



Town of Oxford

CLIMATE CHANGE ADAPTATION RISK ASSESSMENT

REV 0:	MARCH 2022	Issued for Review
REV 1:	OCTOBER 2025	Updated for AR6 Climate Projections and Current Demographic Trends



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INTRODUCTION

AIM Network conducted a cohort program with several Nova Scotian municipalities to create asset management plans. As part of this process, the communities conducted a high-level risk assessment in accordance with the Federation of Canadian Municipalities Guide for Integrating Climate Change and Asset Management (the FCM Guide). The intent of this exercise is to identify where critical assets are at risk from climate change impacts so that future infrastructure decisions can incorporate adequate climate planning and so that climate risks can be considered in asset management risk assessments. The Town of Oxford (The Town) participated in a series of workshops to create an asset management policy, define levels of service, conduct risk assessments and complete a climate hazard assessment under the program.

The asset management policy stipulates that the Town will consider long-term sustainability of infrastructure which includes considering impacts of climate change. Through the workshop on climate hazard assessments, the Town considered various climate change hazards and the impact that it could have on their asset portfolio. In 2021 the Town continued with this process to expand the assessment to a comprehensive list of climate hazards for their entire asset service portfolio. This report is the result of that assessment, and identifies critical climate hazards, the potential impact to service delivery, and priority actions to address those risks in the near-term and for future consideration.

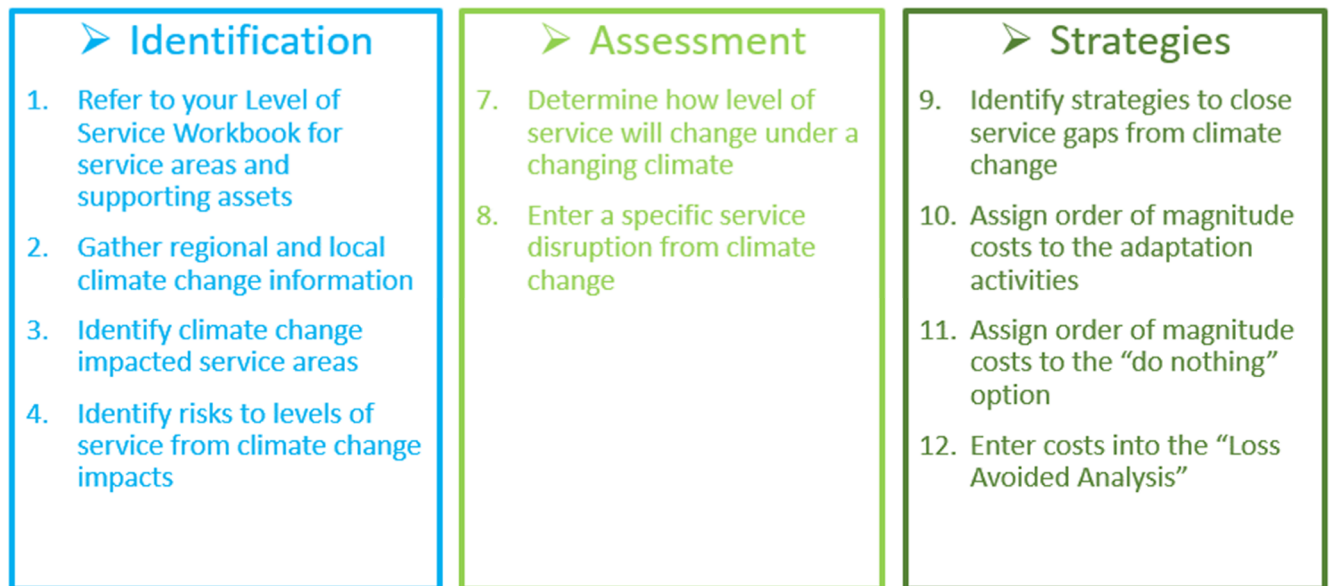
PURPOSE OF THIS REPORT

While this report presents a hazard assessment that encompasses climate projections to 2100, the intent is to support decision making now for future climate resilience. It is intended to triage long-term potential impacts to prioritize actions that can be undertaken, if sufficient funding is available through municipal funds, strategic borrowing and provincial / federal funding programs. The goal of these short-term actions will be to:

- Make individual safety to climate hazards a priority over the expected life of any new or recapitalized infrastructure.
- Address immediately level of service gaps that currently exist and will be made worse by impacts from climate change.
- Identify potential future level of service gaps as the effects of climate change become more pronounced.
- Preserve or improve the historic and aesthetic character of the Town.
- Promote safe and accessible active transportation and pedestrian access to comply with Nova Scotia Accessibility Act requirements.
- Protect sensitive infrastructure.
- Protect or improve economic development potential in the Town.
- Consider inequitable impacts of climate events on vulnerable communities.

