Climate Change Impacts on the Housing Infrastructure at Oneida Nation of the Thames

July 24, 2018

Project No. 163401448

Prepared by:

Stantec

Developed in partnership with:

Ontario First Nations Technical Services Corporation

Sign-off Sheet

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Executive Summary

This report presents the results of the Climate Risk Assessment (CRA) study conducted for the housing infrastructure in the Oneida Nation of the Thames community using the Ontario First Nations Technical Services Corporation (OFNTSC) First Nations PIEVC Protocol; a methodology adapted from Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol [https://pievc.ca/protocol]. The report identifies infrastructure vulnerabilities to current and future severe weather; focusing on different types of housing units. The report establishes a risk profile for the assessed infrastructure and provides recommendations regarding mitigating the risks with the highest consequences.

The methods utilized to develop the report include reviewing background information (such as climate data, infrastructure drawings and existing infrastructure condition reports) and consultation with local personnel (such as Oneida's Housing Coordinator, Environment Services and Public Works staff). The input from local expertise regarding the housing is combined with the background information to develop a risk profile, in the form of a matrix, highlighting assets that may be most at risk under current climate conditions, with respect to specific weather events. The findings under current climate conditions are then re-evaluated against the demands that may be placed on them under future climate scenarios, with respect to the expected change of frequency or intensity of specific weather events.

The results of this process suggest that for the infrastructure identified, under current climate conditions, there are 54 interactions between a selected infrastructure item and a particular weather event that are categorized with a "Moderate" risk threshold rating. Another 16 interactions are categorized with a "High" risk threshold rating. When evaluated against projected future climate conditions, the count of these categories of risk threshold become 57 for "Moderate" and 37 for "High".

The housing assets, school and infrastructure that provide services of the Oneida Nation of the Thames are generally well maintained and provide safe services to the community. The Oneida Council, under budget pressures, has managed to maintain these assets in a state of good repair; the maintenance practices they have adopted and implemented have resulted in resilient infrastructure.

The findings reinforce the need for regular maintenance and property ownership practices and for sound asset management planning for infrastructure. The specific Risk Mitigation and Adaptation Measures recommended for Oneida generally fall into the following categories:

- Considerations to include future climate impacts in the design and construction practices of new housing assets and infrastructure
- Additional monitoring, inspection and maintenance of housing assets and infrastructure conditions by Operations personnel
- Emergency preparedness in case of infrastructure failures, such as back-up power and supplies, and/or exploring arrangements with neighbouring communities for emergency support

- Additional training of Operations personnel and providing them with proper safety equipment when work is required in hazardous conditions.

This report also acknowledges the fact that the analysis conducted has limitations. The intent of the study is to provide an overall risk profile of the housing assets owned and managed by the Oneida Nation of the Thames; the recommendations do not address specific housing or infrastructure issues. This report should not be solely relied upon as a plan to make the housing assets of the Oneida Nation of the Thames more resilient to changes in climate. Rather this report provides a starting point for identifying specific assets and infrastructure that presents the greatest risks in terms of service to the community, and helps identify the assets that deserve a detailed analysis to ensure they can continue effectively and safely serving the Oneida Nation of the Thames in the coming decades.

Abbreviations

ACRS	Asset Condition Reporting System
CRA	Climate Risk Assessment
COO	Chiefs of Ontario
GHG	Green House Gas
ICMS	Integrated Capital Management System
INAC	Indigenous and Northern Affairs Canada
IPCC	Intergovernmental Panel on Climate Change
O&M	Operations and Maintenance
OCCIAR	Ontario Centre for Climate Impacts and Adaptation Resources
OFNTSC	Ontario First Nations Technical Services Corporation
PIEVC	Public Infrastructure Engineering Vulnerability Committee
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
WTP	Water Treatment Plant (potable water)
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

Severe weather and climate uncertainty represent risks to public safety in Canada and around the world, as well as to the safety of engineered systems and the services they provide. In this context, an increasing number of public agencies and organizations that provide public services address climate change adaptation as part of their primary mandate—protecting the public interest, which includes life, health, property, economy, culture and the environment.

