



Climate Change Strategy - Technical Report

September 2014

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Executive Summary

The Town of Oakville is situated on the north shore of Lake Ontario in the Greater Toronto Area (GTA) and is home to over 186 4000 (2014) people and growing.

Methodology

The Town of Oakville joined ICLEI Canada's Changing Climates, Changing Communities municipal climate change adaptation program in 2011 as one of 12 initial signatory municipalities. This decision was based on the involvement that the town's Environmental Policy department had with the creation of this municipal climate change adaptation toolkit.

In 2010 town staff was approached by ICLEI to host a meeting intended to gauge interest across Canada in the development of a strategic, municipal milestone based toolkit approach to climate change adaptation, similar in structure to the municipal Partners for Climate Protection (PCP) greenhouse gas emissions reduction program created several years earlier. This meeting, hosted at Town Hall, drew representation from Nunavut, Vancouver, Alberta, Ontario and New Brunswick.

Council endorsed the participation and formation of the town's Climate Change Adaptation Team at its meeting in May 2011. Since then town staff have been working to identify what impact changing weather patterns and extreme weather will have on the town, both as a corporation and as a community. Representation from each department and input from all staff levels were crucial in identifying the impacts and the degree of vulnerability or risk that each climate change impact could place on the town.

The Town of Oakville has successfully completed Milestones 1 and 2 of the 5 Milestone process. Milestone 3 will be achieved with the endorsement of this Strategy. Milestone 4 and 5 will be awarded for the implementation, tracking, monitoring and continuous improvements made over the life of this strategy.

Vision

To build the town's resiliency to the impacts of a changing climate.

Objectives

Progress made on the consideration and implementation of adaptation actions will work to fulfill the following climate change objectives.

Objective 1: To increase the town's capacity to protect against and respond to projected climate change impacts.

- Comply with current legislation
- Provide input on proposed and existing legislation
- Build mitigation and adaptation considerations into existing and new plans, policies and projects
- Embed climate change considerations in staff reports and purchasing processes

Objective 2: To educate through effective and efficient means of communication.

- Be timely and proactive using a multi- media approach
- Participate in internal and external outreach and educational events
- Encourage training and continuous education through webinars, conferences and courses

Objective 3: To monitor the implementation of adaptation actions and goals in order to make continuous operational improvements.

- Identify and use available funding and partnerships to support actions
- Support innovation and research on best management practices and new technologies
- Initiate, research and implement best management practices (BMP)
- Review impacts and vulnerabilities annually

Data Collection and Projections

Data from Environment Canada projects that the climatic changes expected to impact the town include:

Table 1: Increase in annual averages







Symbol	Climatic Change	Degree of Change	
		Observed	Projected
	Temperature	An increase of 1.3°C occurred between 1976 and 2006.	A further increase of 2.6°C by 2050
	Precipitation	A 12% increase occurred in last 50 years.	A further increase of 5.1% is projected by 2050.

Table 2: Increase in severity and frequency of extreme weather events

Symbol	Climatic Change	Degree of Change	
		Observed	Projected
	High wind	In the past, an average 12 tornadoes were reported to Environment Canada each year in Ontario. Recent numbers have increased: 23 in 2006, 29 in 2009 and 22 in 2013	8 confirmed tornadoes have touched down already in 2014. Possible that rising air and water temperatures will contribute more tornado activity.
	Precipitation, Thunder and Lightning	Tropical Storms: once every 11 years – four have occurred from 2003 to 2009. Thunderstorms: 30 or more occurred each year from 1971 to 2000.	Warmer temperatures and a rise in atmospheric water vapour will cause an increase in thunderstorm activity.

	Winter Precipitation Events	The average annual snowfall for the Toronto area is 122cm, distributed over 40.9 days.	The occurrence of freezing rain is expected to increase in the order of 10 to 20% on average – northern Ontario to expect more than southern Ontario.
	Temperature and Air Quality	16 'extreme heat' days were experienced from 1971 to 2000. Oakville experienced 30 'extreme heat' days in 2005 alone.	These numbers could more than triple by 2080.

Governance Documents

Although the town has much control over the planning and execution of development and infrastructure projects within its boundaries, the town is also influenced by policy and decisions made at multiple levels of government including national, provincial and regional.

The Town of Oakville is a known leader in the field of environmental protection. The development of this strategy has been preceded by a number of on-going climate change mitigation and adaptation policy, procedure, project and program actions that are discussed throughout Section 6.0 of this Strategy.

Impact Statements and Themes

The impacts of climate change and the associated mitigation and adaptation efforts stretch across several levels of governments and many town departments. To help provide clarity to the impact statements and the departments responsible for implementing and overseeing the adaptation actions, these impacts statements were categorized into the following operational themes:

- Natural Environment and Biodiversity
 - Harbour Operations and Lake Ontario
 - Creeks and Channels
 - Urban Forestry, Trails and Natural Areas
- Recreation and Tourism
- Health and Wellness
- Built Environment
 - Transportation Infrastructure and Operations
 - Buildings, Planning and Land Use
 - Storm Water Infrastructure












Section 4.0 of this Strategy categorizes general impact statements related to the projected climatic changes while Section 6.0 categorizes specific impact statements related to their impact on an operational theme.

Conclusions

One of the most beneficial aspects to the development of this Strategy is how it fostered dialogue and generated new ideas building from the interdepartmental team approach.

Of the 39 identified impacts, there are over 400 actions planned, underway or on-going, these will continue to be implemented and tracked. Many of these adaptation actions will cross over themes and have multiple co-benefits across town operations.

Of the 39 impacts, 11 are considered of high vulnerability, although the risk of occurrence is still to be determined.

Vulnerability Level	Impact Statement	Adaptation Actions	Climatic Change
V5	Northerly migration and longer life span of invasive and non-native plants and insects.	18	
V5	Increased instances of trail and park closures and clean up associated with extreme weather events.	7	
V5	Increased stress on vegetation due to extreme weather and changes to soil moisture and composition.	13	
V5	Transportation infrastructure is subject to flooding due to extreme and longer duration extreme precipitation events.	24	
V5	Increased vulnerability of electrical distribution systems due to the occurrence of frequent and intense extreme weather events.	10	
V5	Overland flooding could result from variable temperatures and an increase in the intensity, duration and frequency of extreme weather events.	31	
V4	Winter control operations will be impacted by the variable temperature and precipitation patterns as well as extreme winter storm events.	12	
V4	A decrease in water levels will impact harbour revenue, operations and rates.	10	
V4	Creeks and channels may meet or exceed capacity during extreme precipitation events.	9	
V4	Extreme weather events such as heavy precipitation, high winds and lightning storms can compromise the health and safety of staff and residents.	19	
V4	Increased risk associated with railway and pipeline infrastructure due to extreme temperatures and extreme weather events.	12	

The town is vulnerable to these 11 impacts only if they are to occur, which is what is yet to be determined. It is recommended that the above 11 impacts be scrutinized further through an integrated risk management (IRM) process and by doing so will work to complete Priority Action 1. The IRM process will prioritize the above impacts through discussions on the likelihood of the impact happening and consequence of when it does happen.

Next Steps

Through the development of this strategy, five priorities were determined to be critical in order to improve on the town's climate change preparedness. It is recommended that the town:

- 1) Incorporate climate change considerations, strategies and actions into appropriate policies, procedures, plans and purchasing decisions.
- 2) Continue to research and implement climate change mitigation and adaptation actions including, but not limited to those mentioned in Section 6.0 under the heading Adaptation Actions.
- 3) Develop a tracking and monitoring tool related to climate change adaptation.
- 4) Conduct a more detailed and integrated risk assessment on all impacts with vulnerability of V4 and V5.
- 5) Based on the more comprehensive integrated risk assessments the phased implementation of actions will continue.

Introduction

Town Council's vision 'To be the most livable town' could not be better suited to the discussion of climate change mitigation and adaptation. To be the most livable town one would expect the town to be committed to building resiliency across operations, increasing the town's capacity to respond to a changing climate and extreme weather conditions and to take a proactive approach to emergency management to protect human health and safety and the environment.

Variable temperature and precipitation patterns, more intense, frequent and longer duration extreme weather events, including high winds, heavy precipitation, and lightning and micro-burst storm activity all have severe impacts on our natural and built environments and personal safety which requires us to act and adapt.

In Oakville, we are proud of our community's history of rising to meet these challenges.

The town has implemented **Business Continuity Management (BCM)** to ensure that critical services and functions are maintained in the event of an interruption or emergency. The town will prepare, exercise and maintain plans to facilitate the continuity of critical services and functions so far as is reasonably practical when faced with an interruption or emergency.

Critical Services and Functions are defined in the BCM policy as services and functions which if disrupted, will cause a significant financial, operational, legal or regulatory impact to the town. The BCM policy will be crucial to the implementation of Next Steps recommended in this Strategy.

Town staff has been supported in the development and implementation of key policies, programs, by-laws and procedures that provide clear direction to implement mitigation and adaptation measures into town operations and services in light of our changing climate. These items are discussed in detail throughout Section 6.0 of the Strategy as they are related to building resiliency to specific climate change impacts.

The development and implementation of the Environmental Strategic Plan as an over-arching policy document provided staff with the context to begin and continue work related to climate change adaptation and mitigation.

Environmental Strategic Plan (ESP)

Council approved the initial ESP in December 2005 to help improve the environment in Oakville. The ESP provides opportunities for residents, community groups, commercial interests, industry, resident associations, educators and other stakeholders to identify what they and the town can do to protect and improve their environment. Progress on the implementation of the plan is reported annually to Council.

An update to the ESP was approved by Council in December 2011. This update reflects the success of the accomplishments to date and sets out new actions for the next five years. The development of this Climate Change Strategy acts upon an ESP recommendation.

The development and endorsement of this Climate Change Strategy and the associated community and staff outreach program continues this commitment to further advance the resiliency of our community to climate change.

Livable Oakville - official plan - 2009

Livable Oakville, the town's official plan contains "goals, objectives and policies established primarily to manage and direct physical change and the effects on the social, economic and natural environment of the municipality" from 2009 to 2031. Each of the 'general policies' in Part C of this plan supports the development

and implementation of this Strategy. Climate change is also recognized with a clear policy statement of its own:

“10.2.1 The town recognizes that a key initiative to mitigate the impacts of *climate change* is the reduction of greenhouse gas emissions. The Town will work to mitigate and adapt to *climate change* by initiatives that include, but are not limited to:

- a) Encouraging energy generation from renewable sources as well as *district energy*;
- b) Promoting increased levels of transit usage and active transportation modes;
- c) Establishing targets for reducing greenhouse gas emissions and improving air quality;
- d) Encouraging energy efficient and green buildings; and,
- e) Reducing the risk of *infrastructure* damage during severe weather by encouraging the location of utilities underground and improving Town infrastructure. “

Throughout Section 6.0 of this Strategy the goals and objectives of Livable Oakville will be highlighted as they relate to mitigating and adapting to climate change impacts.

The 2014 Provincial Policy Statement (PPS) under the Planning Act provides municipalities with provincial direction and minimum standards related to climate change previously not included in the 2005 version. The 2014 update requires the consideration of potential climate change impacts and supports the reduction of greenhouse gas emissions through energy efficiency, transit improvements, active transportation, green infrastructure and stricter stormwater management requirements.

The new PPS encourages consideration of climate change and resiliency in land use planning beyond a 20 year timeframe. The five-year review will strengthen the climate change and resiliency aspects of the official plan as outlined in the 2014 PPS.

1.0 Methodology

The Town of Oakville has implemented climate change mitigation programs and has been considering climate change adaptation throughout multiple departmental processes prior to the creation of this formal strategy.

1.1 Partners for Climate Protection

At the meeting of February 2, 2004, Council approved Oakville's membership in ICLEI and the joint ICLEI-Federation of Canadian Municipalities Partners for Climate Protection milestone program to move forward on a greenhouse gas emissions reduction strategy to reduce emissions at both the corporate and community level. The PCP program uses a five milestone framework, to guide municipalities through a structured methodology. The Town of Oakville has achieved up to milestone three of the five milestones.

The greenhouse gas releases and reduction strategies related to the PCP program are discussed further in the Built Environment theme in Section 6.0.

This climate change adaptation program followed a similar methodology to that of the Partners for Climate Protection (PCP) program by using a milestone process and framework with application under advisement by ICLEI.

1.2 Changing Climates, Changing Communities

In 2010 the town had the opportunity to support ICLEI's development of a municipal climate change adaptation milestone program.

The Town of Oakville hosted ICLEI's initial Canada wide meeting, which drew representation from Nunavut, Vancouver, Alberta, Ontario and New Brunswick. Municipal staff from across Canada provided input to ICLEI on how they needed this 'climate change municipal milestone toolkit' to look and function.

The *Changing Climates, Changing Communities* framework and municipal toolkit was developed by ICLEI and launched nationwide in 2011. Town Council endorsed participation in this program through of a formal resolution in May 2011. This initiative and framework is methodical and well suited for municipal application that supports a consistent approach across Canada. Participation offers facilitation, support, collaboration and direction from ICLEI Canada staff and 12 of the participating signatory municipalities.

Council endorsement was an essential component to completing milestone one of the five milestone process. Details on each milestone can be found in Figure 1.



'The diversity of ICLEI's work is best described in three simple phrases: connecting leaders, accelerating action and a gateway to solutions.'

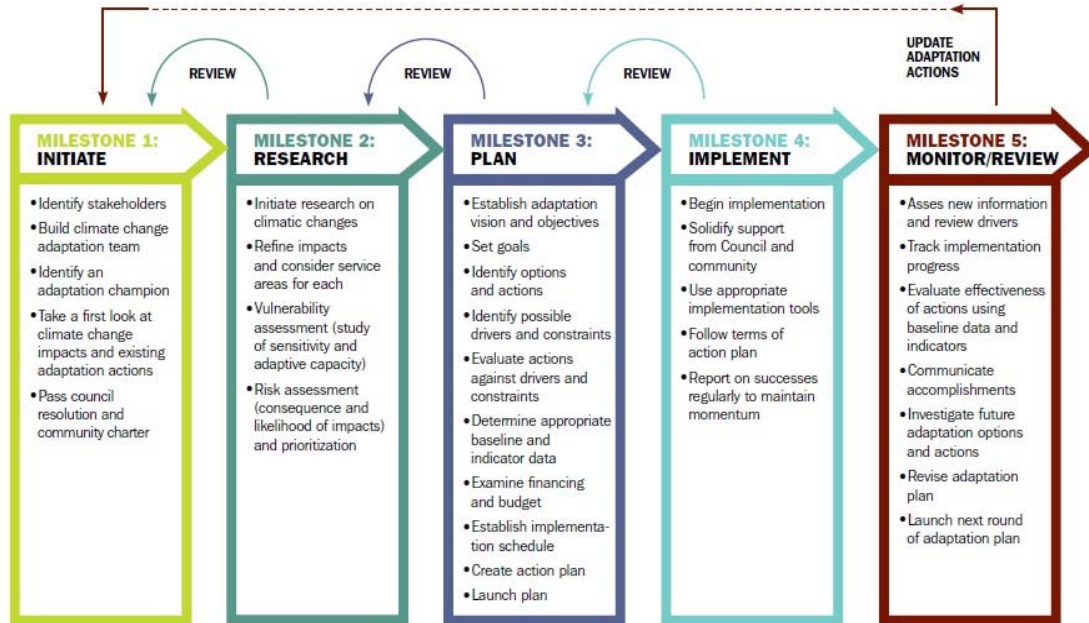


Figure 1: ICLEI's Changing Climates, Changing Communities milestone framework.

Once endorsed by Council, representatives were requested from each of the town's key departments. Refer to Appendix A for a complete list of internal and external team members. The process was highly collaborative and involved:

- Regular team meetings and interviews with staff at various levels and responsibilities to identify impacts related to changing weather patterns and extreme weather events;
- Presenting findings to Council and Senior Management;
- Ongoing interviews and refinement of impacts;
- Conducting vulnerability assessments on the impacts and identifying existing town actions that help to mitigate or adapt to climate change;
- Developing the Town of Oakville's Climate Change Primer – a public outreach document to explain basic climate change science, complexity and cost of climate change and provides the community with actions they can take to improve their preparedness to climate change.
- Examining existing town mitigation and adaptation programs.
- Developing the town's Climate Change Strategy with identified actions and tracking mechanisms.

Milestone 3 will be achieved with the endorsement of this strategy by Council. This is a living document that will be updated as new impacts are identified and new data becomes available. As actions are implemented tracking mechanisms will be discussed, implemented and reported to Council annually.

Although staff has found the ICLEI methodology well suited to the purpose of creating this strategy, this is only one of several resources used by the town. Staff has been actively participating in climate change discussions across Canada and in the Greater Toronto area through several organized networks such as the GTA- Clean Air Council, the Great Lakes Cities Initiative's Municipal Adaptation and Resiliency Service (MARS) and the Professional Engineers of Ontario. These networks and others are discussed in Appendix A.

2.0 Strategy Vision and Objectives

Oakville's vision of being the most livable town could be impacted if work to enhance the town's resiliency to a changing climate is not underway with a defined strategy that can organize and integrate multi-departmental initiatives and track progress to climate change readiness.

2.1 Strategy Vision

To build the town's resiliency to the impacts of a changing climate.

2.2 Strategy Objectives

Many impacts and associated adaptation actions have been identified through the development of this climate change adaptation strategy. Progress made on each of these adaptation actions will work to fulfill the following climate change objectives.

Objective 1: To increase the town's capacity to protect against and respond to projected climate change impacts.

- Comply with current legislation
- Provide input on proposed and existing legislation
- Build mitigation and adaptation considerations into existing and new plans, policies and projects
- Embed climate change considerations in staff reports and purchasing processes

Objective 2: To educate through effective and efficient means of communication.

- Be timely and proactive using a multi- media approach
- Participate in internal and external outreach and educational events
- Encourage training and continuous education through webinars, conferences and courses

Objective 3: To monitor the implementation of adaptation actions and goals in order to make continuous operational improvements.

- Identify and use available funding and partnerships to support actions
- Support innovation and research on best management practices and new technologies
- Initiate, research and implement best management practices (BMP)
- Review impacts and vulnerabilities annually

3.0 Data Collection and Climate Change Scenarios

3.1 Data Collection

The data collected and used to populate this report primarily comes from Environment Canada, Climate Ontario, the International Panel on Climate Change (IPCC) and Canadian Climate Change Scenarios Network (CCCSN). The collected data has been summarized by ICLEI Canada and the Town of Oakville.

Environment Canada has an extensive list of observation stations collecting climate data throughout the country. The nearest observation station, with at least 70% available data in Oakville is located at the Water Pollution Control Plant (WPCP) in south east Oakville, as seen in Figure 2 below.

Observation stations, that have at least 70% available data, are selected by the CCCSN to create Localizer Reports, Oakville's Localizer Report for May 14, 2014 can be found in Appendix B. Localizer Reports can be generated at will and Oakville's report has been generated twice (2011, 2014) during the development of this Strategy.

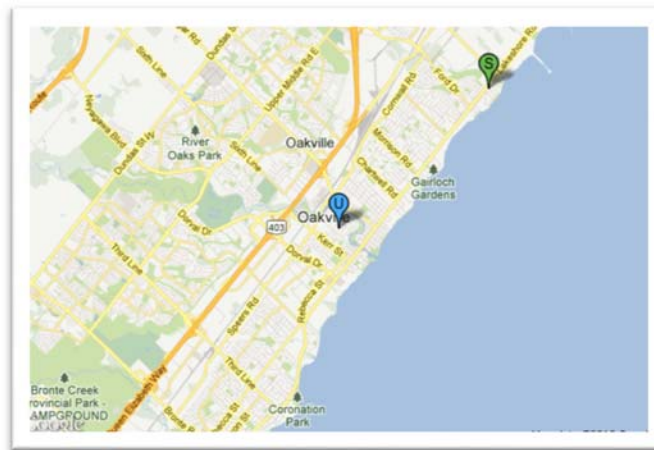


Figure 2: Location of data observation station in Oakville, Ontario. (Oakville WPCP (id: 615N745) (43.48N 79.63W))

3.2 Climate Change Baseline and Projection Timeframes

The CCCSN Localizer Reports allows a user to obtain climate change projections from an ensemble of climate models. The Localizer uses the climatology of the observation station for the period of 1971 to 2000 as the baseline climate. As recommended by the IPCC, the most recent 30 year 'climate normal' period should be used as the climatological baseline for impact and adaptation assessments as this data:

- Is representative of present-day or average;
- Encompasses a range of climatic variations and weather anomalies;
- Provides adequate coverage of a wide range of climate variations; and
- Is of high quality.