METHODOLOGY

The methodology follows an amended process from the FCM Guide to conduct a multi-hazard assessment of all asset classes. It is important to consider all potential climate hazards for all asset classes to create a comprehensive risk assessment and manage the risk of incorrectly prioritizing limited capital funds for climate action.



The fourth element in integrating climate change considerations into asset management is management, which suggests incorporating these recommendations into asset management plans, monitoring progress and incorporating a continuous improvement process. This step is not included in this report, as the Town will be taking these recommendations to identify potential funding pathways for projects, and intends to build the priority actions into capital programs as financing options become available. Completed projects will include monitoring and continuous improvement programs.

EXPECTED CLIMATE CHANGE IMPACTS ON INFRASTRUCTURE

The Town of Oxford is expected to experience a range of climate impacts in the future including:

- Increased frequency and volume of precipitation
- Increased riverine flooding at the River Philip, Little River and Black River, with potential for tidal impacts from long-term sea-level rise on river levels
- Increased frequency and duration of summer drought
- Increased maximum temperatures
- Increased duration of heat waves
- Increased wind velocity

In the cohort program, The Town completed a level of service assessment which identified the following service areas that will be considered in the hazard assessment:

- Potable water supply and distribution
- Wastewater collection and treatment
- Stormwater collection
- General transportation
- Recreation and cultural services
- General government administration
- Protective services (fire and emergency response)

Through the Municipal Asset Management Program, the Town collected a comprehensive inventory of assets. Linear assets are collected in GIS and fleet and facilities are collected in an Excel based facility catalogue tool.

OBJECTIVES

The objective of this analysis is to conduct a high-level review of climate impacts on municipal services, risk weighted costs to the municipality and potential adaptation interventions to consider when building capital programs from asset management information.

The process identified in the FCM Guide, taken in context with the asset management program delivered through Municipal Asset Management Program training will:

- Identify and classify the risks and the vulnerabilities based on their probabilities, frequencies, and the severity of their consequences.
- Prioritize preferred adaptation measures.
- Categorize those preferred adaptation measures to align with capital investment priorities identified in the asset management program.

The report is organized as followed:

- Description of the expected changes in climate and extreme weather events.
- Identification and classification of climate related risks and vulnerabilities by asset class.
- Presentation of the results of the assessment.
- Prioritization of actions to address the risks identified.

LOCAL CONTEXT

Oxford is a small town in Cumberland County on the Chignecto Isthmus in northern Nova Scotia. It sits at the confluence of the River Philip, Black River, and Little River, a historic seasonal hunting and travel route. It is located near the Trans-Canada Highway (Hwy 104), which links the town to regional centres such as Amherst and Truro.

The municipality covers 10.68 km² and had a 2021 population of 1,170 (-1.7% since 2016), with a density of 109.6 people/km² and a median age of 46 years. These figures place Oxford among Nova Scotia's older, smaller service centres typical of rural Cumberland County.

This report has been updated with information contained in the Nova Scotia Department of Municipal Affairs (DMA) *Municipal Profile and Financial Indicators Results 2022-2023* for the Town of Oxford, released in 2024. Since this report was originally published, the population estimate for Oxford has increased to approximately 1,320 residents, or close to a 15% increase from 2021 levels. This is a stark reversal of decreasing trends prior to 2021, resulting in a greater load on municipal infrastructure and a corresponding increase in the number of residents at risk from the events in this report.