The impacts of severe weather add to the existing stresses on infrastructure and the services it provides. In addition to factors that reduce the capacity and performance of these assets (e.g. age, increased demand, material weathering, design and construction inadequacies, lack of maintenance, or extension of service life beyond design), the increased intensity of weather events can produce an incremental load that can cause asset failure.

Infrastructure vulnerability and risk assessments are the foundations to ensure climate change is considered in engineering design, operations and maintenance of community infrastructure, buildings, and facilities. Taking the time to identify the services and related assets that are vulnerable to the impacts of climate change, provides opportunities for improved planning and the development of cost-effective solutions to increase resiliency of infrastructure assets to these new weather patterns.

This report presents the results of the Climate Risk Assessment (CRA) study conducted for the Oneida Nation of the Thames housing assets using the First Nations PIEVC Protocol, a methodology adapted from Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol [https://pievc.ca/protocol].

1.1 COMMUNITY DESCRIPTION

Oneida Nation of the Thames is a flourishing and vibrant Iroquois community[1]. The Oneida Nation of the Thames, like other Iroquois Nation's is a sovereign independent Nation with its own traditional hereditary and contemporary systems of governance and law. Established in 1840 as the "Oneida Settlement", it has transformed from an agricultural society into a modern and versatile Iroquois community.

The Oneida Nation of the Thames is home to 2,159 residents and has a total membership of 6,108. Located in picturesque southwestern Ontario, the Oneida Nation Settlement borders lush and fertile agricultural lands and is nestled along the eastern shore of the Thames River 30 kilometers south of the City of London.