The future time periods of 2020, 2050 and 2080 are added to the observed baseline which results in a projected scenario that is 'bias-corrected' to the location. The 2050 projected scenario is the most trusted time period, as projections start to deviate thereafter. As recommended by Environment Canada, the projected timeframe of 2050 is used for this strategy.

3.3 Climate Change Scenarios

For the purpose of this strategy the town uses the data represented in the A2 High Emissions and B1 Low Emissions scenarios. Each scenario is made up of over 20 different global climate models and characteristics of each scenario can be found in the table below. The A2 High Emissions scenario, is considered to be closest to observed trends.

Scenario	A2 High Emissions	B1 Low Emissions
Population Growth	Low	Low
GDP Growth	Very High	High
Energy Use	High	Low
Land Use Change	Low	High
Oil/Gas Resource Availability	Medium	Low
Technological Change	Rapid	Medium
Change Favouring	Non-fossil fuel	Efficiency and dematerialization

Figure 3: Climate change scenario characteristics.

Monthly, seasonal and annual projected values of temperature and precipitation are calculated from the collective of these models.

4.0 Climatic Changes Projected for Oakville

This section describes the anticipated climatic changes for Oakville broken down by: 1) increases in annual averages and; 2) increases in severity and frequency of extreme events. Information on other climate change scenarios and timeframes can be found in Appendix B, Oakville's Localizer Report, generated by Environment Canada.

As noted, for the purpose of this strategy the A2 High Emissions and B1 Low Emission scenarios and timeframe projection of 2050 are used.

The climatic changes projected for Oakville are:



4.1 Increase in annual average temperatures



4.2 Increase in annual average precipitation

4.3 Increase in the severity and frequency of extreme weather events including:



High wind



Heavy and longer duration precipitation events with increased lightning



Extreme temperatures



Winter precipitation

These changes are also impacting communities worldwide and range from the destruction of urban forests, to the spread of infectious disease, to the degradation of steel and concrete infrastructure – to name only a few.

'The Complexity and Cost of Climate Change' is discussed in more detail on both a national and local level in *Oakville's Climate Change Primer*. Information is provided on how the complex interaction of the climate system and society contributes to the difficulty in identifying climate changes and impacts, as well as the costs of these impacts.

Despite the complexity of climate change, there are projections for different regions based on meteorological models. Modelling of southern Ontario's climate has produced three distinct expectations including: an increase in average annual temperatures, an increase in average annual precipitation, and an increase in the severity and frequency of extreme weather events.



4.1 Increase in average annual temperatures

Between the years 1976 and 2006, the average annual temperature in Canada increased by 1.3°C.¹ By 2050, the annual temperature increase is projected to be between 2.3°C to 3.7°C in southern Ontario² and 2.6 °C in Oakville (Appendix B). This annual increase is projected from the A2, High Emissions (business as usual) climate scenario (shown in Figure 3).

Table 3: Baseline and 2050 projected temperature data using A2 and B1 emission scenarios.

	Annual	Winter	Spring	Summer	Fall
(1971-2000)	8°C	-3.9°C	6.2°C	19.4°C	9.5°C
A2	2.6 ± 0.6°C	2.9 ± 0.5°C	2.4 ± 0.5°C	2.7 ± 0.4°C	2.6 ± 0.3°C
B1	2 ± 0.5°C	2.1 ± 0.5°C	1.9 ± 0.6°C	2 ± 0.6°C	2 ± 0.6°C

Note: Temperature baselines and projections have been generated by the Canadian Climate Change Network Scenarios (CCCSN) for Oakville.

Even with a decrease in energy use, lower gross domestic product growth and a change favouring efficiency as noted in the B1 scenario, a 2°C increase in temperature is still projected to occur. The largest shift in temperature will likely occur in the winter months, as depicted by both A2 and B1 emission scenarios. Figure 4 compares the 2050 scenario to 2020 and 2080.

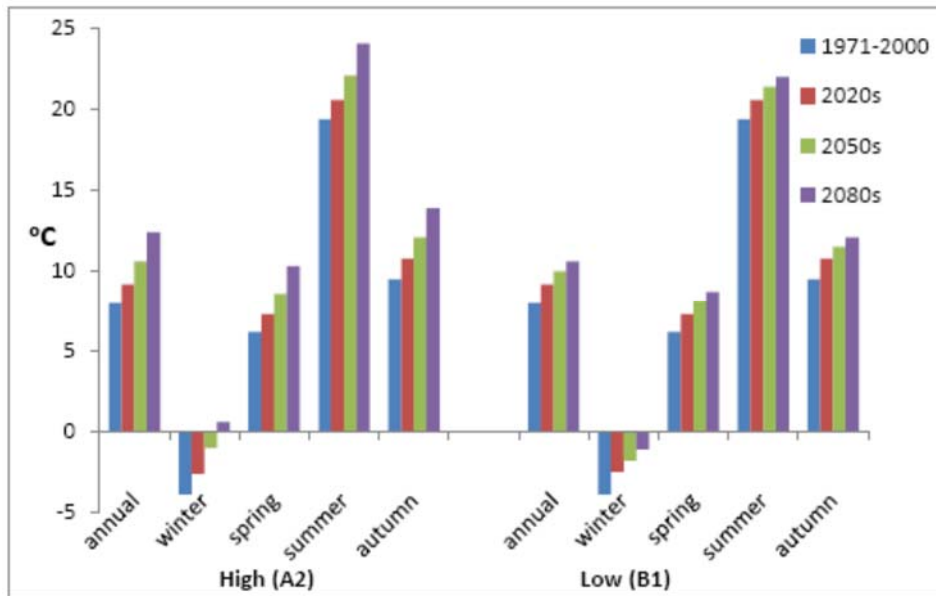


Figure 4: Average baseline and projected annual and seasonal temperatures in Oakville.

Note: Temperature baselines and projections have been generated by the Canadian Climate Change Network Scenarios (CCCSN) for Oakville, ON. For a more detailed breakdown of temperature (by month) for Oakville see Appendix B: CCCSN Localizer Report.

A rise in temperature, especially in the winter months, will have impacts on natural, built and human systems. Table 4 summarizes these impacts that will be seen in Oakville and classifies them according to a 'theme' to help provide clarity to where those impacts will be felt and actions will need to be taken.

Table 4: Summary of general impact statements related to an increase in average annual temperatures.

Impact	Theme
Northerly migration and longer life span of invasive, non-native and noxious plant species.	Natural Environment and Biodiversity Health and Wellness
Increased freeze/thaw cycles and variable temperatures will stress infrastructure.	Natural Environment and Biodiversity Health and Wellness Built Environment
Changes to soil composition and moisture levels.	Natural Environment and Biodiversity
Increasing temperatures and decreasing water levels could lead to vulnerable farming practices and local food supply.	Natural Environment and Biodiversity
Decrease in water levels will threaten sensitive aquatic species and habitats as well as recreation facilities at town harbours.	Natural Environment and Biodiversity
Longer seasonal staff and equipment contracts.	Natural Environment and Biodiversity
Increased energy and water usage in summer months.	Natural Environment and Biodiversity Recreation and Culture Health and Wellness Built Environment
Changes in the migration patterns and habits of native wildlife.	Natural Environment and Biodiversity

 **4.2 Increase in average annual precipitation**

On average, annual precipitation in Canada is increasing although it is quite variable from region to region. In the last 50 years, it has been observed that a 12% increase in average annual precipitation has occurred and another 5.1% increase is expected by 2050. (Appendix B)

An increase in the average annual precipitation is not a major issue in and of itself; it is more the warmer winter precipitation events that are of concern. Precipitation in the form of rain is expected to increase 10 to 20 per cent in winter months resulting in ice and sleet conditions and increasing vulnerabilities across town operations.

Increased average precipitation in the winter months does not allow water to infiltrate, recharge our groundwater supply, or nourish our vegetation. More precipitation may be falling but not when it is needed most. Table 6 compares seasonal baseline and projected precipitation data.

Table 6: Baseline and 2050 projected precipitation data in millimeters, using A2 and B1 emission scenarios.

	Annual	Winter	Spring	Summer	Fall
(1971-2000)	803.9	166.9	193.9	221.1	222.1
A2	5.1%	10.0%	7.4%	-0.8%	5.0%
B1	4.0%	6.9%	6.6%	2.3%	0.6%

Note: Precipitation baselines and projections have been generated by the Canadian Climate Change Network Scenarios (CCCSN) for Oakville, ON.

As noted in both emission scenarios in the above table, the largest increase in precipitation will occur in the winter months. The A2 'business as usual' emission scenario predicts a decrease in summer precipitation events, causing several operational impacts when coupled with rising temperatures.

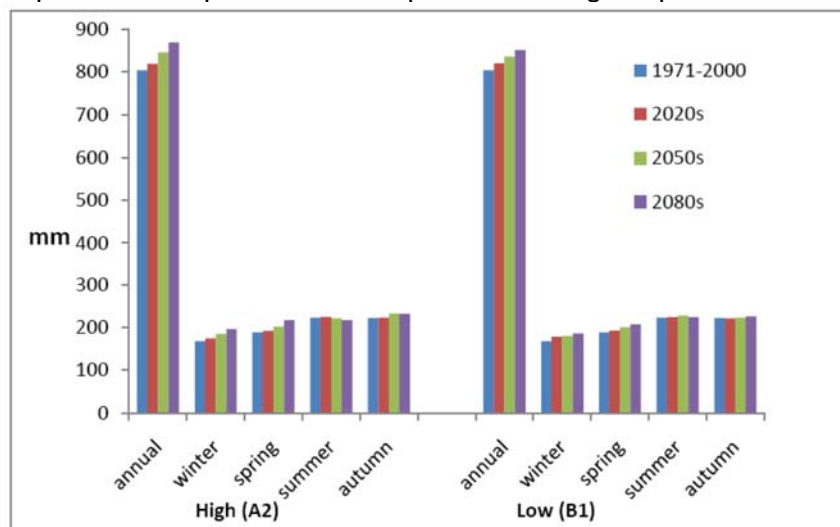


Figure 5: Average projected annual and seasonal precipitation for Oakville, ON.

Changes to annual precipitation and to precipitation patterns will impact both natural and human systems, much like changing temperatures. Some of these impacts are affected by changing temperatures, which contributes to the complexity of climate change. Table 7 summarizes these impacts and classifies them according to theme.

Table 5: Summary of general impact statements related to an increase in average annual precipitation.

Impact	Theme
Increased safety concerns and maintenance associated with longer duration winter precipitation events.	Health and Wellness Built Environment
An increase in available mosquito breeding grounds as the result of increase temperatures and precipitation.	Natural Environment and Biodiversity Health and Wellness Built Environment

Increased distribution of debris (fallen trees, litter, and natural debris).	Natural Environment and Biodiversity
Increased chance of flooding.	Health and Wellness Built Environment
Degraded water quality from an increase in overland run-off.	Natural Environment and Biodiversity Health and Wellness

4.3 Increase in severity and frequency of extreme weather events

The implications of an increase in the severity and frequency of extreme weather events is much harder to prepare for and adapt to than the increase in annual averages as previously discussed. Although extreme weather can generally be predicted by meteorologists, seismologists and others, these events usually come in quickly, often leaving little or no time for preparedness in the '*eye of the storm*', making emergency preparedness planning a key tool in any extreme weather situation.

From an operational standpoint, extreme weather events test the town's resiliency. Urban forests, transportation corridors, utility services, staff and residents all become vulnerable. Day to day operations is put on hold to respond to storm aftermath and priority situations. Operationally, this puts added stress on workload, budgets and work/life balance for those staff called upon to respond.

An evacuation plan, 72 hour preparedness kit, back-up generator and/or a charged cell phone can make all the difference in being prepared to respond to extreme weather. Information on weather proofing residential homes and properties is discussed in *Oakville's Climate Change Primer*.

The fallout of extreme weather events often results in one or more impacts including environmental degradation, human health and safety implications, and displacement of people, property damage/loss and critical service (energy, water) disturbances. These impacts touch on each pillar of sustainability affecting our social, economic, cultural and environmental norms.

Extreme temperatures are also classified under extreme weather due to the projection of an increase in the intensity and frequency of occurrences. An increase in the intensity and frequency of extreme temperature events differs from an increase in annual average temperatures in that it describes single-day 'events' of unseasonable and often unsafe weather. A single event can put work, school and social events on hold, delaying regular operations, and they can also have a drastic impact on the natural environment. Extreme temperature events pose a health risk to residents, and during times of risk (summer and winter) it is important to be aware of temperature alerts.

The Halton Region Health department tracks extreme temperature events in Halton and issues alerts based on current and predicted weather patterns from Environment Canada. What compounds the impact of extreme heat is the occurrence of the accompanying poor air quality or smog conditions experienced in the Golden Horseshoe.

An increase in the frequency and duration of extreme temperature events such as cold or heat, often accompanied by smog, pose health and safety risks to town staff and residents.

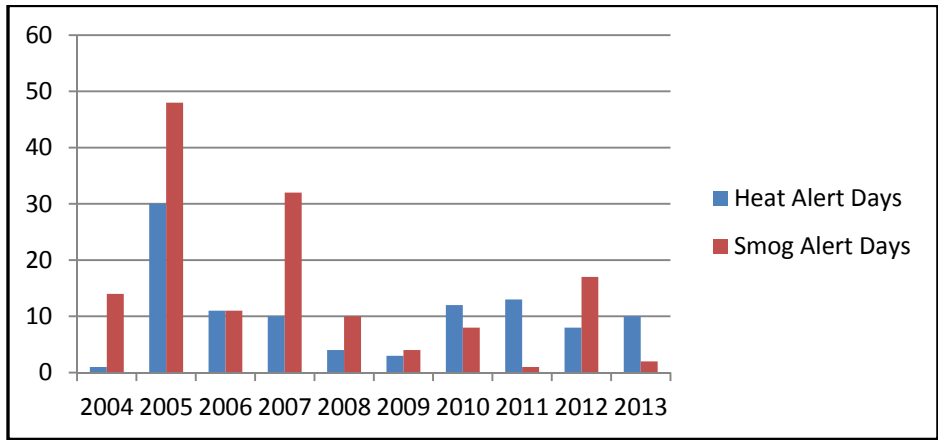


Figure 6: Number of Heat and Air Quality Advisories in Halton from 2004 – 2013.

In the baseline period of 1971 – 2000, Oakville experienced only 16 ‘heat alert days’ in 30 years. Oakville experienced 30 ‘heat days’ in 2005 alone, and it is predicted that these numbers could more than triple by the 2080s.³

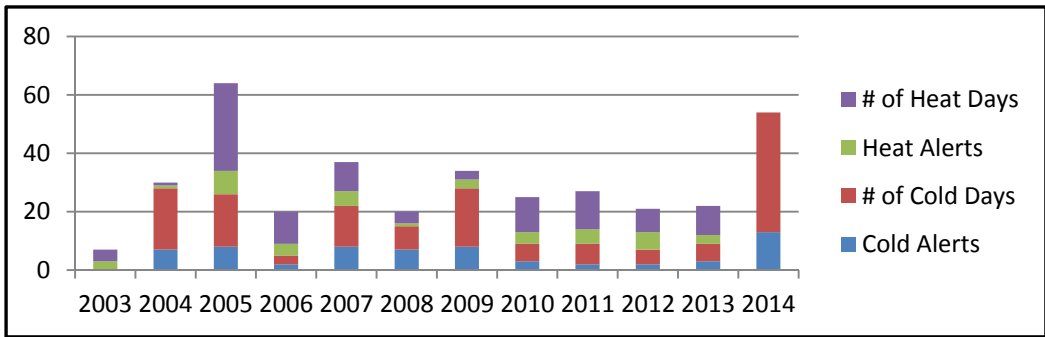


Figure 7: Number of extreme temperature (heat and cold) alerts and number of days for which alert was issued in Halton Region.

Depicted in the table above is the variability of temperatures experienced in Halton Region over the past 10 years. The winter of 2014 was unseasonably cold, setting new records for both the frequency and duration of extreme cold events.

The unusual cold of the winter and the resulting health and safety risks to residents were well-publicized, but there are other impacts of extreme weather events. Table 8 summarizes impacts to town operations related to an increase in the frequency and severity of various types of extreme weather events including extreme temperatures, extreme precipitation, extreme wind and other events. These impacts are classified according to theme.

Table 6: Summary of general impact statements related to an increase in the frequency and severity of extreme weather and extreme temperatures.

Impact	Theme
Increased enactment of the Emergency Management Plan, Extreme Weather Protocols and Standard Operating Procedures.	Natural Environment and Biodiversity Health and Wellness Built Environment
Increased risk to recreational users of town property and Lake Ontario.	Recreation and Tourism Health and Wellness
Increased chance of flooding due to increased intensity and longer duration precipitation events.	Natural Environment and Biodiversity Health and Wellness Built Environment
Infrastructure projects could experience stress, damage and delays.	Natural Environment and Biodiversity Built Environment
Degraded water quality from an increase in overland run-off.	Natural Environment and Biodiversity Health and Wellness
Increased distribution of debris (fallen trees, litter, and natural debris).	Natural Environment and Biodiversity Built Environment
Cancellation of sporting and special events due to extreme weather events.	Recreation and Tourism
Increase in annual energy and outdoor water use, related costs and distribution issues.	Health and Wellness Built Environment
Extreme heat will stress vegetation causing drought conditions and changing soil moisture levels and composition.	Natural Environment and Biodiversity
The urban heat island effect will be accelerated with extreme temperatures in the summer months.	Natural Environment and Biodiversity Recreation and Tourism Health and Wellness Built Environment

Each of the impacts noted in the tables above have been refined to become more specific as they relate to affected town operations. These more specific impact statements have been subjected to a vulnerability and risk assessment and are ranked in Section 6.0.

5.0 Vulnerability Assessment

The Changing Climates, Changing Communities climate change adaptation tool provides the framework for both vulnerability and risk assessments. Town staff have processed all impacts through the vulnerability assessment and from this point will conduct a risk assessment on the most vulnerable impacts as a recommended action going forward.

Following ICLEI's BARC program protocol, all town impacts were processed through a vulnerability assessment, which is similar to the town's internal risk assessment process. The town's level of vulnerability was determined based on:

- 1) Sensitivity: If the impact occurs, will it affect the functionality of the service area?; and
- 2) Adaptive Capacity: Can the service area adjust to the projected impact with minimal cost and disruption?

As shown in Table 7, vulnerability is directly related to the town's ability to function and adapt to these changes.

Table 7: ICLEI's climate change adaptation vulnerability assessment matrix.

		Sensitivity: Low → High				
		S1	S2	S3	S4	S5
<u>Adaptive Capacity</u> Low ↓ High	AC1	V2	V2	V4	V5	V5
	AC2	V2	V2	V3	V4	V5
	AC3	V2	V2	V3	V4	V4
	AC4	V1	V2	V2	V3	V3
	AC5	V1	V1	V2	V3	V3

Sensitivity

- S1 - No, functionality would stay the same
- S2 - Unlikely, functionality will stay the same
- S3 - Yes, functionality will likely get worse
- S4 - Yes, functionality will get worse
- S5 - Yes, functionality will become unmanageable

Adaptive Capacity

- AC1 – No, will require substantial costs (\$\$\$) and staff intervention
- AC2 – No, will require significant costs (\$\$) and staff intervention
- AC3 – Maybe, will require some costs (\$) and staff intervention
- AC4 – Yes, but will require slight costs (\$) and staff intervention
- AC5 – Yes, no to little costs and staff intervention needed

A risk assessment is a natural next step to follow a vulnerability assessment. An over-arching goal of this strategy is that all impacts with a vulnerability of above V4 be subject to a detailed and specific risk assessment in line with the town's integrated risk management program.

6.0 Themed Impacts

All impacts have been categorized under ‘themes’ allowing impacts to be assessed more specifically in relation to actual service areas and/or departments, many impacts and associated actions affect several departments and levels of government.

All impacts have been processed through the Changing Climate, Changing Communities vulnerability assessment and are colour coded below to match the vulnerability matrix in Table 7.

The following icons represent the pillars of sustainability. Their presence on the theme banner indicates connection to the represented pillar.



The impact statements in Section 6.0 are also identified as they relate to aspects of sustainability including environmental, economic, social and cultural.



6.1 Natural Environment and Biodiversity - Harbour Operations and Lake Ontario



Department and Stakeholders Impacted: Parks and Open Space, Engineering and Construction, Development Engineering, Environmental Policy, Conservation Halton, Halton Region Public Health, TOWARF, consultants, boating community



6.1.1

A decrease in water levels will impact harbor revenue, operations and rates.