The DMA report and census data released after the original report also produced additional demographic data relevant to the assessment. Based on the 2021 census, 31% of the population is older than 60-years old, and the median income is approximately 25% below the provincial average. This adds key considerations to the assessment contained in this report:

- Sustainable active transportation routes and accessible pedestrian ways are core functions of the Town with a larger than average portion of the population in high-risk demographics for mobility issues and adverse health outcomes from falls due to unsatisfactory pedestrian routes.
- Lower income residents tend to drive less, use public transportation more and rely on pedestrian routes more.
- To capitalize on a beginning trend of increasing population in middle demographics (a recent 20% increase in adults between 40 and 49-years of age), Oxford needs to demonstrate reliable services, a commitment to reconciling existing level of service issues and maintaining affordability through addressing existing risks that will be exacerbated by climate change.

Oxford brands itself the “Wild Blueberry Capital of Canada,” anchored by Oxford Frozen Foods, which operates from the town and is the world's largest provider of wild blueberries, as well as a major processor of carrots and value-added foods. Agriculture and food processing remain part of a broader Cumberland economy that also includes forestry across ~328,000 ha of woodlands in the region.

Since the original report was created, Oxford Frozen Foods, the main economic driver in the Town and a major part of the regional agri-food business, has approached the Town requesting partnerships to support increased housing supply based on a need to attract and retain employees for the business. This indicator has changed some of the risk analysis in this report, adding an economic driver to the impact of service disruptions and a social consequence to nuisance service disruptions as municipalities compete to attract and retain residents of working age to avoid economic stagnation that can occur if population growth is restricted to those past working age.

The town's setting confers both environmental assets and risks. Large portions of Oxford lie on the River Philip floodplain, and the community has experienced extreme rainfall events; notably 302 mm in ~30 hours during the remnants of Tropical Storm Harvey in 1999.

Oxford and its surroundings are also situated in gypsum-karst terrain. A high-profile sinkhole opened in 2018 near the Town's Lions Park, and provincial geological investigations describe extensive underlying Windsor Group evaporites and karst features in the Oxford area. Nearby Slade Lake (southwest of town) has drained episodically, likely via karst conduits, underscoring ongoing subsurface instability that can affect land use and infrastructure.

Oxford's economic identity (wild-blueberry agriculture and processing), highway access, aging demographic profile, floodplain location, and karst geology combine to shape its regional role and its resilience priorities, particularly flood risk management, risks from heat to an aging population, sustainable water supply, and developing asset management strategies suited to a small population base that has begun to experience increasing development demands after historical declines.

CLIMATE RISK ASSESSMENT

Oxford has completed a high-level portfolio screening of assets for climate risk using the process in the FCM Guide to determine focus areas to consider for future design. Where potential exposure to climate change events is identified, future repair, renewal or replacement should consider climate adaptation using a standard framework like the Public Engineering Vulnerability Committee (PIEVC) Protocol. The portfolio screening of service areas for climate risk identified the following areas of risk exposure. For each asset area, this assessment considers the likelihood that the infrastructure can experience an impact from weather events impacted by climate change and what the potential impacts are relative to baseline levels, where the baseline levels are the historical design conditions.

Precipitation and Wind

The impact estimates are taken from the Pacific Climate Impacts Consortium (PCIC) national model, which has been adopted by climatedata.ca. Values quoted in this assessment are based on near-term global mean temperature increases of 1.5 degrees and longer-term increases of 2.5 degrees, with 3.5 degrees shown for reference. **Table 1** shows changes related to precipitation and wind.

Table 1: Climate Change Parameters

Design value	Description	Units	1.5°C	2.5°C	3.5°C
IDFCF	Rainfall IDF Change factor	ratio	1.159	1.271	1.384
PAnn	Annual Total Precipitation	ratio	1.105	1.157	1.203
R1d50	1 in 50-year (2%) 1-day rainfall	ratio	1.159	1.271	1.384
R15m10	1 in 10-year (10%) 15-min rainfall	ratio	1.159	1.271	1.384
RAnn	Annual Total Rainfall	ratio	1.128	1.194	1.236
RL50	Annual max. rain on snow	ratio	0.84	0.644	0.434
WP50	1-50 driving wind pressure	ratio	1.049	1.043	1.049

The assessment also considered increases in **extreme heat**, both by number of days above 30 degrees Celsius and frequency of heat waves, defined for this as three or more consecutive days with temperatures above 30 degrees Celsius.

The number of dry days is projected to remain relatively consistent through end of the century. However, context matters greatly. With an increase in overall precipitation and change in seasonal rain patterns for a greater frequency of rain events in fall and spring, a steady mean of dry days mean that these seasonal increases in precipitation must be balanced by a corresponding relative decrease in summer precipitation. This indicates that as seasonal precipitation extremes (such as the up to 38% increase in short and long duration storms) becomes more pronounced, so will the inverse: more frequent extended periods of dry days in the summer months, representing drought conditions.