[1] Source: https://oneida.on.ca/

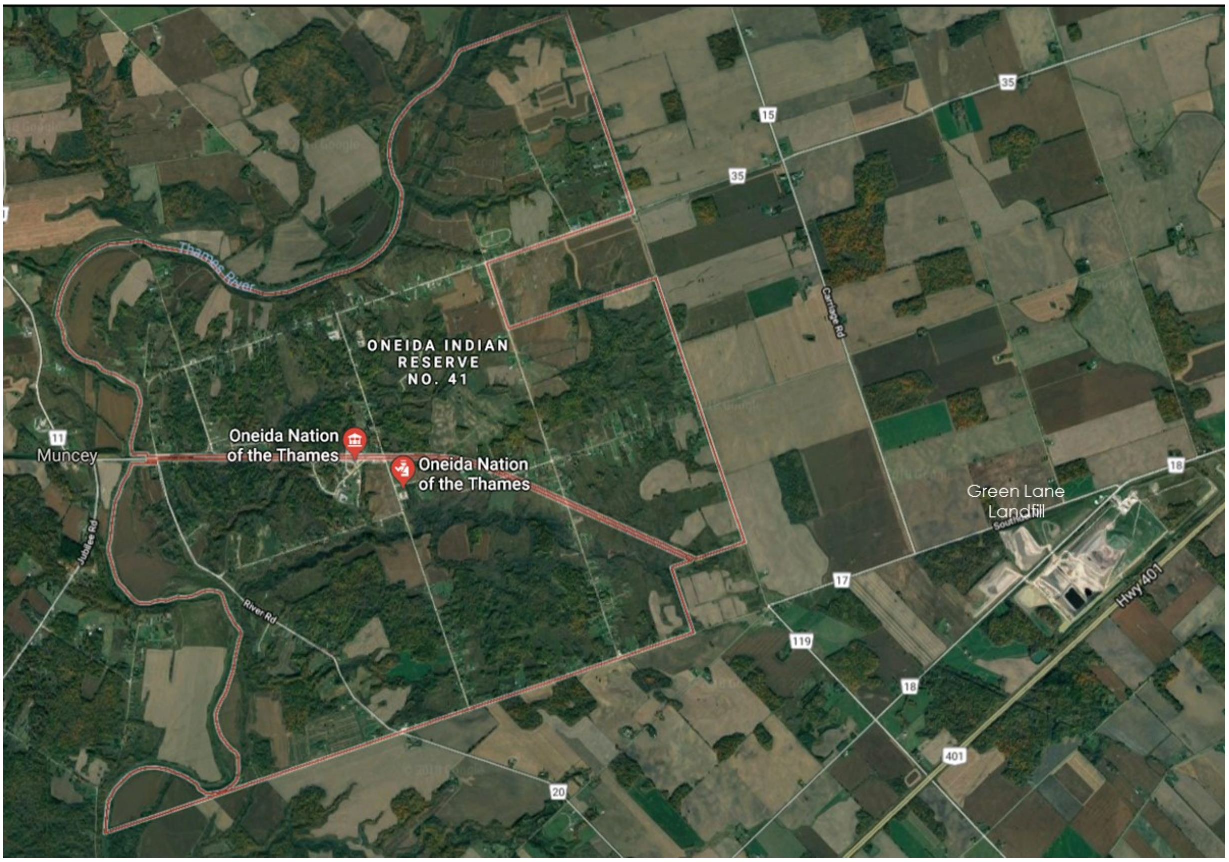

Figure 1: Satellite view of Oneida and surrounding area (Source: Google Earth).

The region has a humid continental climate influenced by its proximity to Lake Huron and regional elevation changes. Due to its continental location, the region experiences large seasonal contrasts with summers usually warm to hot and humid, with a July daily average temperature of 20.8 °C[2]. The region experiences frequent thunderstorms due to its summer weather and the convergence of air flows originating from Lake Huron and Lake Erie.

1.2 SCOPE OF THE STUDY

The objectives of the study are to:

- Identify infrastructure vulnerabilities to current and future severe weather. Oneida infrastructure considered in the study included the community's Senior's Complex, Standing Stone School and representative housing units.
- Establish a risk profile for the identified infrastructure.
- Provide recommendations regarding mitigating risks with the highest consequences to the assets, services, and community.

[2] Source: http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=4789&autofwd=1

1.3 PROJECT TIMELINE

Table 1 shows the timeline for the project.

Table 1: Timeline for the Project

Phase	Completion Date
Start-up meeting	August 2, 2017
Workshop 1: Define the project	September 19, 2017 October 26, 2017
Workshop 2: Gather the data	October 26, 2017
Workshop 3: Complete the risk assessment	November 16, 2017 December 8, 2017
Request engineering analysis (optional)	N/A
Workshop 4: Prepare recommendations for action	December 8, 2017 January 16, 2018
Produce Climate Risk Assessment Report (this document)	July 24, 2018

1.4 PROJECT TEAM

The Project Team included key staff from Oneida and Ontario First Nations Technical Services Corporation (OFNTSC) supported by subject matter experts from Stantec and Risk Sciences International (RSI). The members of the Project Team are listed below.

Table 2. Project Team

Project Team	
<u>Oneida Nation of the Thames</u> • H. Grant Doxtator, Councillor • Chanda Kennedy, Band Administrator • Jenelle Cornelius, Environmental Technologist • Ron Elijah, I/Public Works Administrator <u>Southern First Nations Secretariat (SFNS)</u> • Randy Doxtator, Housing Advisor, Technical Services	<u>OFNTSC</u> • Elmer Lickers, Senior O&M Advisor <u>Subject Matter Experts Support Team</u> • Guy Félio, Senior Advisor (Stantec) • Heather Auld, Climatologist (RSI)

2.0 STEP 1: PROJECT DEFINITION

This first step of the Climate Risks Assessment (CRA) using the FN PIEVC Protocol involves setting the general boundary conditions for the project. The CRA project team identifies the infrastructure to be assessed and its key attributes, such as location, condition, known concerns, etc. The team identifies the overall climatic elements that affect the infrastructure and past weather events that have caused disruptions or failures to the service(s) provided by the asset(s).

The Project Team met at Workshop 1 on September 19 2017 to define the project parameters; the validation and consensus on the project infrastructure was done prior to beginning Workshop 2 on October 26, 2017.

Following a presentation on the objectives of the project, an overview of the methodology for the climate risk assessment, and the Mohawk Council of Akwesasne Water/Wastewater Climate Risk Assessment project, the team discussed the assets to include in the study.