S4 + AC2 = V4

Increased temperatures and evaporation coupled with erosion from extreme weather will act to lower water levels in Fourteen Mile and Bronte Creeks as well as Lake Ontario. Sediment accumulation within Oakville's harbours directly impacts operations and their suitability for recreational uses, since fees are based on the running length of the boat – the shallower the water, the smaller the vessel, the lower the fees.

Harbour staff provides water, electrical services, haul-out services, and mast stepping and unstepping. Operating, maintenance and capital improvements are funded from fees charged to boaters.

Sediment Management Strategy (SMS) - 2013

Mitigate **Adapt**

This study takes a comprehensive approach to investigating the main sources of sediment within the watersheds of both Oakville and Bronte harbours. Sediment dredging operations are performed routinely in both harbours to allow for continued and convenient recreational boating.

The study was conducted involving stakeholders and public consultation. The study results have been provided to Council along with recommendations.

Adaptation Actions

- Track the implementation of SMS recommendations.
- Continue with public communication to provide residents an opportunity to learn about the study.
- Consider recommendations within work plan and budget development.

Harbours By-law 2012-007

Mitigate / Adapt

The by-law helps promote the safe public use of the harbours by providing greater clarity of the rules and regulations for all boaters on items such as moorings, launch, haul, storage and maintenance.

Adaptation Actions

- Continue to monitor and enforce the environmental goals within this by-law.

- Continue to enhance the Clean Marine program action plan and track the implementation of initiatives.

Recreation Boating Feasibility and Capacity Study - 2013

Mitigate **Adapt**

The intent of this two phase project is to conduct a Harbours Feasibility and Capacity Study with respect to recreational boating across the Region of Halton. The intent of the study will be:

- To provide a comprehensive analysis of current harbour capacity within the Greater Toronto Area (GTA)/Golden Horseshoe region and specifically within Halton.
- To assess the changing demographic profile of the area and the impacts of these changes on the anticipated demand for recreational boating, the sources and location of this demand.
- Identify trends in the type of boating and berth requirements with the aim to make recommendations on whether or not additional harbour capacity is warranted within Halton.

Adaptation Actions

- Monitor the results of the phase one.
- Include and monitor climate change adaptation measures into phase two of this study.

Oakville Harbours Financial Strategic Business Plan - 2011

Mitigate **Adapt**

This plan recommends that a detailed dredging study be undertaken and states that dredging is a critical issue. Options are provided for funding the dredging project.

Adaptation Actions

Track the implementation and progress of the following plan recommendations:

- Conducting a detailed dredging study to focus on ways to manage required dredges in the most efficient and cost effective manner.
- Explore alternative approaches to dredging including but not limited to annual mini dredges to remove localized high silt areas that may increase the frequency for larger full dredging operations.
- Once the last mechanical dredge has been completed consider establishing a maintenance schedule associated with the section or smaller scale dredges.

6.1.2

More frequent and intense weather events will stress breakwall and shoreline structures.

S3 + AC3 = V3

Increased wind and wave action, severity of winter weather events and an increase in freeze thaw cycles will stress breakwall and shoreline structures making them more prone to failure and damage.

During extreme weather events harbour staff respond by relocating boats at risk of damage from primarily wind and wave action but other times from debris coming down the channel. All work conducted on the shoreline must adhere to all regulatory requirements including Conservation Halton's permitting process and Shoreline Policy.

Livable Oakville - official plan - 2009**Mitigate / Adapt**

10.13.4 Development in and around Lake Ontario shall consider best management practices respecting the shoreline. Any shoreline hardening and design features shall, among things, avoid wind-blown algae collection traps as determined by the Conservation Authority.

Adaptation Actions

- Monitor application of official plan requirements.

Shoreline Inventory and Assessment Study - 2012**Mitigate / Adapt**

This study is updated every four years with the next update scheduled for 2016. The top 10 shoreline sites requiring restoration and remediation were identified and prioritized. Based upon available capital budget, the top eight projects were proposed for immediate action. An additional 17 sites were identified as secondary sites requiring maintenance.

A Bi-annual Shoreline Monitoring Program for all shoreline sites has been identified in the original 2006 study.

Adaptation Actions

- Track the progress and effectiveness of remediated sites.
- Continue to enhance the Bi-annual Shoreline Monitoring Program.
- Monitor the maintenance of shoreline features as recommended in the study.
- Include climate change adaptation considerations into the 2016 SAS update.
- Support the design and construction of climate sensitive shoreline features.

Oakville Harbours West Shore Master Plan - 2008**Mitigate / Adapt**

This plan addresses priority and planned projects at the Oakville Harbours.

Adaptation Actions

To track the recommended actions of this master plan that are related to climate change including to:

- Identify distinct projects based on immediate need (i.e. failing shoreline protection along west shore of 16 Mile Creek and Lake Ontario shorelines).
- Complete approval process to adopt this document as a guideline for future development.
- Identify and apply for federal and provincial funding opportunities for infrastructure replacements and shoreline improvements.
- Identify and initiate process to take landscape maintenance budgets to a higher level than those currently applied.
- Consider the installment of a wave attenuator to break wave action prior to reaching piers, shoreline structures and breakwalls.

Fire Master Plan (FMP) - 2011**Mitigate / Adapt**

The FMP suggests conducting a risk assessment of the Town's harbours to determine an adequate level of service for fire prevention, public education and fire suppression.

Adaptation Actions

- Monitor the results of the harbour's risk assessment and include details and outcomes into the Clean Marine Action Plan.
- Prepare fiscally for the implementation of initiatives and technologies to build the harbours resiliency to climate change impacts including:
 - Account for the purchase of 10 pound fire extinguishers to provide added relief against fires.
 - Extension cord maintenance and inspection program to limit fires set by faulty or malfunctioning cords.

6.1.3

Overland runoff carrying litter, natural debris and pollutants will diminish lake water quality.

S2 + AC3 = V2

Increased precipitation and especially heavy precipitation events cause quantities of water running overland, carrying with it litter, natural debris (sediment, goose feces), oils and fuels from driveways and parking lots as well as fertilizers and other chemicals used on lawns and gardens.

Degraded water quality can impact the users of town harbours, aquatic life and habitat.

Beach Water Quality Testing – On-going

Mitigate **Adapt**

Samples taken by Halton Region Health Department are analyzed by the Provincial Public Health Laboratory for E. coli bacteria, which is used as an indicator of fecal pollution. Testing locations in Oakville are Bronte Park Beach, Coronation Park West, and Coronation Park East. Harbour staff communicate the results of this testing by posting results at town harbours and through the town website.

Algae is monitored by viewing and observing the Lake Ontario water.

Adaptation Actions

- Provide easier access to Beach Water Quality results via website and social media.
- Anticipate increased water quality testing to coincide with an increase in precipitation events.
- Prepare for increased beach closures and the communication efforts surrounding these closures.

Creek Erosion Inventory and Assessment Study – 2011

Mitigate / Adapt

This study is reviewed and updated every four years with the next update scheduled for 2015. The top 20 sites for remediation based on the Erosion Assessment study were identified and ranked. The top 10 sites were projects recommended to be undertaken immediately and remediation costs for these sites were estimated.

Adaptation Actions

- Track progress on the 2015 update.
- Include climate change adaptation considerations in the 2015 update.

The town in partnership with the Ministry of the Environment (MOE), Halton Region, Conservation Halton and the Great Lakes and St. Lawrence Cities Initiative engaged in innovative work to support the development of a long term Water Sustainability Plan (WSP). The WSP will integrate planning and management strategies to conserve and strategically manage water and minimize the discharge of pollutants to area waterways and Lake Ontario.

Adaptation Actions

- Track the development of the WSP and the identification of existing water management strategies.
- Monitor the results of:
 - Addressing potential governance issues for delivering and managing municipal water, wastewater and stormwater services.
 - Monitoring and tracking improved environmental performance in water conservation and pollution reduction.
 - Considering the cumulative impacts on the watershed for water quality and quantity.
 - Identifying opportunities for cost savings through water conservation, efficiency and re-use.

Sediment Management Strategy Study - 2013

The Sediment Management Strategy Study takes a comprehensive approach to investigating the main sources of sediment, both natural and non-natural within the watersheds of both Oakville and Bronte harbours. Sediment dredging operations are performed routinely in both harbours to allow for continued and convenient recreational boating.

The study was conducted involving stakeholders and public consultation. The study results have been presented to Council along with recommendations.

Adaptation Actions

- Continue with public open houses to provide residents an opportunity to learn about the study.
- Consider recommendations within work plan and budget development.
- Track the implementation of recommendations.

Goose Management Plan – On-going

Town staff are employing an overall goose management program to control the population of resident geese. Egg oiling, turf sweeping, coyote decoys, goose feeding by-law and habitat modification are other programs designed to deal with the overpopulation of Canada geese along Oakville's waterfront.

Adaptation Actions

- Continue and enhance the goose management program for the protection of Lake Ontario water quality.
- Continue and enhance public outreach and education associated with the goose management program especially the negative impacts associated with feeding geese.

Clean Marine Commitment - On-going**Mitigate / Adapt**

Through this commitment harbour operations have implemented actions to protect and enhance the water quality of Lake Ontario. These actions include increased hazardous waste collection and diversion, fuel top-up limits, goose deterrent pilot projects and increased spills training for staff.

Adaptation Actions

- Continue to implement and monitor actions contained in our Clean Marine Action Plan.
- Continuously improve and implement water quality protection measures at town harbours.
- Continue to provide support for spills response training and equipment.
- Continue participation in the Clean Marine Program and the accompanying environmental audits and performance review.
- Increase plantings along north of the Lakeshore to help improve water quality.
- Consider an incentive program to decommission harbour vessels of two stroke engines.

Oakville Harbours West Shore Master Plan - 2008**Mitigate / Adapt**

This plan addresses priority and planned projects at the Oakville Harbours. Erosion control is recommended in the goals below.

5.0 Outfall - Some repairs are required to control erosion at the existing outfall.

11.0 Steep Slope, Visual Improvement, Greening - the existing slope had vegetation removed by, and will be subject to severe erosion.

Adaptation Actions

Monitor progress made on the implementation of Next Steps and Conclusions in this plan that relate to improving lake water quality, including to:

- Identify distinct projects based on immediate need (i.e. failing shoreline protection along west shore of 16 Mile Creek and Lake Ontario shorelines);
- Initiate applications with various approval bodies to address improvements to west shoreline, filling, fish habitat;
- Identify shared improvement projects such the outfall from the Region of Halton's waterworks plant;
- Identify and initiate process to take landscape maintenance budgets to a higher level than those currently applied.

Salt Management Plan (SMP) - 2011**Mitigate Adapt**

Due to the adverse effects that salt has on the environment, the Salt Management Plan aims to reduce salt use by including best salt management practices, and using new technologies to ensure its most effective use over the road system. The implementation of better road salt management practices and equipment has resulted in at least a 15 per cent reduction in the use of salt.

Adaptation Actions

- SMP states that the road authorities will continue to research and encourage the use of viable and cost-effective new technologies and chemicals to reduce the environmental impacts of winter maintenance activities.

- Continue town support to the implementation of better road salt management practices and equipment which has resulted in at least a 15 per cent reduction in salt usage.
- To continue to support the implementation of the Salt Management Goals for the Key Operational Practices and Strategies.

Water Resource Outreach and Education - On-going









Mitigate / Adapt

Town provides storm water education to residents through it's website, use of social media and through partnerships with Halton Region and Conservation Halton that include the Halton Children's Water Festival, Stream of Dreams and Yellow Fish Road.

Adaptation Actions

- Continue with annual funding and staff support for the Halton Children's Water Festival, Yellow Fish Road and Stream of Dream programs.
- Continue and enhance water resource protection outreach and education initiatives including the town's electronic school EcoLetter, Library Backpack Lending Program and summer EcoCamp programs.

Summary Table

Vulnerability Level	Impact Statement	Adaptation Actions	Climatic Change
V4	A decrease in water levels will impact harbour revenue, operations and rates.	10	 
V3	More frequent and intense weather events will stress breakwall and shoreline structures.	14	  
V2	Overland run-off carrying litter, natural debris and pollutants will diminish lake water quality.	30	  



6.2 Natural Environment and Biodiversity



- Creeks and Channels

Department and Stakeholders Impacted: Development and Environmental Engineering, Parks and Open Space, Environmental Policy, Engineering and Construction, Conservation Halton, Halton Region, Ministry of the Environment



6.2.1

Creeks and channels may meet or exceed capacity during extreme precipitation events.

S4 + AC2 = V4

More frequent and intense precipitation events do not allow time for rainwater to infiltrate into the ground. The majority of water will run overland into the nearest creek or channel. Increased freeze thaw cycles may also work to cause ice jams resulting in overland flooding.

The safety impacts associated with flooding are discussed in Theme 6.4: Health and Wellness.

Flood Prioritization Study - 2008

Mitigate / Adapt

In 2008, the town completed a Flood Prioritization Study on the town's major open-channel waterways, streams, rivers and lakes to identify flood-sensitive areas in Oakville. The study used information from previous subwatershed studies and consolidated all the information into one document. One of the objectives of this study was to see all flood-sensitive areas in relation to one another. These areas were categorized as low, medium or high risk, enabling the town to start setting priorities for flood mitigation projects such as the:

- Flood Mitigation Options Study – Fourteen Mile Creek and McCraney Creek which is set for completion in 2015
- Flood Mitigation Options Study – Lower Morrison Creek and Wedgewood Creek which is to be initiated in 2015

Adaptation Actions

- Track and monitor the completion of each study phase.
- Future studies will look at the town's storm sewer network and overland flow routes, recognizing that these routes, if compromised, can also present a flood risk.
- Continue and enhance public outreach efforts.
- Continue to monitor the province and other municipalities for best management practices related to climate change adaptation.
- The study has put the town in a position to take advantage of provincial, federal or private flood reduction/mitigation funding programs, track the progress made on obtaining this funding.
- Conduct a more detailed evaluation of creek flood-prone sites in an effort to determine the most viable and effective flood mitigation alternatives.
- Determine the degree of flooding, identify and assess alternatives for mitigation, and recommend preferred alternatives to be implemented.

Water Control Program and Flood Warning Initiative – On-going**Mitigate / Adapt**

Conservation Halton conducts water level monitoring of Bronte Creek and both Fourteen and Sixteen Mile Creeks.

Adaptation Actions

- Continue to enhance communication and education efforts surrounding imminent and projected flooding, high water levels and safety around creeks and channels.

Livable Oakville – official plan - 2009**Mitigate / Adapt**

10.6.1 The Town will encourage innovative programs and construction methods which support the sustainable development and redevelopment of buildings. Sustainable features sought by the town may include, but are not limited to: c) green roofs or high albedo roofs that contribute to the reduction of the urban heat island effect; d) permeable paving and other innovative stormwater management methods;

10.10.1 Stormwater management techniques shall be used in the design of new developments to control both the quantity and quality of stormwater runoff. In areas where soil types permit, on-site infiltration shall be encouraged to the maximum extent feasible.

10.10.2 Where existing watercourses are sufficiently wide to carry storm flows, there shall be no modification of these areas, except for erosion control and water quality maintenance measures to the satisfaction of the town, the Conservation Authority and the Province.

10.10.8 The use of permeable surfaces and soft landscaping shall be encouraged where possible.

Adaptation Actions

- Monitor the encouragement, implementation and barriers associated with the implementation of the goals that relate to increased areas of permeability and maximum on-site infiltration.
- Track the installation of best management practices related to stormwater infiltration.

6.2.2

Extreme weather will result in increased natural debris (fallen trees, sediment and branches) entering creeks and channels.

S3 + AC3 = V3

More intense and frequent wind and precipitation events will increase the chance of flooding due to blocked storm water systems. Wind and precipitation events accelerate erosion leading to downed trees and branches as well as increased litter and natural debris distribution.

Reaches of the river banks are very steep and hard to stabilize, therefore extreme wind and rain can often down trees that could in turn dam the creek or channel requiring immediate remediation.

Creek Erosion Inventory and Assessment Study – 2011**Mitigate / Adapt**

This study is updated every four years with a scheduled update in 2015. The top 20 sites for remediation based on the Erosion Assessment study were identified and ranked. The top 10 sites were projects recommended to be undertaken immediately and remediation costs for these sites were estimated.

Adaptation Actions

- Track and monitor remediation efforts and possible co-benefits.
- Continue to monitor the change to sediment transport process through these studies.
- Continue to monitor bank stabilization through this assessment process.

Harbours West Shore Master Plan - 2008

Mitigate / Adapt

The Oakville Harbours West Shore Master Plan discusses actions for creek bank stabilization along the west shore of Lake Ontario.

11.0 Steep Slope, Visual Improvement, Greening

- This area is the narrowest section of shoreline.
- The existing slope had vegetation removed by, and will be subject to severe erosion.
- Greening of this slope is proposed with low vegetation. In keeping with the abstraction of nature theme, this green slope could take form resulting from some alternate and innovative approaches.
- There are some examples from around the world that deal with steep slope areas such as this, in a nontraditional manner.

32.0 Existing Steep Vegetated Slope

- The recommendations for this area are to reinforce and enhance the existing slope with the primary view towards erosion control and visual improvement.

Adaptation Actions

- Monitor progress made on the Next Steps and Conclusions in this plan that relate to improving lake water quality, including to:
 - Identify distinct projects based on immediate need (i.e. failing shoreline protection along west shore of 16 Mile Creek and Lake Ontario shorelines).
 - Initiate applications with various approval bodies to address improvements to west shoreline, filling, fish habitat.
 - Complete approval process to adopt this document as a guideline for future development.
 - Identify shared improvement projects such the outfall from the Region of Halton's waterworks plant.
 - Identify and apply for federal and provincial funding for infrastructure replacements and shoreline improvements.

Outfall Debris Clearing Program – On-going

Mitigate / Adapt

The Roads and Works department leads a debris clearing program that supports on-going maintenance of identified 'hot spots' that are cleared annually or as required prior to and after large precipitation events.

Adaptation Actions

- Consider increasing the maintenance schedule of 'hot spot' clearing.
- Appoint designated staff to the outfall debris clearing program.

- Monitor the efficacy of the debris boom installed at Navy Flats. If functioning well, consider developing a maintenance plan to remove collected debris.

6.2.3

Exposed creek banks are becoming home to invasive, noxious and non-native plant species.

S3 + AC3 = V3

Decreasing water levels are exposing nutrient rich bank soil and the most aggressive and opportunistic plants inhabit these soils. Unfortunately the most aggressive and opportunistic species are not always the most local. Often invasive species are very adaptable to new climates, soils and moisture levels.

Many plants have survival techniques within them to ensure their continued existence, Garlic mustard for example, not only blankets a forest floor so that other smaller species are deprived of light it also excretes substance into the soil that inhibits the growth of other plants.

Unfortunately eradicating these species in protected areas such as floodplains and creek banks is difficult due to environmental protection regulations. Also accelerating the problem is the ability for certain plants, such as giant hogweed, to spread its seeds via water, as found in creek systems.

Oakville Wildlife Strategy - 2011

Mitigate / Adapt

This Strategy provides an overview of the town's existing baseline natural features and makes ten recommendations to support and enhance wildlife and biodiversity in the town. Relevant recommendations include: education and outreach program; beaver management program; Canada goose habitat management guidelines; wildlife corridors and habitat identification and development; Invasive species strategy; Wildlife friendly development procedures; road ecology program (including salt management component); monitoring and data collection; expanded resources.

Adaptation Actions

- Protect and enhance wetlands and groundwater recharge areas in north Oakville.
- Track the progress on the recommended development of a comprehensive biodiversity monitoring program.
- Support ongoing policies, procedures and programs.
- Continue to monitor the province and other municipalities for changes and direction on climate change adaptation.
- Develop invasive species strategy in collaboration with key agencies (Conservation Halton).
- Develop an overall Biodiversity Strategy.

Sustainable Building Guidelines - 2010

Mitigate / Adapt

For town facilities states that the planting (trees and shrubs) shall comprise hardy species tolerant of urban conditions (pollution/salt/drought tolerant, compacted soils).

No planting of invasive species on properties or streets adjacent to a natural heritage system (valleylands, woodlands, wetlands) or parks. A list of potential invasive species is referenced on the Halton Region website.

Adaptation Actions

- Continue to enhance staff awareness and use of the Sustainable Design Guidelines.
- Begin to monitor the implementation of goals and actions related to climate change mitigation and adaptation.

Livable Oakville – official plan - 2009

Mitigate / Adapt

10.10.2 Where existing watercourses are sufficiently wide to carry storm flows, there shall be no modification of these areas, except for erosion control and water quality maintenance measures to the satisfaction of the Town, the Conservation Authority and the Province.