Temperature

Based on the current datasets, looking at the median projections (moderate likelihood of occurrence), the number of days above 30 degrees will increase from a historical annual mean of 13 days per year to a projected mean of 39 days, or an increase of 26 days relative to baseline. The number of heat wave days (where they fall within a three-day consecutive period) will increase from a current annual mean of 0.1 days (rare) to between a mean of 1.6 days per year (annual occurrence).

Forest Fires

There is no quantitative data on the increased probability of **forest fires**, but fires have been occurring at an increasing rate in Canada. The root causes are increases in dry periods, expansion of developed areas across the country, lack of public education on fire safety and fire smart landscaping, and increased frequency of lightning strikes. Furthermore, increasing heat days causes an increase in evaporation effects, compounding the drying of forest areas from seasonal dry periods and increasing the potential of fires to spread and persist despite management efforts. Forest fires have caused the two most expensive insurable events in Canada's history, the Fort MacMurray wildfire in 2016 and the Jasper wildfire in 2024. In Nova Scotia, recent years have demonstrated a trend of increasing forest fire occurrence resulting from prolonged hot and dry summer months.

Freeze-thaw Cycles

Freeze-thaw cycles can impact surface infrastructure like concrete pads in parks, sidewalks and roadways. During freeze-thaw cycles, water from rain, snow and ice melt in the ground expands when freezing and contracts when thawing. This expansion and contraction cycle can cause cracking and fatigue in concrete pads, sidewalks and asphalt roads. Climate models predict that days with freeze-thaw cycles will reduce from a historical average of 97 days to between 55 and 93 days, effectively reducing the wear on surface structures.

IMPACTS ON INFRASTRUCTURE SERVICES

This section examines how specific service areas may be impacted by the changing climate norms identified in the previous section.

Potable Water

There were no risks identified to the potable water transmission and distribution system resulting from climate change. However, the Town water supply pipes are aging, and the combination of unreliable distribution from leaks and breaks can compound the supply issues identified below.

The water supply system from the Town's wellfield has these potential exposure pathways:

- a) Decreased summer water levels from more prolonged drought periods are already being experienced in watersheds across Atlantic Canada. This poses a potential risk to availability of

water as these drought periods become more prolonged. The current likelihood above baseline levels is **moderate** and future likelihood is **extremely high**. The consequences are increasing frequencies of water restrictions **and limitations to development capacity**, with increasing future risk of water shortages.

- b) Increasing wind energy, which can impact building envelopes (exterior cladding and roof structures) is forecast to increase. The likelihood of impacts above baseline levels is **moderate** and future likelihood is **moderate**. The consequence of this is increased maintenance on building envelopes and unexpected repairs to building exterior cladding and roof coverings.
- c) Heat is not anticipated to have an impact on potable water except as it contributes to longer and more frequent droughts.
- d) Forest fire risk is anticipated to continue to increase, threatening municipal structures. Current likelihood of occurrence above baseline, given the location of structures relative to forested areas is **moderate**, with **an extremely high** future likelihood. The Town's wellfield is in a rural area with heavy forest cover. **Consequences of occurrence are high to catastrophic** from interruption to water supply from decreased access to water treatment facilities and damage to buildings. The Town's primary water reservoir is sufficiently protected from fire by buffers of surrounding farm fields, but access via the highway could be impacted in the event of a major fire, further reducing the Town's ability to provide reliable water supply.
- e) The current second reservoir in Oxford is beyond its end of life and is affecting the capacity for fire protection in some areas of town through reduced hydrant pressure and inadequate ability to respond to a major forest fire event because of reduced water storage. This reduces the Town's ability to respond to climate change driven fires and water shortages **and creates a risk of hindering economic development and housing expansion**.

Recommendations

The Town's asset management program currently has a focus on investing in the critically aging water distribution system. A key element of climate readiness is to proceed with replacing the secondary Pugwash reservoir and conducting a water study to ensure that adequate supply and pressure is available to respond to fire events and increasing frequency and duration of drought events.