The Project Team decided to assess the climate (current and future) risks to Oneida's owned and operated housing assets: the Seniors Complex, quad-plex and duplex housing units, a representative single family dwelling and the Standing Stone School. The Project Team also included other infrastructure that provides services to these housing assets (water, wastewater and roads); however, the analysis of this additional infrastructure was done at a lower level of detail.

2.1 CLIMATE RELATED CONCERNS

Discussions focused on current concerns on meteorological events that have or are causing infrastructure and operations disruptions and/or failures, and on observations of changes in climate patterns. Following are the main points raised and discussed during Workshops 1 and 2.

- Snow storms - mid to late 1970s; December 2007[3]
- Localized weather events – intense short duration rains; strong wind gusts
- Wind damage – in September and October 2017, increase in applications for wind damage repairs; reports of high winds and tree damage
- Tornado – possibly in 1965; also in 1984 and 2009[4]

[3] Information related to the December 2007 winter storm was found at https://en.wikipedia.org/wiki/Early_December_2007_North_American_winter_storm
[4] Information related to August 2009 tornadoes was found at https://www.theweathernetwork.com/news/articles/southern-ontario-severe-storms-tornado-watch-devastating-tornadoes-storm/104590

- Ice storm - March 2007[5]; April 2018[6]

2.2 PHYSICAL ASSETS TO BE CONSIDERED

During Workshop 1 the goal was to identify the infrastructure components that will be considered in the assessment. During the Workshop, the Project Team listed the following preliminary infrastructure to be assessed.

- Seniors Complex
- Quad-plex
- Duplex
- Single family units (owned and maintained by the Oneida Nation Council; representative of the community's housing assets)
- Additional support infrastructure at or near properties
    - Potable water
    - Wastewater treatment
    - Roads
    - Water Supply system
- Operations personnel
- Third-party services

In Workshop 2, the Project Team confirmed the asset list and decided to include to the assessment the Standing Stone School.

The community expressed concerns with activities occurring in areas neighbouring the Oneida Nation territory that have impacts on the infrastructure and are likely to be affected by future climate changes; they are:

1. Increased drainage volumes from neighbouring agricultural areas that flow on Oneida lands that have caused localized flooding; and

2. Potential climate change impacts on the City of Toronto Green Lane Landfill, East of Oneida (see Figure 1).

2.3 TIME HORIZON FOR THE STUDY

The time horizons for the study were selected as current conditions (establishing the baseline risks) and 2050s (2035 to 2065[7]) for future conditions. The future timeframe corresponds to the service life of many components of the assets being evaluated in this assessment.

[5] Information related to the March 2007 storm was found at https://ec.gc.ca/meteo-weather/default.asp?lang=En&n=53169766-1#r3

[6] Note this event was added at a later date than Workshops 1 and 2. Information found at: https://globalnews.ca/news/4145554/ice-storm-ontario-weather-update/

[7] Climate is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of meteorological variables such as temperature, precipitation and wind over a period of time, typically 30 years. (Source: World Meteorological Organization). The "2050s" projected climate is therefore the projected average over the 30-year period from 2035 to 2065.

3.0 STEP 2: DATA COLLECTION

3.1 INVENTORY OF INFRASTRUCTURE COMPONENTS

Information on the assets for this climate risk assessment was obtained from the staff of the Oneida Nation. It included relevant reports (e.g., the 2016 ACRS report[8]), policy[9] and planning documents, as well as information gathered during the workshops and a site visit. No inspections of the condition of the assets under consideration were conducted.

3.1.1 Oneida Senior Citizens Complex

The Oneida Seniors Complex is designed for people who are at least sixty (60) years of age or are living with a disability[10]. It is designed for those wishing to live independently and do not require full-time care providers. The rental units in the Oneida Seniors Complex are complete with all necessary appliances (including a fridge and stove). Heat, hydro, water, and sewage service are all provided for the tenants, as well as exterior and interior maintenance of the property and building common areas. The following images show different angles of the Complex and supporting infrastructure.