Adaptation Actions

- Monitor application of official plan requirements.
- Monitor and track changes to legislation to ensure compliance.

6.2.4

Warmer, shallower water will threaten sensitive aquatic species and habitats.

S2 + AC4 = V2

Oakville residents are fortunate to live in one of the most bio diverse areas in Ontario with over 900 different species of plants, 185 types of birds, 30 species of amphibians and reptiles, 29 mammals and 58 different kinds of fish.

Many aquatic species are sensitive to slight changes in water temperature as it directly relates to the amount of available oxygen in the water. Algae blooms as a result of increased temperatures can also alter oxygen levels in the water, when extreme can lead to fish die off.

Although we may get increased precipitation overall, it is projected that the increased temperatures and less ice cover on water bodies will lead to increased evaporation and even lower water levels.

Livable Oakville – official plan - 2009

Mitigate / Adapt

10.1.1 The general objectives for sustainability are: a) to minimize the town's ecological footprint; b) to achieve sustainable building and community design; c) to preserve, enhance and protect the town's environmental features, natural heritage systems and waterfronts; d) to enhance the town's air and water quality; e) to maintain the existing urban forest; and, f) to progressively increase the urban forest to achieve a canopy cover of 40% - town-wide beyond the life of this Plan.

10.10.2 Where existing watercourses are sufficiently wide to carry storm flows, there shall be no modification of these areas, except for erosion control and water quality maintenance measures to the satisfaction of the town, the Conservation Authority and the Province.

Adaptation Actions

- Track and monitor the implementation of the Livable Oakville objectives.
- Protect and enhance wetlands and groundwater recharge areas in north Oakville.
- Define a natural heritage system for areas south of Dundas Street, including buffers, linkages and identifying areas needed for future study.
- Continue to monitor changes to Conservation Halton design standards.

This Strategy provides an overview of the town's existing baseline natural features and makes ten recommendations to support and enhance wildlife and biodiversity in the town. Relevant recommendations include: education and outreach program; beaver management program; Canada goose habitat management guidelines; wildlife corridors and habitat identification and development; Invasive species strategy; wildlife friendly development procedures; road ecology program (including salt management component); monitoring and data collection; expanded resources.

Adaptation Actions

- The Ministry of Natural Resources (MNR) has a pilot program for habitat banking. Development projects that impact the natural environment may be subject to regulations requiring compensation for the destroyed habitat. The habitat banking program allows organizations (e.g. the Town) to submit habitat restoration projects they would like completed. The program then matches those who have compensation requirements with those who would like projects completed. Creek and waterway projects are prominent in this program.
- The development of an effective salt management strategy adjacent to environmentally sensitive areas as part of the road ecology strategy.
- To address the likely northern migration of wildlife with warming conditions, identification and enhancement of wildlife corridors and habitat to allow for adequate movement of species.
- Continuation and enhancement of effective monitoring and data collection for Oakville's creeks and waterways. Both Conservation Halton and the town have existing programs that can be built on. More effective data sharing should be explored.
- Expanded staff resources to address natural heritage systems and biodiversity should be considered.

6.2.5

Lower water levels, accelerated erosion and increased overland run-off will degrade water quality.

S1 + AC3 = V2

Increased wind and precipitation events will accelerate erosion and overland run-off. Overland run-off and sediment from erosion carry pollutants (motor oil, fertilizers), natural debris (leaves, branches, sediment from erosion) and litter with it.

This study is updated every four years with the next update scheduled for 2016. The top 10 shoreline sites requiring restoration and remediation were identified and prioritized. Based upon available capital budget, the top eight projects were proposed for immediate action. An addition 17 sites were identified as secondary sites requiring maintenance.

Bi-annual Shoreline Monitoring Program for all shoreline sites identified in the original 2006 study.

Adaptation Actions

- Track the progress and effectiveness of remediated sites.
- Continue to enhance the Bi-annual Shoreline Monitoring Program.

- Monitor the maintenance of shoreline features as recommended in the study.
- Include climate change adaptation considerations into the 2016 SAS update.

Water Resource Education and Outreach - On-going

Mitigate / Adapt

Town provides storm water education to residents through its website, use of social media and through partnerships with Halton Region and Conservation Halton that include the Halton Children's Water Festival, Stream of Dreams and Yellow Fish Road.

Adaptation Actions

- Continue with annual funding and staff support for the Halton Children's Water Festival, Yellow Fish Road and Stream of Dream programs.
- Continue and enhance water resource protection outreach and education initiatives including the town's electronic school EcoLetter, Library Backpack Lending Program and summer EcoCamp programs.

Salt Management Plan (SMP) – On-going

Mitigate / Adapt

Due to the adverse effects that salt has on the environment, the Salt Management Plan aims to reduce its use by including best salt management practices, and using new technologies to ensure its most effective use over the road system. The implementation of better road salt management practices and equipment has resulted in at least a 15 per cent reduction in salt usage.

Adaptation Actions

- SMP states that the Road Authorities will continue to research and encourage the use of viable and cost-effective new technologies and chemicals to reduce the environmental impacts of winter maintenance activities.
- Continue to support the implementation of better road salt management practices to limit impacts on water quality.
- Continue to support and track the implementation of the Salt Management Goals for the Key Operational Practices and Strategies.
- Continue to work in partnership with Halton Region and neighbouring municipalities.

Water Sustainability Plan (WSP) - 2014

Mitigate / Adapt

The town in partnership with the Ministry of the Environment (MOE), Halton Region, Conservation Halton and the Great Lakes and St. Lawrence Cities Initiative engaged in innovative work to support the development of a long term (WSP). The WSP will integrate planning and management strategies to conserve and strategically manage water and minimize the discharge of pollutants to area waterways and Lake Ontario.

Adaptation Actions

- Track the development of the WSP and the identification of existing water management strategies.
- Track progress on addressing potential governance issues for delivering and managing municipal water, wastewater and stormwater services.
- Monitor and track improved environmental performance in water conservation and pollution reduction.

- Monitor the results as consideration is given to the cumulative impacts on the watershed for water quality and quantity.
- Track and research opportunities for cost savings strategies through water conservation, efficiency and re-use.

Oil / Grit Separator Units – On-going

Mitigate **Adapt**

The town has a comprehensive inventory and database of both town-managed and unassumed stormwater management ponds and recently compiled an inventory of town -owned oil/grit separator (OGS) units. All of these engineered controls are set in place to manage the risk of flooding and pollution that is discharged to the stormwater system. This information along with existing storm sewer infrastructure information has been compiled in a comprehensive layer in GIS.

Adaptation Actions

- Research implementing a dedicated OGS maintenance program.

Stormwater Quality Monitoring Program – On-going

Mitigate **Adapt**




This program includes both dry and wet weather sampling of ponds and outfalls, designed to obtain background data for comparison and verification of established by-law limits.






In 2009, six meteorological monitoring stations and hydraulic monitoring equipment were installed in four ponds.

Adaptation Actions

- Track the progress of this program's development.
- Increase monitoring to coincide with wet weather events.
- Implement dedicated staff time to the maintenance of oil/grit separator unit.

Summary Table

Vulnerability Level	Impact Statement	Adaptation Actions	Climatic Change
V4	Creeks and channels may meet or exceed capacity during extreme precipitation events.	9	
V3	Extreme weather will result in increased natural debris (fallen trees, sediment and branches) entering creeks and channels.	11	
V3	Exposed creek banks are becoming home to noxious and non-native plant species.	10	

V2	Warmer, shallower water will threaten sensitive aquatic species and habitats.	9	 
V2	Lower water levels, accelerated erosion and increased overland run-off will degrade water quality.	19	  





6.3 Natural Environment and Biodiversity

- Urban Forestry, Trails and Natural Areas



Department and Stakeholders Impacted: Parks and Open Space – Forestry, Horticulture and Turf, Environmental Policy, By-law Services, Conservation Halton



6.3.1

Northerly migration and longer life span of invasive and non-native plants and insects.

S5 + AC1 = V5

The migration patterns of plants and insects are responding to the warmer temperatures. This is allowing for species to inhabit areas previously deemed too cold and this is having devastating effects on Oakville's natural areas.

The town refers to Conservation Halton's list of invasive species and plants based on the recommendations included in Halton Region's native and drought resistant species.

Oakville Wildlife Strategy – 2011

Mitigate / Adapt

Develop an invasive species strategy that ties procedures together and includes policies and guidelines for addressing invasive species on a comprehensive and consistent basis.

Adaptation Actions

- Track the development of an Invasive Species Strategy.
- Participate in invasive species pilot project for early detection and management (collaboration with the Invasive Species Center, planned for 2015-2018).

Urban Forest Strategic Management Plan (UFSMP) - 2008 and Urban Forest Effects Model (UFORE)

Mitigate / Adapt

The UFSMP 2008-2027 is currently being reviewed along with the 2006 UFORE modelling in order to update the status of the town's canopy cover and actions for improvement on the lands south of Dundas Street. There have been actions to improve forest health and canopy cover underway within the existing strategy. The update will consider factors such as climatic changes, impacts, natural predators, invasive species and community changes. One mechanism to protect trees recently before Council is the town's Tree Protection By-law.

Adaptation Actions

- Track the implementation of the following action items as they relate to building resilience to non-native and invasive species:
 - The adoption of adaptive management fill urban forestry policy objectives in light of the constantly changing ecological, social and regulatory environments.
 - Ensuring there is adequate species diversity throughout the urban forest.

- Ensure, that when possible, the seed source is within the collection zone for Oakville as established by the Forest Gene Conservation Authority.
- Track the active adaptation management process and tools used to manage our urban forests.
- Monitor and amend, if needed, the procurement process to ensure seed diversity.

Invasive Species Monitoring Program – On-going

Mitigate / Adapt

Town staff respond to various invasive and non-native species for the protection of our native biodiversity, recently some of the more problematic and devastating non-native or invasive species have been gypsy moth, emerald ash borer, garlic mustard, giant hogweed.

Emerald Ash Borer (EAB) is an invasive insect from Asia that attacks and kills untreated Ash trees. The town has a strategy to detect and manage EAB in Oakville.

To monitor for the presence of Asian Long-Horned Beetle (ALHB) the town has hung ten ALHB traps in select trees in the east area of town. ALHB has not been detected in Oakville.

Adaptation Actions

- Continue to be proactive regarding invasive species identification and eradication.
- Continue to partner with external agencies and levels of government to track migration patterns, presence and best management practices associated with eradication.
- Monitor invasive and non-native pests to the south due to the anticipated northerly migration.

Healthy Green Spaces Strategy - 2008

Mitigate / Adapt

Developed for the protection and enhancement of green spaces within the town. This document serves as a tracking mechanism for action items declared in other municipal plans and policies.

Adaptation Actions

- Track the implementation and success of the ‘future opportunities’ and action items contained in the strategy.
- Continue to support and expand partnership network.

Sustainable Design Guidelines (SDG) - 2010

Mitigate / Adapt

Guidelines that relate to increasing our vegetation’s resilience to invasive and non-native include:

- To provide the necessary stabilization with native, non-invasive species suitable for erosion control.
- That no planting of invasive species on properties or streets adjacent to a natural heritage system (valleylands, woodlands, wetlands) or parks.
- Avoid planting monocultures which can be vulnerable to diseases.

Adaptation Actions

- Continue to enhance staff awareness and implementation of the Sustainable Design Guidelines.
- Begin to monitor the implementation of goals and actions related to climate change mitigation and adaptation.
- To monitor the implementation of sustainable landscaping guidelines.

Invasive Species Outreach and Education – On-going

Mitigate / Adapt

Other invasive species such as Garlic Mustard, Buckthorn, Giant Hogweed, Phragmites and Dog Strangling Vine presents risks for Oakville’s natural environment.

The town has an aggressive outreach and education program to educate staff and residents about current invasive species located in Oakville.

Adaptation Actions

- Continue to conduct outreach and education program on problematic invasive species.
- Continue to track this programs success through outreach events, social media and website interactions.
- Continue with and expand local community group partnerships to organize and execute invasive species removal and community action to eliminate invasive species.

6.3.2

Increased instances of trail and park closures and associated clean up associated with extreme weather events.

S5 + AC1 = V5

Extreme weather severely impacts the natural areas in Oakville. Trail and park closures are common after extreme weather events due to fallen trees, hanging limbs and other associated risks. Recovering operationally, from an extreme weather event involves coordination between many departments and sectors of the community.

There are obvious safety concerns associated with extreme weather and natural areas which are discussed in theme 6.5: Health and Wellness.

Extreme Weather Response – On-going

Mitigate / Adapt

Town staff need to be prepared to respond in a coordinated and timely fashion.

Adaptation Actions

- Review the operational impacts of recent extreme weather events in Oakville.
- Consider increasing after-hour staff resources to be better equipped to respond.
- Track the incorporation of extreme weather response protocols in the town’s EMP.
- Continue to help and solicit help from neighbouring municipalities and the provincial government.
- Increase extreme weather response training and awareness.

Weather Related Closures and Cancellations – On-going

Mitigate / Adapt

During inclement weather, every effort is made to ensure that town-owned facilities remain open for as long as is safely possible. However, on rare occasions severe weather may necessitate the closure of town facilities.

Adaptation Actions

- Begin to track closures and remediation efforts related to extreme weather events.
- Continue to enhance communication efforts surrounding park and trail closures.

6.3.3

Increased stress on vegetation due to extreme weather and changes to soil moisture and composition.

S5 + AC1 = V5

An increase in extreme weather events including high wind, lightning, heavy precipitation coupled with aggressive invasive species are stressing and damaging local vegetation while depleting the town's canopy cover.

Also stressing local vegetation is the increased temperatures and variable precipitation patterns. Although precipitation is expected to increase it doesn't necessarily mean that it will come when needed most. As the moisture levels and air temperature changes so does the composition of the soil, causing even more stress.

Trees and shrubs are experiencing early budding, blooming and the die off of new growth as a result of the warmer and more variable temperatures. Warmer and more variable temperatures will also alter the soil composition and moisture levels again impacting local vegetation and our urban forest stands.

Livable Oakville – official plan - 2009

Mitigate / Adapt

10.1.1 The general objectives for sustainability are: a) to minimize the town's ecological footprint; c) to preserve, enhance and protect the town's environmental features, natural heritage systems and waterfronts; e) to maintain the existing urban forest; and, f) to progressively increase the urban forest to achieve a canopy cover of 40%.

10.12.2 For every square metre of leaf area that is removed from town property or from town road rights-of-way, sufficient trees will be replanted to replace the lost square metres of leaf area.

10.12.3 The town shall ensure that appropriate space for tree protection and tree planting within road rights-of-way are included in the design of new roads or road improvements.

10.12.4 The town shall develop standards for the protection of trees to assist with the review of planning applications and municipal consents by utilities.

10.12.5 The town shall develop standards for the planting of new trees to assist with the review of planning applications.

10.12.6 Tree removal on private property shall be subject to the town's private tree protection by-law.

Adaptation Actions

- Monitor application of official plan requirements.
- Define a natural heritage system for areas south of Dundas Street, including buffers, linkages and identifying areas needed for future study.
- Review and update Natural Heritage policies (Part D, Section 16).

**Urban Forest Strategic Management Plan (UFSMP) - 2008
and Urban Forest Effects Model (UFORE)****Mitigate / Adapt**

The UFSMP 2008-2027 is currently being reviewed along with the 2006 UFORE modelling in order to update the status of the town's canopy cover and actions for improvement on the lands south of Dundas Street. There have been actions to improve forest health and canopy cover underway within the existing strategy. The update will consider factors such as climatic changes, impacts, natural predators, invasive species and community changes. One mechanism to protect trees recently before Council is the town's Tree Protection By-law.

Adaptation Actions

- Track the active adaptation management process and tools used to manage our urban forests.
- Continue to monitor and track changes to the ecological, social and regulatory environments as they are impacted by climate change.

Urban Forest Strategic Master Plan – North Oakville**Mitigate / Adapt**

Several initiatives in this plan work to ensure survival rates of newly planted and existing vegetation. They include:

- Updating and expanding the landscape standards to reflect realistic soil volume requirements.
- Conducting periodic site reviews during construction, and regular inspections to monitor tree health during the first 5 years of growth to identify problems or issues impacting the trees ability to reach maturity.
- Forming partnerships with Non-Government Organizations whose grass-roots greening initiatives include planting events, parkland stewardship and greenspace planning.

Adaptation Actions

- Monitor and track the implementation and associated results of the above initiatives.

Sustainable Building Guidelines - 2010**Mitigate / Adapt**

Guidelines that relate to increasing our vegetation's resilience to a changing climate include:

- Providing for a suitable minimum soil volume to ensure long-term tree growth and survival.
- Topsoil/planting soil should be of good quality suitable to the growth of selected trees and vegetation.
- Appendix G – Topsoil Requirement Matrix of this guide provides more detail.
- Planting (trees and shrubs) shall comprise hardy species tolerant of urban conditions (pollution/salt/drought tolerant, compacted soils).
- Consult with the town's Landscape department and adhere to size recommendations and minimums established by the town with respect to trees, shrubs and groundcover.
- Avoid planting monocultures which can be vulnerable to diseases.

Adaptation Actions

- Continue to enhance staff awareness and implementation of the Sustainable Design Guidelines.
- Begin to monitor the implementation of goals and actions related to climate change mitigation and adaptation.

Healthy Green Spaces Strategy- 2008

Mitigate **Adapt**

Developed for the protection and enhancement of green spaces within the town. This document serves as a tracking mechanism for action items declared in other municipal plans and policies.

Adaptation Actions

- Track the implementation and success of the 'future opportunities' and action items contained in the strategy.
- Continue to support and expand partnership network.

Oakville Wildlife Strategy - 2011

Mitigate **Adapt**

The Oakville Wildlife Strategy provides recommendations for supporting wildlife and biodiversity in Oakville.

Adaptation Actions

- Identify and map publicly owned lands for restoration priority.
- Research and consider reclassifying lands, identified through the 2005 Halton Natural Areas Inventory, for inclusion in the Environmentally Sensitive Area (ESA) system.
- Develop and invasive species monitoring program or partner with a stakeholder agency such as Conservation Halton.

6.3.4

Increased water use in summer months will occur due to an increase in average and extreme temperatures.

S3 + AC3 = V3

An increase in water use in the summer months can be directly contributed to increased and extreme summer temperatures. When temperatures are high, water evaporates faster leaving lawns, gardens and pools in need of more frequent top ups. The use of town facilities, including indoor/outdoor pools and splash pads is on the rise when temperatures are high.

Sustainable Building Guidelines - 2010

Mitigate / Adapt

Requirements related to water conservation from a landscaping perspective include:

- If irrigation is required (general planting), consider using non-potable sources (roof, parking lot, grey water).
- If landscape irrigation is desired or required, consider using an efficient drip irrigation system connected to a non-potable source (roof, parking lot, grey-water) in combination with existing centralized irrigation control systems.
- Prior to design and implementation, items 3 and 4 will need to be discussed in detail with the Landscape and Facilities and Construction Management departments.

Adaptation Actions

- Continue to enhance staff awareness and use of the Sustainable Design Guidelines.
- Monitor implementation of water conservation aspects of town projects.

Halton Region Water Use By-law and Water Conservation Strategy - 2014

Mitigate / Adapt

The region has developed a by-law to ensure protection and conservation of municipal water resources.

Adaptation Actions

- Sharing of regional drinking water system management processes with town staff.
- Work in partnership with Halton Region to develop a comprehensive town water conservation strategy.

Water Sustainability Plan - 2014

Mitigate / Adapt

The town in partnership with the Ministry of the Environment (MOE), Halton Region, Conservation Halton and the Great Lakes and St. Lawrence Cities Initiative engaged in innovative work to support the development of a long term Water Sustainability Plan (WSP). The WSP will integrate planning and management strategies to conserve and strategically manage water and minimize the discharge of pollutants to area waterways and Lake Ontario.

Adaptation Actions

- Track the development of the WSP and the identification of existing water management strategies.
- Monitor the results of:
 - Improved environmental performance in water conservation and pollution reduction.
 - Identifying opportunities for cost savings through water conservation, efficiency and re-use.

6.3.5

Changes to the migration patterns and habits of wildlife will occur with warmer and more variable temperatures.

S3 + AC3 = V3

More variable temperatures and precipitation patterns may in turn alter the habits and migration patterns of wildlife.

Oakville Wildlife Strategy - 2011

Mitigate / Adapt

The Oakville Wildlife Strategy provides recommendations for supporting wildlife and biodiversity in Oakville.