The Town should monitor water availability and conduct an internal sensitivity analysis to understand how much capacity the water supply has for resilience to lower water levels and to accommodate future development and increased water demands. If this sensitivity analysis indicates that supply is operating at or near capacity, we recommend a more detailed study to define future seven-day low water supply and investigate feasibility and quantity of alternate supplies. For forest fire prevention, the Town should audit all municipal sites using FireSmart Canada guides, especially at the well field and reservoirs, to minimize the risk of impacts if fires occur near buildings and include mitigation activities in emergency response plans

Wastewater Collection and Treatment

The wastewater collection system has these potential exposure pathways:

- a) Where a sewer system has inflow and infiltration from stormwater, increased rainfall volume and intensity can increase loads on lift stations which can reduce the lifespan of pumps and, in extreme events, cause backups in the system. The current likelihood of experiencing increased pump runtime or backups is **low**. Future likelihood of increased pump runtime is **high**, and stormwater driven backups are **moderate**, with increasing likelihood in the absence of bylaw control of cross connections (roof drains or foundation drains connected to the wastewater

system) and with increasing age of the pipe system. Consequences of occurrence are increased maintenance and decreased life of lift station pumps and damage to private property from sewer backups.

- b) Increasing wind energy, which can impact building envelopes (exterior cladding and roof structures) is not forecast to have an appreciable increase. The likelihood of impacts above baseline levels is **low** and future likelihood is **moderate**. Consequences are increased maintenance requirements on building envelopes.
- c) Forest fire is anticipated to continue to increase, threatening municipal structures. Current likelihood of occurrence above baseline, given the location of structures relative to forested areas is **moderate**, with a **high** future likelihood. Consequences of occurrence are interruption to wastewater treatment facilities from blocked access and damage to buildings.

Recommendations

1. Implement and enforce bylaws to prevent cross connections that allow stormwater to enter the system.
2. Develop a dedicated reserve fund for wastewater collection system upgrades to minimize the number of pipes operated beyond expected useful life.
3. Audit all municipal sites using FireSmart Canada guides.

Stormwater Collection

There is a clear indication that future storms will be more intense and more frequent than the present. While there isn't enough data to make clear determinations, many regions in Canada, from Vancouver to Toronto to Halifax, have experienced recurring extreme rainfall in the last 15 years that has an extremely low probability of occurring without considering that climate change is having an impact. This suggests that increasing frequency and intensity of rainfall is already occurring and will continue to become more pronounced. The stormwater collection system has these potential exposure pathways:

- a) Increased rainfall intensity will cause high flows that exceed the design frequencies and rates of existing infrastructure. This effect is increased where development created impervious areas that were not anticipated when storm systems were originally built. The current likelihood of experiencing flow that exceed design frequencies baseline levels is **moderate**. Future likelihood is **extremely high**. Consequences of these impacts are increased occurrences of street flooding and the potential for surface flooding in buildings.
- b) Existing flooding at the Town Hall on Main Street is already being experienced. The original storm system was developed for a 5-year level of service with inadequate overland flow relief paths at Main Street and James Street. With current global warming levels approaching 1.5 degrees, the current level of service is approaching 2-years, with more frequent and increasing magnitudes of flooding in this area. At this location, the current likelihood of experiencing flows that exceed design frequencies baseline levels is **high**. Future likelihood is **extremely high** with increasing consequences as the magnitude of rainfall increases. This is a priority area for the Town to address to prevent impact to emergency vehicle transportation, and access to pedestrian transportation routes during flood events. There is also a risk of limiting economic development and demand for growth if service levels are not raised to the minimum expected by the community.
- c) Increased rainfall volume can increase erosion potential in open channels. This occurs both from extreme flows during infrequent events and chronic increases in mean annual flow from increases in storm intensity of frequent events. Current likelihood of experiencing increased erosion above baseline levels is **low** with **moderate** future likelihood. Banks of the local

watercourses are well established and there are no critical erosion areas identified in the risk assessment. No action is suggested currently outside of monitoring for any changes to the erosion patterns following work along watercourse banks and after major riverine flooding events.