Figure 2. Front View of Entrance Senior Citizens Complex

[8] Oneida Nation of the Thames, *Asset Condition Report System* report prepared by First Nations Engineering Services Ltd (October 2016)
[9] Oneida Nation of the Thames, *Housing Policy – Procedures and Guidelines,* approved by Oneida Council, February 2015
[10] Source: Oneida Nation of the Thames, *Housing Policy – Procedures and Guidelines,* approved by Oneida Council, February 2015

Step 2: Data Collection
July 24, 2018

Figure 3. View of Front Individual Units of Senior Citizens Complex

Figure 4. Side View of Senior Citizens Complex with Propane Tanks

Figure 5. View of the Back Units of the Senior Citizens Complex

Figure 6. Back-up Generator at the Senior Citizens Complex

3.1.2 Quadplex

This four-unit housing complex is unique in Oneida. The Quaplex is serviced by community water and wastewater. The Oneida Council provides the tenants with heating; A/C, if desired, is the responsibility of the tenants.

The majority of the roof for the Quadplex is asphalt shingles; part of the roof was replaced with a metal roof in recent years as shown in Figures 8 and 9.

Figure 7. Front View of Quadplex

Figure 8. Rear View of Quadplex

Figure 9. Quadplex Roof: Metal and Asphalt Shingles

3.1.3 Duplex

This two-unit building is unique in Oneida. The Duplex is serviced by community water; wastewater is treated on-site. It has an asphalt shingles roof and vinyl siding.

Figure 10. Duplex: Angle View

Figure 11. Duplex: Side and Back View

3.1.4 Single Family Units

Figures 12 to 15 show examples of single dwelling units owned and maintained by the Oneida Council. The newer units (such as Unit #1 in Figure 12) have metal roofs, while the older (such as units #2, #3 and #4 respectively in Figures 13 to 15) have asphalt shingles roofs. All Oneida Council housing units are serviced by community water; some are connected to the community wastewater collection system, others have on-site treatment. Most units use propane as fuel for heating.

Figure 12. Single Family Unit #1

Figure 13. Single Family Unit #2

Figure 14. Single Family Unit #3

Figure 15. Single Family Unit #4

3.1.5 Standing Stone School

Standing Stone School is a community Junior Kindergarten to Grade 6 elementary school serving approximately 210 students[11]. It was built in 1976 and an addition constructed in 1997.

The Standing Stone School consists of a combination of concrete block and steel frame construction[12]. The foundation is poured concrete walls and footings. The roof is a combination of a multi-level flat roof system and some sloped metal roof sections. Approximately half of the roof was reconstructed in 2013. The exterior walls are brick veneer. The flooring is mainly vinyl tiles, there is a combination of painted concrete block and painted gypsum board interior walls and a combination of acoustical ceiling tiles and painted gypsum board ceilings. The heating is provided by propane fired boilers, while the cooling is provided by a cooling tower system. The lighting is mainly fluorescent units.

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[11] Source: https://oneida.on.ca/standing-stone-school/
[12] Source: Oneida Nation of the Thames, *Asset Condition Report System* report prepared by First Nations Engineering Services Ltd (October 2016)

The Standing Stone School is protected by a security alarm, a fire alarm and by a video surveillance system. It is equipped with fire extinguishers and emergency lighting.

The School water is supplied via a piped water system. Wastewater is treated on-site.

Figure 16: Standing Stone School Entrance (Source: https://oneida.on.ca/standing-stone-school/)

Figure 17. Satellite View of Standing Stone School (Source: Google Earth)

3.2 CONDITION OF INFRASTRUCTURE COMPONENTS

In terms of condition/performance rating, no field inspection was carried out by the Project Team. The condition and performance of the assets was exclusively based the ACRS inspection report (2016) for INAC funded assets, as well as information gathered during a site visit (exterior only) and from the Oneida staff on the Project Team.

3.3 CLIMATE CONSIDERATIONS

The general temperature and precipitation annual average profile for the closest Environment Canada weather station (St Thomas WPCP, Station ID 6137362) is shown in Figure 18 below.