Adaptation Actions

- Research and consider identifying and mapping key wildlife corridors and habitats as per the province's 2010 Natural Heritage Manual.
- Research and develop wildlife friendly development options and construction guidelines (e.g. development checklists, site plan guidelines, best management practices (BMP) for town infrastructure and development projects, staff/contractor training).

Road Ecology Strategy - underway

Mitigate / Adapt

The Road Ecology Strategy provides a comprehensive overview and mapping of the town's natural resources as they intersect with transportation infrastructure. Mitigation measures and options for minimizing the impact of this infrastructure on the environment (in particular wildlife) are set out.

Adaptation Actions

- Implement recommendations of the road ecology strategy and integrate into transportation infrastructure management processes and town policies.
- Define a natural heritage system for areas south of Dundas Street, including buffers, linkages and identifying areas needed for future study.

Coyote Management Strategy (CMS) - 2012

Mitigate / Adapt

As a result of an increase in coyote sightings and encounters in Halton Region the town developed the CMS. This strategy included:

- Community partnership to provide educational coyote workshops to schools.
- Trained town staff on coyote safety and awareness.
- Developed a coyote management plan and initiatives under the town's Oakville Wildlife Strategy.
- Posted signs in parks and along trails where coyotes are known to frequent. Installed wildlife-proof lids on garbage cans in high-risk trails and parks. Cans are labelled with the town's phone number and residents are directed to call if garbage is overflowing.

Adaptation Actions

- Compare coyote sightings per season to annual weather patterns to see if a correlation exists.
- Compare increased coyote sightings to areas of where development is occurring to see if a correlation exists.
 - If correlations exist, proactively target education campaigns accordingly.

6.3.6

An increase in available mosquito breeding grounds will result from an increase in temperatures and precipitation.

S3 + AC3 = V3

Warmer and wetter weather will increase standing water and available mosquito breeding grounds. Town staff responds to all West Nile Virus (WNV) complaints on town and private property. The town's By-law staff respond to WNV concerns on private properties and complaints are primarily related to unopened pools. Town staff do not remediate natural areas such woodlots or wetlands but will repair ruts caused by machinery in approved areas.

The health impacts and associated staff and residential outreach and education program are discussed in theme 6.5 Health and Wellness.

Town of Oakville's WNV Protocol – On-going

Mitigate / Adapt

Increased precipitation and temperatures will allow for a longer WNV season as well as for more available standing water sites.

Adaptation Actions

- Prepare for a longer WNV season and response to a more calls per season.
- Continue to support and participate in Halton Region's WNV Surveillance program.

6.3.7

An increase in the distribution of litter from high wind and extreme weather events will occur.

S3 + AC3 = V3

High winds and heavy precipitation have the ability to distribute litter that was previously contained.

Litter By-Law - updated 2011

Mitigate / Adapt

The town prides itself on working towards a clean and litter free environment. The by-law supports this goal.

Adaptation Actions

- Increase litter prevention, control and abatement programs for special events.
- Track compliance issues and barriers to compliance.
- Continue to implement parks recycling and waste diversion programs.

Litter Abatement Outreach – On-going









Mitigate / Adapt





Halton Region used mobile street signs to provide information on how to contain litter in recycling bins on windy days. The town of Oakville uses several means of communication to deter littering including website, public space signage, social media and public outreach events.

Adaptation Actions

- Incorporate Halton Region’s recycling box litter control messaging and devices into town outreach displays.
- Continue to participate and encourage others to participate in the Great Canadian Shoreline Clean-up, Operation Clean Sweep, all Earth Day clean-up efforts, and other community cleanup activities.

Summary Table

Vulnerability Level	Impact Statement	Adaptation Actions	Climatic Change
V5	Northerly migration and longer life span of invasive and non-native plants and insects.	18	
V5	Increased instances of trail and park closures and clean up associated with extreme weather events.	7	  
V5	Increased stress on vegetation due to extreme weather and changes to soil moisture and composition.	13	   

V3	Increased water use in summer months will occur due to an increase in average and extreme temperatures.	7	
V3	Changes to the migration patterns and habits of wildlife will occur with warmer and more variable temperatures.	6	
V3	An increase in available mosquito breeding grounds will result from an increase in temperatures and precipitation.	2	
V3	An increase in the distribution of litter from high wind and extreme weather events will occur.	5	



6.4 Recreation and Tourism



Department and Stakeholders Impacted: Recreation and Culture, Parks and Open Space, Facilities and Construction Management, Environmental Policy, Strategy, Policy and Communications Halton Region, Conservation Halton, community groups, residents



6.4.1

Increased use of and need for public green space, recreation centres, libraries, parks, splash pads and pools.

S3 + AC3 = V3

Oakville offers 1,420 hectares of parkland, over 300 kilometres of trails, and more than 200 parks, garden plots, off-leash dog parks, playgrounds, skateboard parks, splash pads, sports fields, tennis courts, two harbours and 31 waterfront parks.

Increasing development and population growth is one reason for the increased need for recreation facilities but extreme weather including extreme temperatures is another.

Shade can be provided naturally, by trees and shrubs, or by non-natural features such as play structures, shade shells and a variety of other canopies. Due to the positive air quality impacts that trees have, increasing the town's tree canopy is a town priority. Unfortunately, this goal has a lot working against it; extreme weather, invasive species and drought to name a few. While the town has proactive tree protection measures, enforceable tree protection by-laws and aggressive tree canopy cover targets sometimes non-natural 'cooling' facilities are also warranted.

These types of non-natural 'cooling' facilities incur design, installation, operation and maintenance costs which would impact town operations.

Parks, Recreation, Culture and Library Master Plan - 2012

Mitigate / Adapt

Goals of this plan that relate to increased recreational facilities include:

- Allocating sufficient funds to maintain and/or upgrade the Town's existing facilities, equipment, and parks. This will require the development and implementation of an asset management program for facility upgrades.
- Facilitating the provision of infrastructure and management tools to ensure that services are delivered in an effective and efficient manner.
- Continuing to provide necessary assistance to volunteer based organizations, which are the foundation of the Town-wide leisure delivery system. Without this strong volunteer base, the Town will not be able to continue to offer its citizens the range of recreation, cultural, and open space opportunities that are presently available.
- Continue to obtain sufficient amounts of parkland for passive and active activities. This includes providing both an accessible distribution and a diverse range of opportunities, as well as preserving, protecting and enhancing unique natural features.

- Addressing the shortage of soccer fields by developing new fields, adding lights to existing fields (where appropriate), installing artificial turf, and/or converting under-utilized ball diamonds (where appropriate).

Adaptation Actions

- Track the increase in use of facilities in relation to increased temperature and extreme temperature events.
- Amend cooling map and smartphone app to include all new infrastructure.
- Continue to engage the public through citizen surveys to identify needs and gaps in relation to a changing climate.

Living Oakville - official plan - 2009

Mitigate / Adapt

10.1.1 The general objectives for sustainability are: a) to minimize the Town's ecological footprint; b) to achieve sustainable building and community design; c) to preserve, enhance and protect the Town's environmental features, natural heritage systems and waterfronts; d) to enhance the Town's air and water quality; e) to maintain the existing urban forest; and, f) to progressively increase the urban forest to achieve a canopy cover of 40% Town-wide beyond the life of this Plan.

Adaptation Actions

- Monitor the application of official plan requirements.
- Monitor the encouragement of the sustainability objectives in relation to providing access to cooling facilities in Oakville.

Oakville Harbours Financial Strategic Business Plan - 2011

Mitigate / Adapt

This plan calls for the town to acquire the federal-owned lands within Bronte Beach Park and the Bronte Harbour Marina.

Adaptation Actions

- Add all new green space acquired by to the town's on-line cooling facilities map and smartphone app.

Recreation Boating Feasibility and Capacity Study - 2013

Mitigate / Adapt

The intent of this two phase project is to conduct a Harbours Feasibility and Capacity Study with respect to recreational boating across the Region of Halton. The intent of the study will be:

- To provide a comprehensive analysis of current harbour capacity within the Greater Toronto Area (GTA)/Golden Horseshoe region and specifically within Halton.
- To assess the changing demographic profile of the area and the impacts of these changes on the anticipated demand for recreational boating, the sources and location of this demand.
- Identify trends in the type of boating and berth requirements with the aim at making recommendations on whether or not additional harbour capacity is warranted within Halton.

Adaptation Actions

- Monitor the results of the phase one. If a new harbour location is deemed necessary, include and monitor climate change adaptation measures into phase two of this study.

Extreme Weather Protocol (EWP) – On-going**Mitigate / Adapt**

Enactment of the town's EWP in relation to heat and smog events results in increased communication to the public regarding how to avoid heat stroke, extended hours of operation of pools, splash pads and other recreational facilities. During heat and smog alerts, the town website is updated and posters are hung at the entrance of all town facilities.

Adaptation Actions

- Track the use of facilities during extended hours of operation to gauge use related to heat events.
- Promote parks and outdoor shaded facilities as cooling infrastructure.

Water Sustainability Plan (WSP) - 2014**Mitigate / Adapt**

The WSP will integrate planning and management strategies to conserve and strategically manage water and minimize the discharge of pollutants to area waterways and Lake Ontario.

Adaptation Actions

- Track the development of the WSP and the identification of existing water management strategies.
- Monitor the results of:
 - Improved environmental performance in water conservation and pollution reduction.
 - Identifying opportunities for cost savings through water conservation, efficiency and re-use.

6.4.2**Increased sport field damage and/or increase in field closures due to extreme weather.****S2 + AC3 = V2**

When asked in the 2013 Citizens Survey 'What are the qualities or features of the Town of Oakville that make it livable? 27% of respondents chose Parks/Recreation/Sports/Teams, up 3% from 2011.

Cancellation of sporting events due to field closures impacts both town revenue and reputation as well as disappoints and inconveniences everyone involved. Compounding the inconvenience factor is that cancellations for extreme weather are usually issued less than 12 hours prior to the event; not a lot of notice can be issued as weather patterns change often and this can create conditions warranting closure quickly.

Allowing play time on fields that are saturated can result injury and significant turf damage. More of the safety factors are discussed in Health and Wellness theme.

Sport Field Irrigation and Monitoring – On-going**Mitigate / Adapt**

The town employs a sophisticated central irrigation system that is able to report on and project soil moisture levels and deficiencies in the irrigation system that in turn save many man hours and repair cost.

Adaptation Actions

- Track the number of field closures per season and the revenue impact that resulted.

Field Closure Policy – On-going



Mitigate / **Adapt**

Town staff will initiate field closure depending on saturation levels, location of field and the sport played on the field. All these factors are taken into consideration since some fields, located on sandy soils may have better drainage features and some sports incur increased wear and tear on fields more than others.

Adaptation Actions

- Raise community awareness of the potential for field closures during and after extreme weather events.
- Ensure sporting groups are aware of the town's field closure policy prior to requesting their use.

Summary Table

Vulnerability Level	Impact Statement	Associated Actions	Climatic Change
V3	Increased use and need for public green space, recreation centres, libraries, parks, splash pads and pools.	12	
V2	Increased sport field damage and / or increased field closures due to extreme weather.	3	



6.5 Health and Wellness



Department and Stakeholders Impacted: Human Resources, Halton Region Public Health, Environmental Policy, Recreation and Culture, Strategic Business Services, Strategy, Policy and Communications, By-law, Health Canada, Toronto Public Health, Ministry of the Environment and Climate Change



6.5.1

Extreme weather events such as heavy precipitation, high winds and lightning storms can compromise the health and wellness of staff and residents.

S4 + AC2 = V4

Halton Region, regional municipalities and Conservation Halton work to publicize extreme weather notices through local media, websites and social media.

Extreme Weather Protocols- On-going

Mitigate / **Adapt**

Cold Alert issued by Halton Region Health Department when:

- Daily predicted low of -15 ° C without wind-chill.
- Environment Canada issues a warning for outdoor activity (-35 ° C).
- Extreme weather conditions, such as a blizzard or ice storm.

Heat Alert issued by Environment Canada when:

- The temperature is expected to reach 30°C (86°F) or more.
- The humidex value is expected to reach 40°C (104°F) or more.
- When the temperature is 40°C (104°F) or greater.

Precipitation Warnings issued by Environment Canada when:

- Short Duration: when 50 mm or more of rain is expected within one hour, categorized as a significant rain event by EC.
- Summer Precipitation: when 50 mm or more of rain is expected within 24 hours; or When 75 mm or more of rain is expected within 48 hours.
- Winter Precipitation: when 25 mm or more of rain is expected within 24 hours.

High Wind Warning issued by Environment Canada when:

- Inland winds are blowing steadily at 60-65 km/h or more.
- Winds are gusting up to 90 km/h or more.

A Watershed Condition Statement – Flood Outlook is issued by Conservation Halton. This statement asks:

- Residents to be cautious around trails, rivers, streams, lakes, ponds and parks.
- Detailed information is available on their website.

Adaptation Actions

- Ensure that protocols are in place and operational.
- Prepare for the increased enactment and review of Extreme Weather Protocols.
- Enhance communication efforts surrounding the protocols.
- Monitor changes made to alert criteria.
- Continue to review and revise protocols as necessary.

Standard Operating Procedures (SOP) – On-going

Mitigate / **Adapt**

Town SOPs cover air quality advisories, heat alerts, severe lightning, sun protection and WHMIS training.

Adaptation Actions

- Prepare for the increased enactment and review of SOPs.
- Identify gaps if gaps exist in SOP coverage and amend as needed.
- Continue to monitor changes to alert criteria.

Emergency Management Plan – 2014 update

Mitigate / **Adapt**

In a special meeting of Council, the 2014 EMP was presented. Key facts presented in this report are:

- Emergency Management includes provisions for planning and full response to a large-scale emergency affecting the town's residents, property or services.
- Specific plans are in place to respond to rail and pipeline related issues in Oakville.
- Council has an important role in emergency response.

Adaptation Actions

- Prepare for the increased enactment of the EMP.
- Continue with the legislated detailed annual review and report to Council to incorporate necessary updates in response to climate change impacts.
- Track the lessons learned in regard to past extreme weather events such as the Midnight Madness micro burst storms and the December 2013 ice storm.

Emergency Preparedness Outreach and Education- On-going

Mitigate / Adapt

Developed in 2014, *Oakville's Climate Change Primer*, serves to educate the public on the science behind climate change, what changes to expect in Oakville and how to protect residents and their property against the impacts of extreme weather.

Adaptation Actions

- Once final, the Primer will be posted on-line and promoted to the public.
- Increase education efforts surrounding the importance of preparedness in dealing with protection against extreme weather impacts.
- Utilizing and equipping faith based organizations with emergency preparedness training.
- Continue to provide 72 hour emergency preparedness checklists and information at public outreach events.
- Continue the organization and execution of Emergency Preparedness Week and Fire Prevention Week activities.
- Continue to provide information to staff at the annual Health and Wellness Fair.

Extreme weather precautions were written into the 2013 SEUG including cautions pertaining to extreme heat, high winds and lightning. Event organizers are asked to be aware of current and forecasted weather and make appropriate, safe decisions according to the weather conditions.

Adaptation Actions

- Town staff need to ensure evacuation plans are submitted for large scale community events. Town staff need to demonstrate leadership by using tent weight (sandbags or other), communicating weather patterns and always making plans and decisions considering safety first.
- New event coordinator position created in 2014.

6.5.2

Increased risk associated with railway and pipeline infrastructure due to extreme temperatures and weather events.

S4 + AC2 = V4

The stress of extreme temperatures, increased wind activity and severe weather events will compromise the safety and reliability of railway and pipeline systems. Severe weather and wind events can cause debris on tracks, power outages leading to signal failure and other storm induced accidents. Extreme temperatures and temperature fluctuations can also cause rails to buckle or land underneath to scour and washout in warmer wetter winters.

Pipelines and railways are often used to transport highly volatile materials that could provide far reaching and devastating impacts to the natural environment, health and welfare of humans and the built environment, making adapting these systems to climate change crucial.

Emergency Management Plan – 2014 update

In a special meeting of Council, the 2014 EMP was presented. Key facts presented in this report are:

- Emergency Management includes provisions for planning and full response to a large-scale emergency affecting the town's residents, property or services.
- Specific plans are in place to respond to rail and pipeline related issues in Oakville.
- Council has an important role in emergency response.

Adaptation Actions

- Continue with the legislated detailed annual review and report to Council as required.
- Track the progress made on railway and pipeline plans.
- Be cognizant of what is being transported through Halton Region especially through Oakville.

Spills Response – On-going

Town staff is sometimes put into the position of being a first responder to hazardous waste spills in Oakville. Town staff is equipped for initial containment, consisting of applying absorb-all or booms to initially contain the hazardous material. The town also becomes involved in communicating information to residents and monitoring the progress of spills response being carried out by others in order to ensure the protection and health and safety of residents and the environment.

Adaptation Actions

- To investigate and record current spills response protocols, responsibilities and procedures.
- To increase the level of staff training in relation to spills response, remediation and management.
- To create a formalized approach and protocol for responding to spills in Oakville.
- Continue to work in partnership with the Halton Co-operative Purchasing Group to retain a spills response contractor.
- To continue to work cooperatively with other agencies involved in spills response

Emergency Preparedness Outreach and Education – On-going

Mitigate / **Adapt**

As part of Enbridge’s “Emergency Preparedness” planning they are informing municipalities of the following:

- Where their pipes are located.
- Precautions to take when working near Enbridge infrastructure.
- Emergency contacts.

Adaptation Actions

- Use and equip faith based organizations with emergency preparedness training.
- Continue to provide 72 hour emergency preparedness checklists and information at public outreach events.
- Continue the organization and execution of Emergency Preparedness Week and Fire Prevention Week activities.
- Continue to participate and gain knowledge of the various dangers and emergency preparedness surrounding railways and pipelines in Oakville.

6.5.3

Extreme summer temperatures will result in increased heat and air quality alerts and related illnesses.

S3 + AC3 = V3

Located on the north shore of Lake Ontario and in the midst of the GTA major transportation corridors, development and industry, Oakville is prone to health and wellness impacts related to poor air quality, urban heat island effects, extreme temperatures. Extreme heat can take a toll on the health of people all ages especially when compounded with poor air quality.

Livable Oakville – official plan - 2009

Mitigate / **Adapt**

10.11.1 The Town will work to improve air quality through its land use and transportation decisions including, but not limited to:

- a) Concentrating activity centres;
- b) Encouraging mixed use development;
- c) Providing a well-connected pedestrian and bicycle network where feasible;
- d) Providing convenient and efficient transit service;
- e) Implementing parking policies, primarily through the Zoning By-law, that do not undermine the encouragement of transit and active modes of transportation; and,
- f) Establishing policies and by-laws that protect and enhance the urban forest.

Adaptation Actions

- Track the progress made on meeting the goals and objectives related to climate change mitigation and adaptation.

Energy Conservation and Demand Management Plan - 2014

Mitigate / Adapt

Through the Partners for Climate Protection (PCP) Program, the town has tallied its greenhouse gas emissions and set reduction targets, all in the effort to protect and enhance local air quality and limit the town's contribution to climate change. The outcomes of this program are discussed in the theme Built Environment.

Adaptation Actions

- Track the progress made on meeting the goals and objectives related to climate change mitigation and adaptation.
- Track the integration of the PCP program into the Energy Conservation and Demand Management Plan.

Extreme Weather Protocol - Heat and Smog – On-going

Mitigate / Adapt

For the protection of Oakville residents and town staff, the town implements Smog, Heat and Extreme Weather Protocols on days when the local air quality and weather may impact health.

Adaptation Actions

- Prepare for the increased enactment of protocols.
- Monitor employee medical leaves (ie. Sick days) in relation to local air quality reports.
- Continue to partner and share information with Health Canada and Toronto Public Health to develop the 2015 Cooling Centre smartphone app to be launched for the PanAm Games.

Urban Forest Strategic Management Plan (UFSMP) - 2014

Mitigate / Adapt

As a component of the UFSMP (2008 – 2027) the 2006 Urban Forest: Our solution to Pollution included goals related to green infrastructure being valued as cooling facilities and an integral tool to improve local air quality include:

- Obtaining detailed outputs on the human health benefits from Oakville's urban forest.
- Investigating the feasibility of an incentive program for private large stature trees in order to maximize filtration of criteria pollutants and GHG's.
- Identifying opportunities for Parks Naturalization that contributes to the forest canopy and prepare capital budget costs.
- Implementing pilot rooftop garden demonstration projects that can contribute to forest canopy coverage.

Adaptation Actions

- Track the progress made on the above initiatives.
- Communicate the health benefits of a mature canopy cover in Oakville.
- Continue to track tree planting initiatives across town and refer to cooling facility map to determine areas in most need.