Recommendations

1. Update municipal design standards to require climate adjusted IDF curves and precipitation forecasts to be used for new stormwater infrastructure and stormwater replacements. Given current indications that impacts are already occurring and the steady and continuous increase of atmospheric greenhouse gases, we recommend adopting a minimum of the moderate case projections for low-risk infrastructure (failure causes street flooding) and extreme projections for high-risk infrastructure (failure causes risk to health and safety or building flooding).
2. Proceed immediately with capital works to improve the drainage system along Main Street from Hanlon Street to James Street and consider low impact development approaches such as reducing the paved area of the street, adding permeable pavers, increasing vegetative cover along boulevards, adding active transportation corridors more suited to an older population and including rain gardens at catch basin locations. Depending on detailed hydraulic analysis, a flap gate to prevent storm system inflow from Black River may also be appropriate.
3. Conduct annual inspections of rivers and culverts and maintain them in a clean state, removing brush and debris.
4. Conduct annual inspections of riverbanks for early warning of erosion issues and reinforce problem areas with riprap or deep rooting vegetation.

Transportation (Roadways and Sidewalks)

Transportation systems have these potential exposure pathways:

- a) Increased rainfall intensity is discussed under stormwater collection.
- b) Increased occurrence of extreme heat days can cause accelerated wear on asphalt roads when the asphalt pavement is warmed and used by heavy load vehicles. Likelihood of this occurring above baseline is currently **low**, and in the future **high**. The consequence of this is decreased lifespan of roads and increased maintenance requirements for crack sealing and pothole repair.
- c) Forest fire can interrupt transportation routes. Likelihood of this occurring above baseline is currently **moderate**, and in the future **high**. The consequence of this occurrence is moderate given that some areas of Town have limited access routes, so emergency response times may be increased if primary access routes are blocked.
- d) Decreasing freeze-thaw cycles will *increase* the lifespan of roadways and sidewalks. The likelihood of this occurring relative to baseline is currently **low**, and in the future is **moderate**. The consequence of this occurring is extending the life of roads and sidewalks and reducing the amount of maintenance activities required.

Recommendations

1. Decrease asphalt areas on side road platforms such as Main Street and incorporate roadway maintenance (crack sealing and overlay) into municipal planning and monitor changes to degradation profile of roads for increases or decreases in expected life or time for distress (cracking and potholes) to occur.

Buildings, Fleet and Facilities

- a) Increased rainfall frequency and intensity can increase the number of storms that exceed the capacity of roof drainage structures. This can result in water pooling on flat roofs and backups in pipe systems that convey water to the stormwater system. Facilities with poor grading for surface water drainage can experience a higher risk of flooding as more intense storms are slower to be conveyed off site. Current likelihood of occurrence relative to baseline is **moderate**, increasing to **extremely high** under future conditions with significant increases in intensity predicted. The consequence of occurrence is increased maintenance on roof and drainage structures, potential flooding through pipe drainage systems and surface flooding. The lifespans of facilities are short relative to the progression of climate impacts, so future planning is more important than immediate action to reduce risk.
- b) Increasing wind energy, which can impact building envelopes (exterior cladding and roof structures) is not forecast to have an appreciable increase. The likelihood of impacts above baseline levels is **low** and future likelihood is **moderate**. The consequence of this is increased maintenance on building envelopes.
- c) Increased occurrence of extreme heat days can cause increased demand for emergency response centres for cooling, seen during the 2021 heat dome in British Columbia and parts of Alberta. Without adequate cooling centres there is a risk to health for at-risk populations like the elderly and those with chronic health conditions. These occurrences also increase the operations cost of facilities as electricity use for cooling systems increases. Likelihood of this occurring above baseline is currently **low**, and in the future **high**. The consequence is the potential for new demand that municipal recreation facilities act as cooling centres and increases to energy costs of buildings by 1% to 5% annually, along with increased staff costs for operating these facilities as cooling centres.

Recommendations

1. Upcoming updates to Canada's National Building code will address most mechanical and structural requirements for new buildings, and no retrofit action for stormwater control is recommended on existing buildings until ongoing monitoring indicates that the cost of adaptation is offset by the cost of deferred maintenance.
2. The Town should conduct public consultation to determine if existing levels of service should be amended to provide cooling centres for residents if they do not already exist, and plan for increases in energy consumption over time. Any proposed action with this should include an assessment of lifecycle cost of these services to link increased cost to residents with the service provided.
3. We recommend the Town conduct ongoing FireSmart education with residents to encourage property owners to maintain their properties to minimize the risk of fire spread in a catastrophic event.