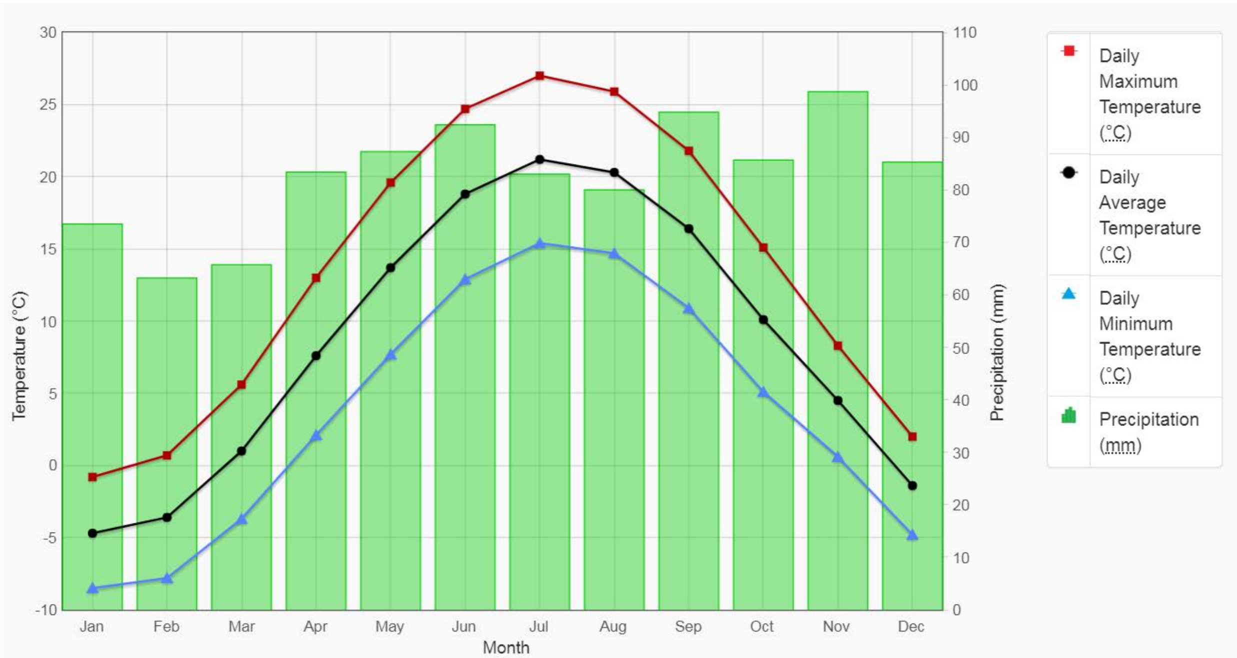

Figure 18. Average monthly temperature and precipitation from St. Thomas WPCP Station

Climate elements were part of the discussions at each of the four workshops of the project. In Workshop 1, participants were asked to recall weather events that may have caused damage/disruptions to the selected infrastructure. During Workshops 2 and 3, the Project Team members reviewed the list of weather elements suggested by the FN PIEVC Protocol and selected those relevant to the infrastructure under assessment and local/regional climate conditions.

The climate considerations presented are the result of discussions among team members at the project workshops, research into public information and news reports, and the following reports:

- *Climate change projections for Ontario: An updated synthesis report for policymakers and planners.* Ontario Ministry of Natural Resources and Forestry, Climate Change Research Report CCRR-44, 2015

- *City of London: Vulnerability of Infrastructure to Climate Change*, Water Resources Research Report by A. Peck et al., University of Western Ontario, 2011

The selection of climate parameters and infrastructure thresholds was the result of the workshops during which the history of infrastructure-weather interactions that have caused structural or functional failures, or service disruptions were discussed.

3.3.1 Climate Trends and Projections

The main source of climate data was the Environment Canada weather station at St Thomas WPCP (Station ID: 6137362)

The figures below provide examples of data used for the study; details are provided in the Workshop presentations in Appendix A. Future climate projections were based on the Intergovernmental Panel on Climate Change (IPCC) RCP[13] 4.5 scenario - a stabilization scenario in which total radiative forcing is stabilized shortly after 2100[14].