Clean Air Plan - 2006**Mitigate / Adapt**

Provides information to staff on the effects of poor air quality and actions that can be taken to protect health as well as help to improve local air quality.

Adaptation Actions

- Update the Clean Air Plan to incorporate climate change impacts.
- Enhance outreach and education efforts to town staff at the Wellness Fair, Earth Day and seasonal staff training events.

Sustainable Green Fleet Procedure - 2009**Mitigate / Adapt**

The procedure aims to reduce idling with the installation of education and control measures, improve fuel efficiency and the reduction of fuel use, promote the use of alternate and renewable fuels, as well as implement a DriveSmart, drivers training program.

Adaptation Actions

- Track the progress made on limiting idling times and the addition of fuel friendly vehicles into the town fleet.
- Track the air quality benefits and greenhouse gas emission reduction resulting from the procurement and use of these vehicles and technologies.

Active Transportation Master Plan - 2009**Mitigate / Adapt**

In October 2009, the town completed an Active Transportation Master Plan (ATMP) study, which included a full review of our pedestrian and cycling facilities network, with an additional focus on how these initiatives blend with transit services. The study results assess current conditions and develop a recommended implementation plan to improve and expand the network, and promote cycling and walking in Oakville.

Adaptation Actions

- Track and promote the implementation of recommendations in the report.
- Track the health benefits or uptake of the implemented recommendations.
- Continue to provide bicycle safety and public education on the health benefits of active transportation.

SmartCommute / Clean Air Commute- On-going**Mitigate / Adapt**

An initiative to support staff in reducing single occupancy vehicle use on their commutes to and from work.

Adaptation Actions

- Track staff participation in these initiatives over time.
- Continue to participate and enhance participation in events including Car Free Day, Bike Week.
- Consider hosting Summer Fun Bus and Bike Day in partnership with the Halton Environment Network and Oakville Public Libraries.

Health Protection Air Quality By-Law - 2010**Mitigate / Adapt**

Town program to report on emissions from facilities and limit air pollution from major emitters in Oakville. Supported by Council this by-law works to limit the release of fine particulate matter that is responsible for human health impacts.

Adaptation Actions

- Continue to implement the requirements of the HPAQ By-Law.
- Track the successes related to air quality improvements resulting from the by-law's implementation.
- Raise awareness of the HPAQB impacts in improving local air quality.

Air Quality Monitoring Program – On-going

Mitigate / Adapt

The Ministry of the Environment and Climate Change (MOECC) operates air monitoring stations across the province to measure the quality of outdoor air. These air monitoring stations are used to generate the:

- Air Quality Index
- Air Quality Health Index (AQHI)
- Air monitoring data

Adaptation Actions

- Continue to work in partnership with all levels of government to help mitigate the negative impacts of poor air quality.
- Continue to implement and strengthen municipal by-laws to support the town's commitment to improving local air quality.
- Continue to monitor the province for changes to air quality regulations.

Idling By-Law- 2002-153

Mitigate / Adapt

Town Council passed this by-law on August 12, 2002. It is an offence for a vehicle to idle for more than five consecutive minutes except in certain circumstances. Outreach and education surrounding the by-law includes involving school communities and promotion of the by-law at idling hotspots.

The town runs an ongoing smog reduction education campaign, targeting town employees. Town vehicles and equipment have stickers reminding staff not to idle.

Adaptation Actions

- Continue to enhance public education program with schools and community groups.
- Continue to monitor Provincial action on regulating idling in Ontario.
- Continue to track idling complaints within Oakville.
- Investigate the potential for strengthening the town's by-law.

Heat, Health and Smog Outreach and Education – On-going

Mitigate / Adapt

Staff are provided information on heat, health and smog, and the precautionary actions they can take to protect themselves. This education is provided via portico, seasonal staff training, staff outreach events and in all new hire Human Resource packages.

Adaptation Actions

- Continue to expand outreach to staff throughout all facilities.
- Continue to partner and share information with Health Canada and Toronto Public Health to develop the 2015 Cooling Centre smartphone app to be launched for the PanAm Games.
- Consider the implementation of innovative cooling or shade structures to be installed in high use parks and sports fields.

6.5.4

An increase in annual average temperatures will cause the northerly migration of invasive species and vector borne diseases.

S3 + AC2 = V3

As temperatures rise, the migration patterns of plants and animals shift northward, some of them invasive and non-native species that have health impacts for those that come into contact with it.

Not only are plants migrating north but so is the occurrence of vector borne diseases including West Nile Virus and Lyme disease. An increase in annual temperatures may also extend the season in which mosquitoes and ticks can transmit these diseases.

WNV Protocol and Regional Surveillance Program – On-going

Mitigate / Adapt

Town of Oakville supports and participates in the regional WNV Surveillance Program which includes response, remediation and communication of WNV activity in Halton.

Adaptation Actions

- Continue to enhance WNV response, remediation and communication efforts.

WNV and Noxious Plant - Staff Education - On-going

Mitigate / Adapt

Staff are provided information on WNV and giant hogweed and the precautionary actions they can take to protect themselves. This education is provided via portico, seasonal staff training, staff outreach events and in all new hire Human Resource packages.

Adaptation Actions

- Continue to enhance staff training pertaining to noxious plants and vector borne diseases.
- Include discussions on Lyme disease, tick identification and removal into seasonal employee training.
- Track any instance of WNV and Lyme disease in Halton Region.

Halton Region's Lyme Disease Response - On-going

Mitigate / Adapt

Lyme disease is a bacterial infection inflicted by the 3 legged tick. The migration of 3 legged ticks are being tracked in association with climate change as their presence and abundance is being noted across Southern Ontario.

Adaptation Actions

- Continue to inquire and research the migration of ticks and Lyme disease in Halton Region.
- Support the opportunity to partner with Halton Region on an education or surveillance program.

Invasive Species Monitoring Program – On-going

Mitigate / Adapt

Town staff respond to various invasive and non-native species for the protection of our native biodiversity, recently some of the more problematic and devastating non-native or invasive species have been gypsy moth, emerald ash borer, garlic mustard, giant hogweed.

Emerald Ash Borer (EAB) is an invasive insect from Asia that attacks and kills untreated Ash trees. The town has a strategy to detect and manage EAB in Oakville.

To monitor for the presence of Asian Long-Horned Beetle (ALHB) the town has hung ten ALHB traps in select trees in the east area of town. ALHB has not been detected in Oakville.

Adaptation Actions

- Continue to be proactive regarding invasive species identification and eradication.
- Continue to partner with external agencies and levels of government to track migration patterns, presence and best management practices associated with eradication.
- Monitor invasive and non-native pests to the south due to the anticipated northerly migration.

6.5.5

Increased health and safety risks associated with electrical disturbances.

S2 + AC3 = V2

When disturbances in electricity are experienced there are many health and safety risks associated. The loss of power could result in:

- Loss of air conditioning or heating affecting vulnerable population.
- The consumption of spoiled food.
- Basement flooding as a result of an inoperative sump pump.
- Growth of mold due to basement flooding.

Extreme temperatures and extreme weather events can all jeopardize local energy distribution channels. The loss of electricity places many people in vulnerable positions due to the lack of:

- Information
- Communication methods.
- Heating and cooling.
- Refrigeration leading to the spoiling of food.
- Basement flooding.

Education and Outreach – On-going

Mitigate / Adapt

Oakville's Climate Change Primer, provides information to residents on how to stay safe while experiencing power outages.

Adaptation Actions

- Make information available at public outreach events and on the town's website.
- Raise awareness of actions the public can take to stay safe during a power outage.

6.5.6

Increased risk to recreational users of Lake Ontario due to an increase in the frequency and intensity of extreme weather events.

S2 + AC3 = V2

Extreme weather can strike fast and sometimes without much warning. Residing on the north shore of Lake Ontario allows for some interesting and complex lake-effect weather patterns.

TOWARF – On-going

Mitigate / Adapt

TOWARF is a Canadian Coast Guard Auxiliary Unit that provides marine search and rescue service with the primary goal of saving lives at risk in western Lake Ontario.

Adaptation Actions

- Continue and enhance relationship with TOWARF and partner with TOWARF on boating safety week and a harbours outreach and education event.

Clean Marine Program - 2006

Mitigate Adapt

In the spring of 2014 town staff included boating safety as part of their outreach and education program.

Adaptation Actions

- Continue to enhance the safe boating initiative as a component of the Clean Marine Program.

Fire Master Plan (FMP) - 2011

Mitigate / Adapt

The FMP suggests conducting a risk assessment of the town's harbours to determine an adequate level of service for fire prevention, public education and fire suppression (page 25).

Adaptation Actions

- Monitor the results of the harbour's risk assessment and include details and outcomes into the Clean Marine Action Plan.
- Prepare fiscally for the implementation of initiatives and technologies to build the harbours resiliency to climate change impacts.

Halton Region Beach Water Quality Testing – On-going

Mitigate Adapt

Samples taken by Halton Region Health Department are analyzed by the Provincial Public Health Laboratory for E. coli bacteria, which is used as an indicator of fecal pollution. Testing locations in Oakville are Bronte Park Beach, Coronation Park West, and Coronation Park East. Harbour staff communicate the results of this testing by posting results at town harbours and through the town website.

Algae is monitored by viewing and observing the Lake Ontario water.

Adaptation Actions

- Provide easier access to Beach Water Quality results via website and social media.

- Anticipate increased water quality testing to coincide with an increase in precipitation events.
- Prepare for increased beach closures and the communication efforts surrounding these closures.

6.5.7

Insecure food systems and higher prices of consumables related to changing weather patterns and extreme weather events.

S2 + AC3 = V2

Local vegetation is feeling the stress of increased temperatures and variable precipitation patterns. Although precipitation is expected to increase it doesn't necessarily mean that it will come when needed most.

Trees and shrubs are experiencing early budding, blooming and the die off of new growth as a result of the warmer and more variable temperatures.

Opportunities that arise are:

- More variability in crop species.
- Higher yields per season due to longer warmer growing season.
- Multiple plantings per season.

Although these opportunities exist, more care and maintenance would be required to take full advantage. To further stress the importance of a secure local food system decreasing lake water levels and worldwide crop devastation due to disease and drought is consistently raising the cost of standard products in Canada.

Ministry of Agriculture and Food - On-going

Mitigate / Adapt

Working in partnership the Ministry of Agriculture and Food and the Ministry of Rural Affairs developed the Local Food Fund (LFF). The LFF provides up to \$10 million in funding per year for three years supporting innovative local food projects that:

- Reduce barriers to regional economic development.
- Result in sustainable regional economic development.
- Have a positive impact on the Ontario economy.

Adaptation Actions

- To provide support to groups working to grow and distribute fresh produce within Oakville.
- To provide support for the implementation of goals and outcomes associated with the Local Food Fund.

Halton Region Agricultural Forum - 2014

Mitigate / Adapt

Hosted by Halton Region in January 2014, this forum was held to provide information on funding opportunities available to the agricultural sector in Halton. The agricultural forum focused on 3 main funding programs:

- Growing Forward 2.
- The Local Food Fund.
- The Greenbelt Fund.

Adaptation Actions

- Consider how town staff can support the on-going efforts of the agricultural sector in Oakville.

Community Gardens – On-going

Mitigate / Adapt

The Town of Oakville has three community gardens with plots available for rent to residents:





- Shell Park – Lakeshore Road West between Great Lakes Boulevard and Chalmers Street, east of Burloak Drive.
- Kingsford Gardens – Sherwood Heights Drive and Kingsway Drive, east of Ford Drive.
- Lyons Lane – Lyons Lane and the South Service Road, east of Kerr Street.

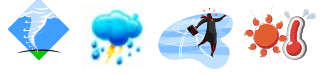


The garden plots are open between May 7 and October 31 for non-commercial use only.

Adaptation Actions








- Consider expanding the existing program to satisfy the annual wait list.
- Continue to research best management practices related to small scale agriculture and community garden plots.
- Encourage food sharing programs such as the programs developed by the Oakville Sustainable Food Partnership.

Summary Table

Vulnerability Level	Impact Statement	Associated Actions	Climatic Change
V4	Extreme weather events such as heavy precipitation, high winds and lightning storms can compromise the health and safety of staff and residents.	19	
V4	Increased risk associated with railway and pipeline infrastructure due to extreme temperatures and extreme weather events.	12	
V3	Extreme summer temperatures will result in increased heat and air quality alert and related illnesses.	32	
V3	An increase in annual average temperatures will cause the northerly migration of invasive species and vector borne diseases.	9	

V2	Increase in health and safety risks associated with electrical disturbances.	2	
V2	Increased risk to recreational users of Lake Ontario due to an increase in the frequency and intensity of extreme weather events	7	
V2	Insecure food systems and higher prices of consumables related to changing weather patterns and extreme weather events.	6	



				
<u>Department and Stakeholders Impacted:</u> Engineering and Construction, Environmental and Development Engineering, Roads and Works, Planning Services, Oakville Transit, Halton Region, Ministry of Transportation				

6.6.1
Transportation infrastructure is subject to flooding due to extreme and longer duration extreme precipitation events.
S4 + AC1 = V5

Overland flooding impacting our transportation infrastructure could be the result of intense precipitation or increase freeze/thaw cycles. Overland flooding stresses storm water infrastructure located within our transportation corridors.

These transportation corridors are used to move people and provide for the mobilization of emergency services. Theme 3: Health and Wellness discusses actions to protect the safety of staff and residents.

Livable Oakville – official plan - 2009

Mitigate / Adapt

The following goals relate to actions that could provide flooding relief:

10.6.1 The Town will encourage innovative programs and construction methods which support the sustainable development and redevelopment of buildings. Sustainable features sought by the Town may include, but are not limited to: b) energy-efficiency technologies that are consistent with high energy efficiency standards (such as Energy Star and LEED buildings), design features and construction practices; d) permeable paving and other innovative stormwater management methods; and, e) water conservation and efficiency measures.

10.10.1 Stormwater management techniques shall be used in the design of new developments to control both the quantity and quality of stormwater runoff. In areas where soil types permit, on-site infiltration shall be encouraged to the maximum extent feasible.

10.10.8 The use of permeable surfaces and soft landscaping shall be encouraged where possible.

Adaptation Actions

- Tracking applications showing an interest in innovative storm water management systems including rain water capture (rooftop or surface) and permeable pavements.
- Tracking implementation and effectiveness of these systems.
- Promote and track implementation of the Sustainable Development Checklist.
- Continue to investigate providing a lot level stormwater incentive program.
- Continue to support staff participation in conferences/ webinars and seminars.
- Initiate a demonstration pilot project in partnership with Institute of Catastrophic Loss Reduction (ICLR) and Western University.

Flood Prioritization Study - 2008

Mitigate / Adapt

In 2008, the town completed a Flood Prioritization Study on the town's major open-channel waterways, streams, rivers and lakes to identify flood-sensitive areas in Oakville. The study used information from previous subwatershed studies and consolidated all the information into one document. One of the objectives of this study was to see all flood-sensitive areas in relation to one another. These areas were categorized as low, medium or high risk, enabling the town to start setting priorities for flood mitigation projects such as the:

- Flood Mitigation Options Study – Fourteen Mile Creek and McCraney Creek which is set for completion in 2015
- Flood Mitigation Options Study – Lower Morrison Creek and Wedgewood Creek which is to be initiated in 2015

Adaptation Actions

- Track and monitor the completion of each study phase - 2nd / 3rd phase to be initiated in 2014 while the final phase begins in 2016.
- Future studies will look at the town's underground sewer network and overland flow routes, recognizing that these routes, if compromised, can also present a flood risk.
- Consider the appointment of dedicated staff to the catchbasin monitoring inspection program.
- Increase monitoring, maintenance and clearing of catch basins.
- Catchbasins are fitted with inlet control devices (ICD) that allow for only a certain amount of storm water to enter, the rest runs overland. Determine if ICDs are contributing to overland flow, if so, the town may consider reassesses road slopes, grading and catchbasin capacity.
- Research updating IDF curves and internal policies on design standards.
- Continue and enhance public outreach efforts.

Inlet Monitoring and Maintenance Program – On-going

Mitigate / Adapt

Clogged inlets and catchbasins often are the cause of flooding. Increased natural debris and litter will enter stormwater systems due to increased wind and precipitation. Inlets are cleared once annually or prior to a large event if deemed necessary. Hotspots have been identified and prioritized for clearing and inspections. Previously town staff cleared upstream of inlets to further guard against potential clogging but new regulations have been put into place that no longer permits it.

Adaptation Actions

- Prepare for increased frequency of inlet monitoring and maintenance.
- Review program to gauge whether a more formalized, inclusive and proactive approach is needed.

Storm Sewer Inspection Program – On-going

Mitigate / Adapt

To support condition assessment of the town's storm sewer system, an inspection program using zoom cameras was carried out in Phase 1 of the Storm Water Master Plan and storm sewer maintenance program prioritization.

Adaptation Actions

- Increased monitoring and maintaining of conveyance.
- Continue to research best management practices
- Ensure only minimal level of infiltration into pipe is occurring.
- Research and implement best management practices related to pipe depth and location.

- Monitor Conservation Halton for changes to design standards.

Emergency Management Plan (EMP) – 2014

Mitigate **Adapt**

The results of the Storm Sewer Master Plan and the Flood Prioritization and Mitigation Studies were used to inform the EMP. Flooding can cause detour and delays in emergency response and often in extreme weather there is more than one issue needing emergency attention.

Adaptation Actions

- Prepare fiscally for the more frequent enactment of this plan.
- Continue to provide support and response training to staff.

6.6.2

Winter control operations will be impacted by the variable temperature and precipitation patterns as well as extreme winter storm events.

S4 + AC3 = V4

Town of Oakville Roads and Works Department maintains 1,900 lane kilometres of roads and 900 kilometres of sidewalks. During inclement weather, every effort is made to ensure that town-owned facilities remain open for as long as is safely possible. Details on impacts and actions related to personal safety on roadways in discussed in the Health and Wellness theme.

The town's Roads and Works Department is equipped to handle the average winter weather events and utilizes combination equipment (plough / salter / sander) for fast response and lower greenhouse gas emissions. Operationally the town will be impacted when there is an increase in the intensity and duration of winter storm events.

Winter Control – Roads and Works – On-going

Mitigate **Adapt**

To limit disruption and safety hazards caused by winter storms, Roads and Works operates on a 24/7 winter road patrol system which allows for immediate response to poor road conditions. Included in the Roads and Works Capital budget is the purchase and installation of road cameras to increase capacity to monitor and respond to unsafe road and pavement conditions.

Adaptation Actions

- Track and monitor the installation of equipment requested in the capital budget.
- Amend budget allocations to meet projected changes in weather.
- Increase number of monitoring sensors installed on maintenance equipment.
- Research winter performance of permeable pavements and other asphalt mixes.
- Research new winter weather equipment and materials – salt brine study underway.
- Increase level of resources needed for response to long duration events - staff coverage – ex. Implement three shift system to deal with the long duration events – increase the number of Road Weather Information Systems (RWIS) stations which forecast existing and expected conditions.

Winter Control- Oakville Transit – On-going**Mitigate / Adapt**

Transit stops are cleared after snow accumulates in excess of five centimetres (two inches), and only after roads are cleared. Transit stops on primary and secondary roads are cleared first. Oakville has over 1200 transit stops that are generally cleared within 48 hours of the end of the storm; however, with a heavy snowfall, or successive winter events, it will take longer to clear stops and stops may need multiple clearings per event. Transit stops are cleared by an external contractor.

Oakville Transit's Care-A-Van service primarily services residents that are severely vulnerable to extreme weather due to predisposed illnesses, age, medical dependencies and appointments. Oakville Transit does recommend limiting unnecessary travel in inclement weather.

In winter weather the Care-A-Van service requires a clear pathway of travel from door to driver, this is sometimes hard to achieve for these residents.

Adaptation Actions

- Increased resources needed to handle long duration events. Stops are often cleared multiple times per events.
- Increase winter maintenance to transit vehicles (wear and tear, increase salt build-up) shelters and concrete pads.
- Prepare for increased calls and rescheduling of service during extreme weather events.

Winter Control – Other– On-going**Mitigate / Adapt**

The departments of Parks and Open Space and Facilities and Construction Management also handle snow clearing on municipal property primarily in parking lots and on sidewalks.

Adaptation Actions

- Amend budget allocations to meet projected changes in weather.
- Research winter performance of permeable pavements and other asphalt mixes.
- Increase level of resources needed for response to long duration events - staff coverage – eg. Implement three shift system to deal with the long duration events – increase the number of Road Weather Information Systems (RWIS) stations which forecast existing and expected conditions.