ACTION PLAN

The vulnerability of critical infrastructure is summarized in the Climate Risk Assessment. The objective of this task was to apply the results of the risk assessment to develop action plans with priority interventions based on the level of risk and vulnerability based on probability, frequency, and consequence. Consequences are based on the consequence of failure matrix included in the Town's asset management program, shown in Table 2.

CONSEQUENCE	RANK	CULTURAL / POLITICAL	ECONOMIC	LEGAL	SAFETY	ENVIRONMENTAL	EQUITY	OPPORTUNITY COST / REWARD
INSIGNIFICANT	1	Public will not notice. No impact to cultural resources or groups. No impact to relations with other levels of government.	Costs are minor and expected within ongoing operational budget.	No regulatory or legal impacts.	No risk to safety above baseline conditions.	No impact to the environment.	Impacts to residents are experienced relatively equally	There is no potential lost opportunity
MINOR	2	Minor public notice, public contacts staff only - single point of contact. Municipality can alert the public prior to widespread social media activity. No impact to cultural resources or cultural groups. No impact to relations with other levels of government.	Unexpected operational cost can be accommodated by redistribution of yearly budget. Grant can offset the unexpected cost.	Failure may result in small claims.	Risk of "near miss" incidents, low risk of injury.	Short term effects to the environment requiring one time remediation of mitigation to restore the system to its original state. Notification to NSE.	Impacts disproportionately affect a specific economic or cultural group for the duration of the service disruption with respect to access to core services like water, transportation, recreation, etc.	Service disruption or delay in project results in a delay of planned economic development, deferred savings in operations costs.
MODERATE	3	Moderate public notice - multiple single points of contact, elected officials are contacted. Social media has a presence in terms of pictures or video. Coverage in local news, requires official municipal response. Impact to cultural groups limited.	Unexpected operational cost requires cancellation of minor planned activities accommodate. No long-term financial impacts. Minor impact to tourism. Grant cannot offset unexpected cost.	Failure may result in litigation and informal inquiry.	More unlikely than likely to cause short- or long-term injury, no risk of loss of life.	Short term effects to the environment requiring temporary remediation or mitigation which restore the system to its original state. Submit plans for approval to NSE.	Impacts disproportionately affect a specific economic or cultural group with respect to access to core services like water, transportation, recreation, etc. that continues in the year following the service disruption.	Service disruption or delay in project could result in a long-term delay of significant economic development opportunities or major operational savings that could be diverted to capital projects.
MAJOR	4	Potential for injury. Mayor / CAO is notified. Public notice is widespread, large volume of multiple contacts. Social media has a strong awareness in terms of pictures or video. Coverage in local news, requires official municipal response. Interruption of service greater than 1 day. Coverage in provincial news. Impact to cultural groups widespread.	Unexpected operational cost requires cancellation of major planned activities to accommodate. Long term financing required to accommodate. Loss of commercial or tourism service greater than 5 days.	Failure may result in class action litigation and formal inquiry.	More likely than not to cause short- or long-term injury, low potential for loss of life.	Long term effects to the environment requiring sustained remediation or mitigation. System may not ultimately reach its original state. NSE issues a directive to the Town.	There are medium-term (<10 years) effects limited to a specific economic or cultural group resulting in displacement / relocation, health impacts or financial loss.	Service disruption or delay in project could result in lost opportunity to realize significant economic development opportunities or major operational savings that could be diverted to capital projects.
CATASTROPHIC	5	Potential for loss of life. Road sinkhole / caving in. Coverage on the National.	Property damage that the Town is liable for. Loss commercial or tourism service greater than a season. Financing requirements may render the municipality insolvent.	Failure results in contravention of laws, significant litigation, court action and multiple litigations.	More likely than not to cause short- or long-term injury, potential for loss of life.	Permanent or long-term environmental effects that cannot be remediated or mitigated. Failure to comply results in legal action.	There are long-term (>20 years) effects limited to a specific economic or cultural group resulting in displacement / relocation, health impacts or financial strain.	Service failure results in inability to achieve strategic plan goals, resulting in a need to redefine the plan. Inability to complete project results in loss of significant (>80%) funding opportunity.

Table 2: Consequence of Failure

Prioritization

Projects are prioritized based on risk. The higher the risk, the higher the priority of the project. **Table 3** shows how priority is determined from the probability and consequence of failure, where a higher score is a higher priority.

