small have a significant role to play in reducing GHG emissions by reducing their use of energy. Over the last decade, the Town of Amherst has made significant progress toward energy reduction while realizing decreased operational costs. A summary of this progress is provided below:

Buildings

- Natural gas conversion - As of 2012, all town buildings have been converted from oil and electrical heating systems to natural gas.
- Efficient lighting – all building and facilities have been retrofitted with efficient lighting, reducing conventional incandescent and fluorescent lighting.
- Upgrated lighting controls – in areas of intermittent occupancy, conventional switches have been upgraded to occupancy sensors, and outdoor lighting is on light sensing timers.
- Stadium upgrades – heat recovery units installed that the stadium capture waste heat from the ice plant to supplement hot water needs for the building.
- Temperature control – thermostats have been upgraded to programmable units that adjust temperatures during off-hours.

Street lighting

- All streetlights and traffic signal lighting have been upgraded to LED.

Vehicles

- Implementation of corporate anti-idling polices to reduce fuel use.

New Facilities

- New Town facilities are designed to minimize energy use. The new waste water treatment facility includes a highly efficient building, as well as, a 50 kw wind turbine (under construction).

The Town's corporate energy consumption has been quantified in the UNSM Corporate Energy and Emissions Spreadsheet as part of a detailed Municipal Energy Audit conducted in 2010 (Nova Dynamics 2010). A detailed spreadsheet of Town energy and emissions as of 2008 was generated as part of the audit, and will be submitted with this plan to the Canada-Nova Scotia Infrastructure Secretariat. Taken from this detailed spreadsheet, the following table summarizes annual Town energy consumption, cost, and emissions as of 2008. It should be noted that due to several significant investments in efficiency upgrades to buildings and street lighting, these numbers may not accurately reflect the Town's current energy consumption.

Emission Category	Energy Type	Energy Consumption	Units	Cost ($)	Emission Factor (tCO2e)	Emissions (tCO2e)
Buildings	Electricity Nat. Gas Fuel Oil	1,733,440 4,360 0	KWh GJ G	254,465 69,528 0	0.868 kgCO2/L 50.79 KgCO2/GJ	1,726 222 0
Water/Sewer	Electricity Oil	1,417,545 5,196	KWh L	165,479 3,572	0.868 kgCO2/L 2.68 kgCO2/L	1,230 35
Street lights	Electricity	949,484	KWH	179,173	0.868 kgCO2/L	824
Vehicles	Gasoline Diesel	104,270 50,211	L L	101,976 49,113	2.34 kgCO2/L 2.63 kgCO2/L	244 132
Totals				**823,306**		**4,413**

As a result of the 2010 energy audit, several recommendations have been implemented as outlined above. While significant mitigation progress has been made, it is currently unclear what further areas of corporate emissions should be targeted on a cost benefit basis. In order to determine the most prudent and effective way to target further reductions in emissions, the team felt that the 2010 Municipal Energy Audit should be updated to reflect efficiency upgrades, new buildings and facilities, and the shared solid waste facility. Based on this review, the Town would establish new goals and objectives to decrease energy use while reducing costs and emissions over time.

Implementation

The second energy audit would be completed in the 2015/2016 fiscal year, at an approximate cost of $15,000.

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