6.6.3**Increased freeze/thaw cycles and extreme heat events will lead to road surface damage.****S3 + AC2 = V3**

Increased temperatures and the occurrence of freeze/thaw cycles will stress pavement resulting in stress fractures and potholes that will require increased monitoring and maintenance. Damage to town vehicles and Oakville transit vehicles could result from this increased road damage.

RoadMatrix – On-going**Mitigate / Adapt**

A computer model adopted by the town and other municipalities in Halton for consistency uses real field-measured data to model both existing road conditions and predicted pavement deterioration. The town has been using this pavement management application program since 1997 to evaluate, analyze, prioritize and develop annual road resurfacing programs for our network of about 705 kilometres of roads.

Adaptation Actions

- Prepare fiscally for increased monitoring and maintenance.
- Need to ensure on-line application is taking climate change (increased freeze thaw cycles and extreme heat) in consideration.
- Consider utilizing specific assessment tools and protocols to better assess the vulnerability of town infrastructure.

Report a Problem – On-going

Mitigate **Adapt**

ServiceOakville's maintains the online Report a Problem tool for service requests for non-emergency issues such as road or sidewalk maintenance, potholes, streetlights, roadway litter and debris, graffiti and damage by snow plows.

Adaptation Actions

- Increase in service requests and associated remediation.
- Increase communication to residents promoting this service.

6.6.4

Extreme heat waves will stress steel and concrete infrastructure including bridge structures and culverts.

S3 + AC2 = V3

Oakville has 44 bridge structures and 64 culverts that become vulnerable under the stresses of extreme weather and variable temperatures.

Variable temperatures usually equate to increased freeze thaw cycles which are known to stress infrastructure. Railway infrastructure is also made vulnerable with the extreme temperatures and weather events. The town is not responsible for the maintenance or operating of railways in Oakville and therefore the responsibility of town lies in the emergency response which is discussed the Theme 3: Health and Wellness.

Bridge and Culvert Database – On-going

Mitigate / **Adapt**

Prioritization of bridge and culvert repairs and maintenance are determined using an online database that rates the performance of each structure.

Adaptation Actions

- Prepare fiscally for increased monitoring and maintenance.
- Determine if appropriate data sets are being used to predict the changing weather patterns as related to the wear and tear on infrastructure.
- Consider utilizing specific assessment tools and protocols to better assess the vulnerability of town infrastructure.

Report a Problem

Mitigate **Adapt**

ServiceOakville's maintains an online Report a Problem tool for service requests for non-emergency issues such as road or sidewalk maintenance, potholes, streetlights, roadway litter and debris, graffiti and damage by snow plows.

Adaptation Actions

- Prepare to increase level of service in relation to requests and associated remediation.
- Track and tally the increase of requests and remediation.

6.6.5

Extreme weather can damage infrastructure and cause projects delays.

S3 + AC3 = V3

High wind and heavy precipitation events could cause damage and delays to town infrastructure projects. Delays and damage could be very costly and risk safety.

Construction Site Requirements – On-going

Mitigate / Adapt

Engineering and Construction require sediment fencing, siltation screens and/ or catch basin filter clothes be installed during construction to help protect local water quality.

In the case of extreme precipitation events these requirements can become weakened and sometimes need to be removed completely to guard against damming and flooding.

Adaptation Actions

- Prepare for increased monitoring, inspection and maintenance of construction site requirements and amend as necessary.

6.6.6

Variable and increasing temperatures are causing changes to the migration patterns and habits of wildlife.

S2 + AC3 = V3

As development occurs and weather patterns change, we can expect that the habits and migration patterns of local wildlife to change with them. Town staff are receiving frequent calls regarding encounters with local wildlife and town staff have put response and tracking mechanisms into place.

Coyote Reporting and Mapping - 2011

Mitigate / Adapt

The town has a comprehensive coyote management program in place that consists of: Reporting system; education and outreach; mapping; risk response protocols; staff training.

Adaptation Actions

- Continue to implement the coyote management program to address potential risks.

Oakville Wildlife Strategy- 2011

Mitigate / Adapt

The Oakville Wildlife Strategy sets out a comprehensive overview of Oakville's natural environment and provides ten recommendations to support and enhance wildlife and biodiversity in the town.

Adaptation Actions

- Research and consider identifying and mapping key wildlife corridors and habitats as per the province's 2010 Natural Heritage Manual.
- Research and develop wildlife friendly development options and construction guidelines (e.g. development checklists, site plan guidelines, best management practices for town infrastructure and development projects, staff/contractor training).

Road Ecology Strategy – In Development

Mitigate / **Adapt**

The Road Ecology Strategy provides a comprehensive overview and mapping of the town's natural resources as they intersect with transportation infrastructure. Mitigation measures and options for minimizing the impact of this infrastructure on the environment (in particular wildlife) are set out.

Adaptation Actions

- Implement recommendations of the road ecology strategy and integrate into transportation infrastructure processes.

6.6.7

An increase in the availability of mosquito breeding grounds will result from increased temperatures and precipitation.

S2 + AC4 = V2

Increasing temperatures and precipitation could result in more available breeding sites for mosquitoes depending on which increase is larger during the WNV season. If temperature increases more in summer precipitation we may see a decrease in available breeding sites due to increased evaporation but if summer precipitation increases more, we can expect the following policies, procedures and actions to be in effect.

WNV Surveillance Program - On-going

















Mitigate / **Adapt**

Halton Region is responsible for the treatment of applicable catchbasins. The town's Roads and Works Department remediates standing water sites located in and along Town of Oakville transportation corridors.

Adaptation Actions:

- Continue to support and participate in Halton Region's WNV Surveillance program.
- Continue to enhance outreach and education initiatives.
- Prepare to respond and remediate more frequently as temperatures and precipitation increase.

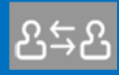
Summary Table

Vulnerability Level	Impact Statement	Associated Actions	Climatic Change
V5	Transportation infrastructure is subject to flooding due to extreme and longer duration extreme precipitation events.	24	 
V4	Winter control operations will be impacted by the variable temperature and precipitation patterns as well as extreme winter storm events.	12	 
V3	Increased freeze/thaw cycles and extreme heat events will lead to road surface damage.	5	  
V3	Extreme heat waves will stress steel and concrete infrastructure including bridge structures and culverts.	5	 
V3	Extreme weather can damage infrastructure and cause projects delays.	1	   
V3	Variable and increasing temperatures are causing changes to the migration patterns and habits of wildlife.	4	
V2	An increase in the availability of mosquito breeding grounds will result from increased temperatures and precipitation	3	 



6.7 Built Environment

- Buildings, Planning and Land Use



Department and Stakeholders Impacted: Planning, Building Services, Zoning, By-law, Environmental Policy, Strategy, Policy and Communications, Facilities and Construction Management, Recreation and Culture, Halton Region, Province of Ontario



6.7.1

Increased vulnerability of electrical distribution systems due to the occurrence of frequent and intense extreme weather events.

S4 + AC1 = V5

Intense and frequent weather events will stress our existing electrical distribution systems. Fallen trees on power lines, lightning strikes, aging infrastructure and electrical overload due to extreme temperatures can all result in a loss of power to portions of the town. The town has implemented Business Continuity Management to ensure critical services and functions are maintained in the event of an interruption or emergency.

Many people become the 'vulnerable population' when confronted with a loss of power. If you can't find your glasses when the power goes out or have no way to get in touch with anyone you are becoming more vulnerable. Information on keeping yourself prepared and safe in these times is discussed in the Health and Wellness theme as well as in *Oakville's Climate Change Primer*.

Town staff participated in Toronto's WeatherWise Partnership bringing together colleagues from across the GTA to discuss the vulnerabilities associated with our electrical distribution system.

Livable Oakville - official plan - 2009

Mitigate/Adapt

Goals related to increasing the electrical system's resiliency to climate change includes:

10.2.1 The Town recognizes that a key initiative to mitigate the impacts of climate change is the reduction of greenhouse gas emissions. The Town will work to mitigate and adapt to climate change by initiatives that include, but are not limited to:

a) encouraging energy generation from renewable sources as well as district energy; e) reducing the risk of infrastructure damage during severe weather by encouraging the location of utilities underground and improving Town infrastructure.

Adaptation Actions

- Monitor the application of official plan requirements.
- Track the encouragement, installation and barriers related to renewable energy installations and the location of underground utilities.

Sustainable Building Design Guidelines - 2010

Mitigate / Adapt

The guidelines focus on the appropriate and efficient use of resources — energy, water and materials — in order to reduce the building’s environmental impact during its lifecycle. In addition to increased sustainability, a consistent approach to design and construction of the town’s facilities will clarify direction and streamline project execution.

Adaptation Actions

- Continue to enhance staff awareness and use of the Sustainable Design Guidelines.
- Begin to monitor the implementation of goals and actions related to climate change mitigation and adaptation.
- Monitor the implementation of rainwater harvesting measures and their associated benefits.

Energy Conservation Outreach and Education- On-going

Mitigate / Adapt

Town staff partner with Oakville Hydro on hosting the annual Energy Conservation Fair to engage staff and residents in energy conservation. This event draws nearly 600 people annually proving that increased energy use and costs are top of mind. Town staff, Oakville Hydro and facilities participate in Earth Hour, annually powering down all non-essential lighting.

Oakville Public Libraries host two energy conservation educational programs to teach the importance and cost saving of simple behavioral changes.

Adaptation Actions

- Continue to enhance the annual Energy Conservation Fair and the link to climate change.
- Enhance promotion of the Watt Not, Waste Not, Earth House and Energy Conservation backpack programs.
- Once approved, post *Oakville’s Climate Change Primer* to the town’s website.
- Research and record which town and community facilities are equipped with back-up generators.
- Research the possible implementation of using faith based organizations as emergency community hubs.

6.7.2

Increased urban heat island effect due to extreme heat events and increased development.

S3 + AC2 = V3

As population increases and development and redevelopment occur the urban heat island effect can become accelerated if the proper measures are not put into place. Preparing for this through proactive planning, zoning and land-use decisions can work to lessen these impacts across town.

Livable Oakville - official plan - 2009

Mitigate / Adapt

10.1.2 Policies

- a) Sustainable development will be one of the criteria when reviewing applications for future land use and for public works and capital expenditures in order to minimize the town’s ecological footprint.
- b) The town will encourage development which reflects the principle of sustainable development through a sustainable development checklist. The checklist will be used as a tool for assessing sustainable development features of applications, including those matters set out in this section or other initiatives.

10.6.1 The town will encourage innovative programs and construction methods which support the sustainable development and redevelopment of buildings. Sustainable features sought by the town may include, but are not limited to: c) green roofs or high albedo roofs that contribute to the reduction of the urban heat island effect; d) permeable paving and other innovative stormwater management methods.

10.10.8 The use of permeable surfaces and soft landscaping shall be encouraged where possible.

Adaptation Actions

- To monitor the application of official plan requirements.
- To link the town's shade mapping exercise with planning decisions for North Oakville
- To continue with public outreach and education campaigns related to heat and health protection.

Sustainable Design Guidelines - 2010

Mitigate / Adapt

All town departments and staff shall follow the Sustainable Design Guidelines (SDG) in order to ensure consistency, compliance, where applicable, and to assist in attaining the town's goals. Where not covered in the SDG all building design decisions shall consider:

- Reduction of heat island reflection effect

Adaptation Actions

- Continue to enhance staff awareness and use of the Sustainable Design Guidelines.
- Begin to monitor the implementation of goals and actions related to climate change mitigation and adaptation.

Livable Design Manual – 2014

Mitigate / Adapt

The manual provides an urban design direction for Oakville supporting the town's official plan – Livable Oakville, with a comprehensive set of design principles and directives applicable town-wide (south of Dundas Street and north of Highway 407) for all forms of development and capital projects. The manual supports successful built form that responds to the local climate by incorporating pedestrian weather features and maximizing solar orientation.

Adaptation Actions

- Track and monitor the implementation of the manual related to urban design that responds to the local climate.

6.7.3

Infrastructure damage may result from more frequent and longer duration extreme weather events and increased freeze thaw cycles.

S3 + AC2 = V3

Extreme winter and summer precipitation events can stress town and residential infrastructure. As development occurs, there is less permeable surfaces in which precipitation can infiltrate the ground, causing more chances of overland flooding.

Increased freeze thaw cycles and extreme temperatures will stress concrete and steel infrastructure including foundations, roof and parking lots and driveways.

There are several small changes that could be made during the planning and construction phases that could significantly limit the cost and damage to infrastructure from extreme weather.

Livable Oakville - official plan - 2009

Mitigate / Adapt

10.1.2 Policies

- a) Sustainable development will be one of the criteria when reviewing applications for future land use and for public works and capital expenditures in order to minimize the town's ecological footprint.
- b) The town will encourage development which reflects the principle of sustainable development through a sustainable development checklist. The checklist will be used as a tool for assessing sustainable development features of applications, including those matters set out in this section or other initiatives.

10.10.8 The use of permeable surfaces and soft landscaping shall be encouraged where possible.

Adaptation Actions

- Monitor the application of official plan requirements.
- Track the development and uptake of the sustainable development checklist.
- Track the encouragement, installation and/or barriers associated with on-site infiltration.

Sustainable Design Guidelines (SDG) - 2010

Mitigate / Adapt

2.4 Stormwater Management

The intention of on-site stormwater management is to minimize the amount of stormwater that leaves the site as an "end of pipe" solution through rainwater harvesting, quantity and quality controls, erosion and sediment control measures.

Adaptation Actions

- Continue to enhance staff awareness and use of the Sustainable Design Guidelines.
- Begin to monitor the implementation of goals and actions related to climate change mitigation and adaptation.
- Monitor the implementation of rainwater harvesting measures and their associated benefits.

Livable Design Manual – 2014

Mitigate / Adapt

The manual provides an urban design direction for Oakville supporting the town's official plan – Livable Oakville, with a comprehensive set of design principles and directives applicable town-wide (south of Dundas Street and north of Highway 407) for all forms of development and capital projects. The manual supports successful built form that responds to the local climate by incorporating pedestrian weather features and maximizing solar orientation.

Adaptation Actions

- Track and monitor the implementation of the manual related to urban design that responds to the local climate.

National and Ontario Building Codes – On-going**Mitigate / Adapt**

Town staff can take an active role in stressing the importance of stricter building code requirements for residential properties in light of climate change. These stricter requirements are usually cheaper and easier to install prior to construction rather than retrofitting existing infrastructure.

Adaptation Actions

- To support and encourage the strengthening of building code standards related to extreme weather impacts on infrastructure.
- Encourage builders and developers to give our changing climate consideration during each phase of construction.
- Investigate opportunities at the municipal level to strengthen new construction requirements to extreme weather.
- Once endorsed, start to promote the use of Oakville's Climate Change Primer to educate homeowners on how they can protect themselves and their properties.

6.7.4**Increase in annual energy consumption due to rising and extreme temperatures.****S2 + AC3 = V2**

Town facilities are responsible for the majority of energy use and greenhouse gas emissions in town operations. These facilities include arenas, swimming pools, splash pads, fields and parking lots all requiring a large amount of electricity.

The town has set greenhouse gas reduction targets and will find meeting them difficult. As our population grows more facilities are being constructed and existing facilities are getting more use.

Energy Conservation and Demand Management (CDM) Plan - 2014**Mitigate / Adapt**

The Town of Oakville developed an energy management plan in 2009. This plan has been updated to go beyond compliance with the Ministry of Energy energy conservation and demand management plan regulation. The energy conservation and demand management plan is complete and will be a living document subject to periodic updates.

Resulting from the work completed on the Partners for Climate Protection program, the Town of Oakville has completed the following:

Milestone 1: Emissions inventory and forecasting, Milestone 2: Setting of an approved reduction target and Milestone 3: Development of the town's Corporate Local Action Plan and Community Energy Plan.

Adaptation Actions

- Track the implementation of actions related to climate change adaptation and mitigation.
- Promote successes of the CDM through climate change outreach and education.
- Track the integration of this program into the Energy Conservation and Demand Management Plan.

Livable Oakville - official plan - 2009**Mitigate / Adapt**

10.2.1 The town recognizes that a key initiative to mitigate the impacts of climate change is the reduction of greenhouse gas emissions. The Town will work to mitigate and adapt to climate change by initiatives that

include, but are not limited to: a) encouraging energy generation from renewable sources as well as district energy; b) encouraging energy efficient and green buildings.

Adaptation Actions

- Monitor the application of official plan requirements.
- Track the encouragement and implementation of renewable energy systems.
- Track the encouragement, installation and/or barriers associated with on-site infiltration.

Energy Conservation Outreach – On-going

Mitigate / Adapt

Town staff partners with Oakville Hydro on the annual Energy Conservation Fair to engage staff and residents in energy conservation. This event draws nearly 600 people annually proving that increased energy use and costs are top of mind. Town staff, Oakville Hydro and town facilities participate in Earth Hour, annually powering down all non-essential lighting.

Oakville Public Libraries host two energy conservation educational programs to teach the importance and cost saving of simple behavioral changes.

Adaptation Actions

- Continue to enhance the annual Energy Conservation Fair and the link to climate change.
- Enhance promotion of the Watt Not, Waste Not, Earth House and Energy Conservation backpack programs.

LEED Commitment - 2009

Mitigate / Adapt

All newly constructed town facilities must be design to meet a minimum of LEED Silver.

Adaptation Actions

- LEED designation for renovation projects as well as new construction.
- Consider a LEED GOLD minimum standard.
- Investigate BOMA Best certification for municipal facilities pilot project.

LEED AP Training – On-going

Mitigate / Adapt

Town staff are encouraged and supported to take energy management, conservation and operational maintenance courses

Adaptation Actions

- Track and encourage employee participating in energy management and conservation training.
- Inclusion of energy demand management training as a pre-requisite for hiring.

Renewable Energy Projects – On-going

Mitigate / Adapt





The town supports the Micro FIT and FIT renewable energy programs and partners with Oakville Hydro on establishing renewable energy projects in Oakville.




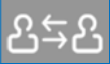



Adaptation Actions

- Expand support and implementation of renewable energy projects in Oakville.

- Continue to work in partnership with Oakville Hydro to support the installation of renewable energy projects in Oakville.

Summary Table

Vulnerability Level	Impact Statement	Associated Actions	Climatic Change
V5	Increased vulnerability of electrical distribution systems due to the occurrence of frequent and intense extreme weather events.	10	
V3	Increased urban heat island effect due to extreme heat events and increased development.	5	
V3	Infrastructure damage may result from more frequent and longer duration extreme weather events and increased freeze thaw cycles.	10	
V2	Increase in annual energy consumption due to rising and extreme temperatures.	15	

 <p>6.8 Built Environment - Storm Water Infrastructure</p>				
<p><u>Department and Stakeholders Impacted:</u> Environmental and Development Engineering, Engineering and Construction, Clerks, By-Law, Conservation Halton, Ministry of Natural Resources, external consultants</p>				

6.8.1
Flooding could result from an increase in the frequency, intensity and duration of extreme weather events.
S4+ AC1 = V5

There are many aspects of climate change that could lead to the potential of overland flooding in Oakville. Extreme weather including heavy precipitation events may present opportunities for stormwater infrastructure to fail or exceed its capacity.

An increased risk of flooding may also occur when debris, natural or otherwise clogs pipes, culverts and stormwater management systems. An increase in freeze thaw cycles can also impact the functionality and flow of stormwater.

Livable Oakville - official plan - 2009 **Mitigate / Adapt**

The following goals relate to actions that could provide overland flooding relief:

10.6.1 The Town will encourage innovative programs and construction methods which support the sustainable development and redevelopment of buildings. Sustainable features sought by the Town may include, but are not limited to: b) energy-efficiency technologies that are consistent with high energy efficiency standards (such as Energy Star and LEED buildings), design features and construction practices; d) permeable paving and other innovative stormwater management methods; and, e) water conservation and efficiency measures

10.10.1 Stormwater management techniques shall be used in the design of new developments to control both the quantity and quality of stormwater runoff. In areas where soil types permit, on-site infiltration shall be encouraged to the maximum extent feasible.

10.10.8 The use of permeable surfaces and soft landscaping shall be encouraged where possible.

Adaptation Actions

- Track the awareness of and barriers associated with the implementation of climate change adaptation actions.
- Track applications showing an interest in innovative storm water management systems including rain water capture (rooftop or surface), permeable pavements and other.
- Track the implementation and effectiveness of these systems.
- Promote and track implementation of the Sustainable Development Checklist.
- Continue to investigate providing a lot level stormwater incentive program.
- Continue to support staff participation in conferences/ webinars and seminars.