Table 3: Risk Matrix

Probability of Failure	Consequence of Failure				
	1	2	3	4	5
1	1	3	6	10	15
2	2	5	9	14	19
3	4	8	13	18	22
4	7	12	17	21	24
5	11	16	20	23	25

Extreme risk, shown in red, should be addressed immediately. High risk, shown in orange, should be addressed in near-term five- or ten-year adaptation planning. Medium risk should be monitored or investigated in more detail to determine if any assumptions can be refined that may shift it into a higher risk category. Low and very low risks do not need any immediate action.

Assessing risk through a climate lens requires consideration of the changes in likelihood and consequence over time. Some have more dramatic early impacts, and some have deferred impacts until future increases reach a “tipping point” that exceed the adaptive capacity of infrastructure. **Table 4** shows the results of the climate assessment along with potential interventions and a timeframe for implementation.

Table 4: Assessment Results

Climate Hazard	Service Area Impact	Current Risk	Future Risk	Proposed Intervention(s)	Current Risk After Action	Future Risk After Action	Aligned with AMP Priority
Precipitation	Potable Water – decreased water levels from drought. Insufficient fire response, pressure for firefighting, water volume for economic and housing development.	17	24	Replace Pugwash reservoir at end of life	6	13	Yes
Wind	Buildings and Facilities – increased maintenance on exterior envelopes and roof coverings. <i>Note: since this report was issued, the primary action; upgrades to the Town hall exterior and roof are completed and this table has been updated.</i>	8	8	Completed	8	8	Yes
Forest Fire	Buildings and Facilities – forest fire presents a risk to multiple service areas through risk to facilities that run water supply, water treatment and sanitary treatment.	18	23	Conduct FireSmart audits of all municipal facilities and create a management program to reduce consequences of major events.	8	16	No
Precipitation	Stormwater - Existing system is not designed for future rainfall amounts	8	20	Amend Town standards to include climate adjusted flows for 10- or 25-year levels of service for storm infrastructure replacements. Continue with renewal along with water, wastewater and transportation systems.	8	4	

Climate Hazard	Service Area Impact	Current Risk	Future Risk	Proposed Intervention(s)	Current Risk After Action	Future Risk After Action	Aligned with AMP Priority
Precipitation	Stormwater – Persistent flooding at Main Street impacts property, emergency response and pedestrian access to services. Flooding impacts development and growth potential	17	23	Implement recommendations to upgrade Main Street from Hanlon Street to James Street	6	6	Yes
Temperature	Emergency Services – increased demand for cooling centres and energy use.	6	20	Conduct community consultation to identify need and willingness to support expanded emergency response services.	TBD	TBD	No
Forest Fire	Emergency Services – risk to private property from an out-of-control fire could easily overwhelm emergency service response capacity.	22	25	Create and deliver an emergency response and FireSmart education program for residents.	13	17	No

CONCLUSION

Climate change is already ongoing and Atlantic Canadian municipalities must act immediately to begin addressing the risk to sustainable service delivery in their communities. In the Town of Oxford, appropriate action is a balance between changing risk and vulnerability profiles as climate change progresses, [demands for economic, housing and service development](#), ability to finance projects based on municipal revenue and outside funding programs and addressing concurrent risks from aging infrastructure.

Priority projects have are recommended based on:

- Alignment with goals of the asset management plan, which is based on aging infrastructure performance and future demand projections for infrastructure services.
- Increased priority of projects that address a current risk compared to a future risk.
- Increased priority of projects that significantly reduce future service risk through the proposed intervention.
- Feasibility of achieving the targeted intervention through existing revenue and funding models.
- Ability to mix a multi-faceted strategy of capital investment, operational improvements and public education.

Based on these priority metrics, the Town is recommended to pursue feasibility studies and funding programs that can support the following near-term goals:

1. Complete a water capacity and pressure study and use the results to support replacement of the Pugwash Reservoir and supporting transmission and distribution system
2. Complete upgrades with recommended low-impact development features to the aging section of Main Street from Hanlon Street to James Street.
3. Implement FireSmart audits for all municipal buildings and develop community engagement for resident level fire safety and emergency planning, and
4. Investigate the need for future upgrades and operational impacts to community buildings that could act as cooling centres during heat wave events.