- Initiate a demonstration pilot project in partnership with Institute for Catastrophic Loss Reduction (ICLR) and Western University.

Storm Water Master Plan - 2012

Mitigate / Adapt

The first phase of a town-wide comprehensive Storm Sewer Master Plan is underway, including information collected on existing infrastructure, 1983 and older, south of the QEW, in College Park and along Falgarwood Drive. The town has identified deficiencies in the sewers in these areas and have developed an implementation plan for the management of stormwater in the built-up portions of the town, prioritizing areas and infrastructure with flood risk.

Adaptation Actions

- Future phases of this study will work to prioritize capital projects for storm sewer improvements.
- The town will develop and analyze possible solutions to deficiencies.
- Public information centres will be scheduled to provide the public with an opportunity to review and discuss the findings.
- Catch basins are fitted with inlet control devices (ICD) that allow for only a certain amount of storm water to enter, the rest runs overland. Determine if ICDs are contributing to overland flow, if so, the town may need to reassess road slopes, grading and catch basin capacity.

Development Engineering Procedures and Guideline Manual – On-going

Mitigate / Adapt

Chapter 3 of this manual provides guideline standards for site plans and site alterations.

Adaptation Actions

- Improve practices related to development near to natural drainage systems and within known vulnerable areas.
- Investigate updating IDF curves.
- Continue with on-going verification of design criteria established through subwatershed studies.

Flood Prioritization Study - 2008

Mitigate / Adapt

In 2008, the town completed a Flood Prioritization Study on the town's major open-channel waterways, streams, rivers and lakes to identify flood-sensitive areas in Oakville. The study used information from previous subwatershed studies and consolidated all the information into one document. One of the objectives of this study was to see all flood-sensitive areas in relation to one another. These areas were categorized as low, medium or high risk, enabling the town to start setting priorities for flood mitigation projects. The study has put the town in a position to take advantage of provincial, federal or private flood reduction/mitigation funding programs.

Adaptation Actions

- Track and monitor the completion of each study phase - 2nd / 3rd phase to be initiated in 2014 while the final phase begin in 2016.
- Future studies will look at the town's underground sewer network and overland flow routes, recognizing that these routes, if compromised, can also present a flood risk.
- Continue and enhance public outreach efforts.
- Continue to increase capacity to monitor and measure meteorological conditions.
- Increase town's capacity to predict and model peak flow conditions.

**Flood Mitigation Opportunities Study for
Fourteen Mile Creek/McCraney Creek Systems - 2013****Mitigate / Adapt**

The Town of Oakville has initiated a Municipal Class Environmental Assessment for a detailed assessment of mitigation and flood reduction alternatives for Fourteen Mile Creek and McCraney Creek from Lake Ontario to Dundas Street. Several flood-prone locations within the study area have been identified as high priority sites as part of the 2008 Town-wide Flood Prioritization Study.

The study is being conducted in compliance with the requirements as described in the Municipal Engineers Association's Municipal Class Environmental Assessment (EA) document (2011), which is approved under the Ontario Environmental Assessment Act.

Adaptation Actions

Track the progress and results of the following recommendations:

- Conduct a more detailed evaluation of creek flood-prone sites in an effort to determine the most viable and effective flood mitigation alternatives.
- Determine the degree of flooding, identify and assess alternatives for mitigation, and recommend preferred alternatives to be implemented.

Outfall Monitoring and Debris Clearing Program – On-going**Mitigate / Adapt**

The Roads and Works department leads a debris clearing program that supports on-going maintenance of identified 'hot spots' that are cleared annually or as required prior to and after large precipitation events.

Adaptation Actions

- Consider increasing the maintenance schedule of 'hot spot' clearing.
- Appoint designated staff to the outfall debris clearing program.
- Monitor the efficacy of the debris boom installed at Navy Flats. If functioning well, consider developing a maintenance plan to remove collected debris.

Storm Sewer Inspection Program – On-going**Mitigate / Adapt**

To support condition assessment of the town's storm sewer system, an inspection program using zoom cameras was carried out in Phase 1 of the Storm Water Master Plan and storm sewer maintenance program prioritization.

Adaptation Actions

- Increased monitoring and maintaining of conveyance.
- Continue to research best management practices
- Ensure only minimal level of infiltration into pipe is occurring.
- Research and implement best management practices related to pipe depth and location.
- Monitor Conservation Halton for changes to design standards.

Emergency Management Plan– On-going

Mitigate / **Adapt**

The results of the Storm Sewer Master Plan and the Flood Prioritization and Mitigation Studies were used to inform the update of the EMP.

Adaptation Actions

- Prepare for the more frequent enactment of this plan that may require more staffing and equipment resources.
- Continue to provide support and training to staff.

6.8.2

Increased freeze/thaw cycles and extreme temperatures will stress and decrease the service life of storm water infrastructure.

S3 + AC2 = V3

The freeze thaw action on concrete, cement and steel weakens the structure by causing stress cracks and fractures. Extreme temperatures both hot and cold also tends to weaken structures making them more prone to failure,

Storm Water Master Plan - 2012

Mitigate / Adapt

The first phase of a town-wide comprehensive Storm Water Master Plan is underway, including information collected on existing infrastructure, 1983 and older, south of the QEW, in College Park and along Falgarwood Drive. The town has identified deficiencies to the sewers in those areas and develop an implementation plan for the management of stormwater in the built-up portions of the town, prioritizing areas and infrastructure with flood risk.

Adaptation Actions

- Future phases of this study will work to prioritize capital projects for storm sewer improvements.
- The town will develop and analyze possible solutions to deficiencies.
- Public Information Centres will be scheduled to provide the public with an opportunity to review and discuss the findings.

Storm Sewer Inspection Program – On-going

Mitigate / Adapt

To support condition assessment of the town's storm sewer system, an inspection program using zoom cameras was carried out in Phase 1 of the Storm Water Master Plan and storm sewer maintenance program prioritization.

Adaptation Actions

- Increased monitoring and maintaining of conveyance.
- Continue to research best management practices
- Ensure only minimal level of infiltration into pipe is occurring.
- Research and implement best management practices related to pipe depth and location.
- Monitor Conservation Halton for changes to design standards.

6.8.3

A decrease in water quality is expected due to increased sedimentation and overland runoff from extreme weather events.

S3 + AC3 = V3

Heavy precipitation events cause quantities of water running overland, carrying with it litter, natural debris, oils and fuels from driveways and parking lots as well as fertilizers and other chemicals used on lawns and gardens. Evaporation is projected to increase with rising temperatures which may compound this problem – higher concentrations of pollutants in overland run-off in less water.

Increased sedimentation is also lowering water levels in creeks and channels connected with our storm water infrastructure.

Storm Sewer Use By-law - 2008

Mitigate / Adapt

This by-law regulates discharges to the public storm sewer system under the jurisdiction of the Corporation of the Town of Oakville. The existing by-law was outdated, no amendments had been made since 1978.

Adaptation Actions

- Continue to review and amend by-law as needed.
- On-going monitoring of storm sewer outlets and manholes adjacent to various land uses.

Oil / Grit Separator Units – On-going

Mitigate / Adapt

The town has a comprehensive inventory and database of both town-managed and unassumed stormwater management ponds and recently compiled an inventory of town -owned oil/grit separator (OGS) units. All of these engineered controls are set in place to manage the risk of flooding and pollution that is discharged to the stormwater system. This information along with existing storm sewer infrastructure information has been compiled in a comprehensive layer in GIS.

Adaptation Actions

- Research implementing a dedicated OGS maintenance program.
- On-gong updates need to be made to the GIS database.

Stormwater Quality Monitoring Program – On-going

Mitigate / Adapt

This program includes both dry and wet weather sampling of ponds and outfalls, designed to obtain background data for comparison and verification of established by-law limits. The implementation of this program was initiated to ground truth the limits established in the Storm Sewer Use By-law

In 2009 six meteorological monitoring stations and hydraulic monitoring equipment were installed in four ponds.

Adaptation Actions

- Track the progress of this programs development.
- Increased monitoring to coincide with wet weather events.

- Implement dedicated staff time to the maintenance of oil/grit separator unit.
- Expand meteorological monitoring network to include North Oakville development.

Goose Management Plan – On-going

Mitigate / Adapt

Town staff are employing an overall goose management program to control the population of resident geese. Egg oiling, turf sweeping, coyote decoys, goose feeding by-law and habitat modification are other programs designed to deal with the overpopulation of Canada geese along Oakville's waterfront.

Adaptation Actions

- Continue and enhance the goose management program for the protection of Lake Ontario water quality.
- Continue and enhance public outreach and education associated with the goose management program especially the negative impacts associated with feeding geese.

Water Sustainability Plan (WSP) – 2013/2014

Mitigate / Adapt

The town in partnership with the Ministry of the Environment (MOE), Halton Region, Conservation Halton and the Great Lakes and St. Lawrence Cities Initiative engaged in innovative work to support the development of a long term Water Sustainability Plan (WSP). The WSP will integrate planning and management strategies to conserve and strategically manage water and minimize the discharge of pollutants to area waterways and Lake Ontario.

Adaptation Actions

- Track the development of the WSP and the identification of existing water management strategies.
- Monitor the results of:
 - Addressing potential governance issues for delivering and managing municipal water, wastewater and stormwater services.
 - Monitoring and tracking improved environmental performance in water conservation and pollution reduction.
 - Considering the cumulative impacts on the watershed for water quality and quantity.
 - Identifying opportunities for cost savings through water conservation, efficiency and re-use.

Water Resource Outreach and Education – On-going

Mitigate / Adapt

Town provides storm water education to residents through its website, use of social media and through partnerships with Halton Region and Conservation Halton that include the Halton Children's Water Festival, Stream of Dreams and Yellow Fish Road.

These program are highlighted on the town website, EcoLetters and Living a Green Life – Oakville's Guide to Environmental Stewardship.

Adaptation Actions

- Continue to enhance and promote associated outreach and education campaigns.

6.8.4

An extended WNV season may occur with increased temperatures and precipitation.

S2 + AC4 = V2

An increase in annual precipitation and temperature may result in a longer mosquito breeding season with more available standing water sites for breeding. The degree of impact will depend on which increase, temperatures or precipitation, is larger during the WNV season. If temperature increases more than summer precipitation we may see a decrease in available breeding sites due to increased evaporation.

WNV Surveillance Program – On-going

Mitigate / Adapt

Halton Region leads the Halton WNV surveillance program. All assumed stormwater ponds are treated and some are baited for the surveillance program.

Adaptation Actions

- Town to continue to support and participate in Halton Region’s WNV Surveillance program
- Continue to implement and carry out the town’s internal protocol for limiting mosquito breeding sites on town and residential properties.

Outreach and Education – On- going



Mitigate / Adapt



Town staff provide residential WNV outreach at community events in partnership with Halton Region. All seasonal Oakville employees are required to attend an Environmental Considerations presentation in which WNV protection and symptoms are discussed.

Adaptation Actions

- Continue to enhance outreach and education efforts.

Summary Table

Vulnerability Level	Impact Statement	Associated Actions	Climatic Change
V5	Flooding could result from an increase in the frequency, intensity and duration of extreme weather events.	31	
V3	Increased freeze/thaw cycles and extreme temperatures will stress and decrease the service life of storm water infrastructure.	7	

V3	A decrease in water quality is expected due to increased sedimentation and overland runoff from extreme weather events.	16	
V2	An extended WNV season may occur with increased temperatures and precipitation.	3	



7.0 Conclusions

The Town of Oakville is a leader in environmental protection, with the many projects, procedure, policies and by-laws that have been endorsed by Council and are being implemented by staff. For each climate change impact that was identified, there is a backbone policy or series of initiatives building the town's resilience to that impact.

















Town staff have used these existing policies and programs to build upon for future action. Under each existing policy, program, procedure or plan, possible adaptation actions have been identified. Some of these adaptation actions are underway and others are to be reviewed, evaluated and if the business case demonstrates clear benefits, implementation would move forward for consideration in workplan and budget development at the appropriate time.






Summary Table

One of the most beneficial aspects to the development of this Strategy is how it fostered dialogue and generated new ideas building from the interdepartmental team approach.

Of the 39 identified impacts, there are over 400 actions planned, underway or on-going, these will continue to be implemented and tracked. Many of these adaptation action will cross over themes and have multiple co-benefits across town operations.

Of the 39 impacts, 11 are considered of high vulnerability, although the likelihood and potential consequences will be further assessed.

Vulnerability Level	Impact Statement	Adaptation Actions	Climatic Change
V5	Northerly migration and longer life span of invasive and non-native plants and insects.	18	
V5	Increased instances of trail and park closures and clean up associated with extreme weather events.	7	  
V5	Increased stress on vegetation due to extreme weather and changes to soil moisture and composition.	13	   
V5	Transportation infrastructure is subject to flooding due to extreme and longer duration extreme precipitation events.	24	 
V5	Increased vulnerability of electrical distribution systems due to the occurrence of frequent and intense extreme weather events.	10	   
V5	Flooding could result from an increase in the frequency, intensity and duration of extreme weather events.	31	 

V4	Winter control operations will be impacted by the variable temperature and precipitation patterns as well as extreme winter storm events.	12	
V4	A decrease in water levels will impact harbour revenue, operations and rates.	10	
V4	Creeks and channels may meet or exceed capacity during extreme precipitation events.	9	
V4	Extreme weather events such as heavy precipitation, high winds and lightning storms can compromise the health and safety of staff and residents.	19	
V4	Increased risk associated with railway and pipeline infrastructure due to extreme temperatures and extreme weather events.	12	

The town is vulnerable to these 11 impacts particularly if there is a high likelihood that they will occur. It is recommended that the above 11 impacts be assessed further through an integrated risk management (IRM) process and by doing so will complete Priority Action 1. The IRM process will prioritize the above impacts through discussions on the likelihood of the impact happening and consequences that can be expected if the impact does occur.

Next Steps

Through the development of this strategy, the following next steps were determined to be important to move forward on the town's climate change preparations. It is recommended that the town:

1) Incorporate climate change considerations, strategies and actions into appropriate policies, procedures, plans and purchasing decisions.

Climate change impacts should be considered when policies, strategies, and actions are being updated, developed or carried out. Staff awareness of the Climate Change Strategy will be broadened such that many staff are aware of the impacts and the town's strategy to becoming more resilient. Activities will include new staff orientation, seasonal staff training and internal promotion.

2) Continue to research and implement climate change mitigation and adaptation actions including, but not limited to those mentioned in Section 6.0 under the heading Adaptation Actions.

Town staff will continue to research and implement appropriate adaptation actions listed in the Strategy. The Climate Change Adaptation Team, continuing its work, can move into the implementation stage that will require more discussions and involvement from their departmental staff and external stakeholders including but not limited to those listed in Appendix A. Staff have been integrated into several climate change networks that are at the forefront of municipal climate adaptation planning. Continued involvement in these groups will ensure that the strategy remains current with climate change science, best management practices and innovative approaches to climate change readiness.

3) Develop a tracking and monitoring tool related to climate change adaptation.

All adaptation actions mentioned in Section 6.0 of this strategy are being tracked and a good number are in the process of being implemented. Through further work and the use of GIS mapping tools and existing town databases a more responsive, consolidated tracking system will be developed going forward.

4) Conduct a more detailed and integrated risk assessment on all impacts with vulnerability of V4 and V5.

A risk assessment is natural next step once the levels of vulnerabilities are established. The Changing Climates, Changing Communities risk assessment process considered the following in their risk assessment:

- i. Consequence- what are the known or estimated consequences (economic, ecological, social, and legal) of a particular climate change impact?
- ii. Likelihood – how likely is it that a projected impact will occur? Some climatic changes, such as increasing average temperatures have more certainty while the frequency of extreme events has less.

$$\text{Risk} = \text{Consequence} * \text{Likelihood}$$

This process only provided a high level screening assessment carried out in Milestone 2 work that staff have determined would be better replaced with a more comprehensive risk assessment in order to further refine adaptation actions. It is proposed that these risk assessments be conducted involving the appropriate departments and the town's executive and senior management.

5) Based on the more comprehensive integrated risk assessments the phased implementation of actions will continue.

Through further review of the town's vulnerabilities and risks more evidence based prioritization involving all necessary stakeholders will refine the strategy actions. These results will be incorporated into the living Strategy document, and brought forward at the appropriate time in departmental work plans and budgets for consideration during the budgetary process.

References

- 1 Warren, F.J. and Egginton, P.A. (2008). Background Information; *in* From Impacts to Adaptation: Canada in a Changing Climate, 2007, *edited by* D.S. Lemmen, F.J. Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 27-56
- 2 Expert Panel on Climate Change Adaptation. (2009) *Adapting to Climate Change in Ontario*.
- 3 and 4 Chiotti, Q. and Lavender, B. (2008): Ontario; *in* From Impacts to Adaptation: Canada in a Changing Climate, 2007, *edited by* D.S. Lemmen, F.J. Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 227-274.
- 5 http://www.cleanairpartnership.org/gta_clean_air_council

Climate Change Team and Associations

Departmental representation is as follows:

Name	Role and Department
Cindy Toth	Team Champion, Director, Environmental Policy
Trisha Henderson	Team Lead, Environmental Coordinator, Environmental Policy
Kristina Parker / Rita Julio / Phil Kelley	Development Engineering
Carly Dodds	Planning
Mary-Ellen Maxwell	Recreation and Culture
Yianni Panagakis	Building Services
Nicole Wolfe	Facilities and Construction Management
Kasia Piskorz / Paul Allen	Engineering and Construction
Enrico Scalera	Road and Works
Donna Doyle	Environmental Policy – Senior Policy Analyst
Tom Mulvale	Parks and Open Space – Horticulture and Turf
John McNeil / Candace Karandiuk	Parks and Open Space - Forestry
Ksryztoff Izakowski	Parks and Open Space - Harbours
Mary Jo Milhommens	Communications
Joanne Phoenix	Oakville Transit
Andy Glynn	Fire / Emergency Preparedness

External interviews conducted with and input gathered from:

Regional Climate Change Training program: Hosted by the GTA – Clean Air Council in 2011 this program provided training for municipal employees in climate change adaptation planning. Webinars and meetings geared towards identifying vulnerabilities and building resiliency in a municipal corporate environment. Halton Region, Milton and Oakville participated in this four day training together with several other GTA municipalities discussing regional and municipal climate change adaptation planning.

Town of Oakville staff work in partnership with neighbouring municipalities and Halton Region on several climate change mitigation and adaptation programs including but not limited to water conservation and protection, West Nile Virus, Heat, Health, Air Quality and Extreme Weather alerts.

Greater Toronto Area – Clean Air Council Since 2001, the Greater Toronto & Hamilton Area Clean Air Council (a network of 24 municipalities and health units from across the area) was established to work collaboratively on the development and implementation of clean air and climate change mitigation and adaptation actions.

The Clean Air Council is based on the premise that municipalities benefit from actions to reduce energy use in order to save money and limit emissions; make the movement of people and goods more efficient; and make communities more livable, competitive and resilient. ⁵

Alliance for Resilient Cities (ARC) 2006 – 2011 - Program of the GTA – CAC, this was a web based approach to educating municipal staff on climate change through webinars and on-line tools and materials, networking with national and international climate change experts.

WeatherWise Partnership - Focusing on the vulnerabilities of the Toronto's energy sector to extreme weather including representatives from all levels of government and municipalities from across southern Ontario.

Great Lakes St. Lawrence Cities Initiative - The Great Lakes and St. Lawrence Cities Initiative launched the Municipal Adaptation and Resiliency Service (MARS) for its member municipalities, to help accelerate and expand adaptation activities. MARS is designed to help municipalities of any size and at any stage of the adaptation process. The Service consists of 1) A Call to Action; 2) A Climate Adaptation Community of Practice; 3) Climate Change Adaptation Training; 4) MARS award; 5) Demonstration Projects opportunities. The town has been involved since it launched in 2013.

Southern Ontario Stormwater Municipal Discussion Group - Initiated by town staff, this GTA wide, and growing, group meet quarterly to discuss best management practices related to stormwater infrastructure in southwestern Ontario.

Professional Engineers of Ontario – The PEO now recognizes climate change and requires professional engineers to consider and factor in climate change impacts into their work. Town staff have participated in climate change discussions at PEO networking events in Oakville.

National Municipal Adaptation Project (NMAP) – The town participated as one of 481 municipalities in the 2012 NMAP survey. It was concluded that of the 481 municipalities only 8 per cent indicated they were in the process of developing a plan or strategy, 5 per cent already have a plan in place and another 8 per cent have incorporated adaptation into an existing plan.