Mean daily temperatures have been increasing over the past 60-plus years as shown in Figure 19 and Figure 20. These figures also show that under the RCP 4.5 scenario, temperatures are projected to continue increasing over the next 30 years.

> The IPCC is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.
>
> IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC). The assessments are policy-relevant but not policy-prescriptive: they may present projections of future climate change based on different scenarios and the risks that climate change poses and discuss the implications of response options, but they do not tell policymakers what actions to take.

On average, Summer precipitation has shown no significant increase or decrease and this trend is projected to continue as shown in Figure 21. Total Winter precipitation has increased over the past 60-plus years, and models project a continuing increase in the future (Figure 22).

Winter rain is of particular interest since it occurs when the ground is frozen and thus stormwater catchment systems may be blocked by snow and ice. For Southern Ontario, the threshold for a weather warning causing flood is a 25 mm rainfall. Figure 23 shows the historical records of 3/5/7 consecutive days of winter rain; from 1980 to 2017, a winter rain greater than 25mm over a 3-day period has occurred almost every year.

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[13] RCP: Representative Concentration Pathways – a greenhouse gas concentration (not emissions) trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5) in 2014.

[14] By comparison, RCP 8.5 is characterized by increasing greenhouse gas emissions over time, representative of scenarios in the literature that lead to high greenhouse gas concentration levels, while RCP 2.6 emission pathway is representative of scenarios that lead to very low greenhouse gas concentration levels.

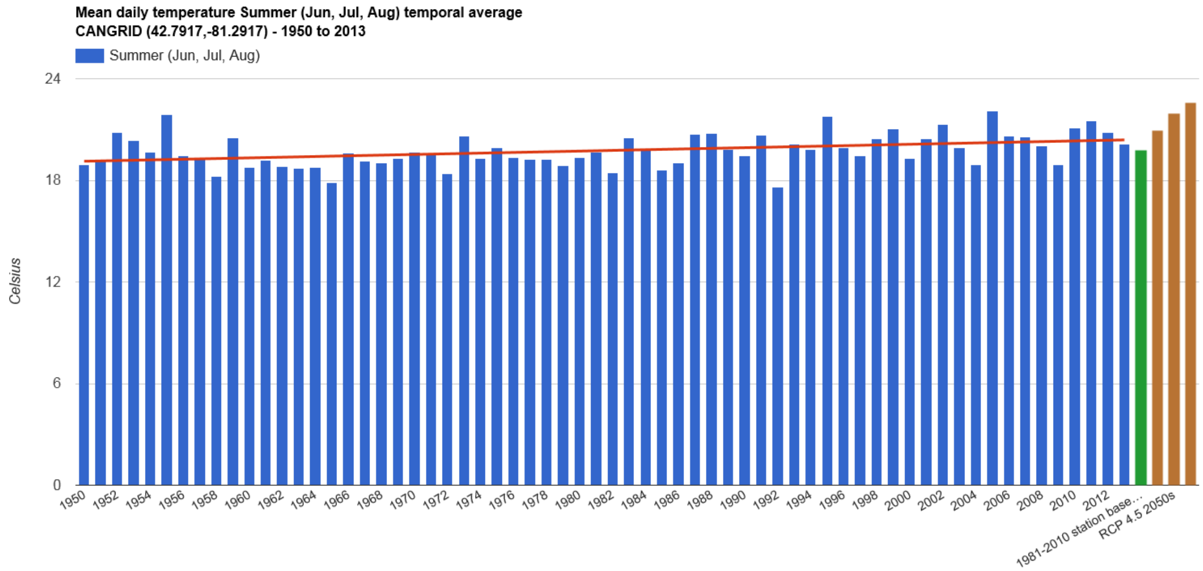

Figure 19. Mean Daily Temperature for Summer - Historical Trend and Future Climate Projection (St. Thomas Weather Station, RCP 4.5)

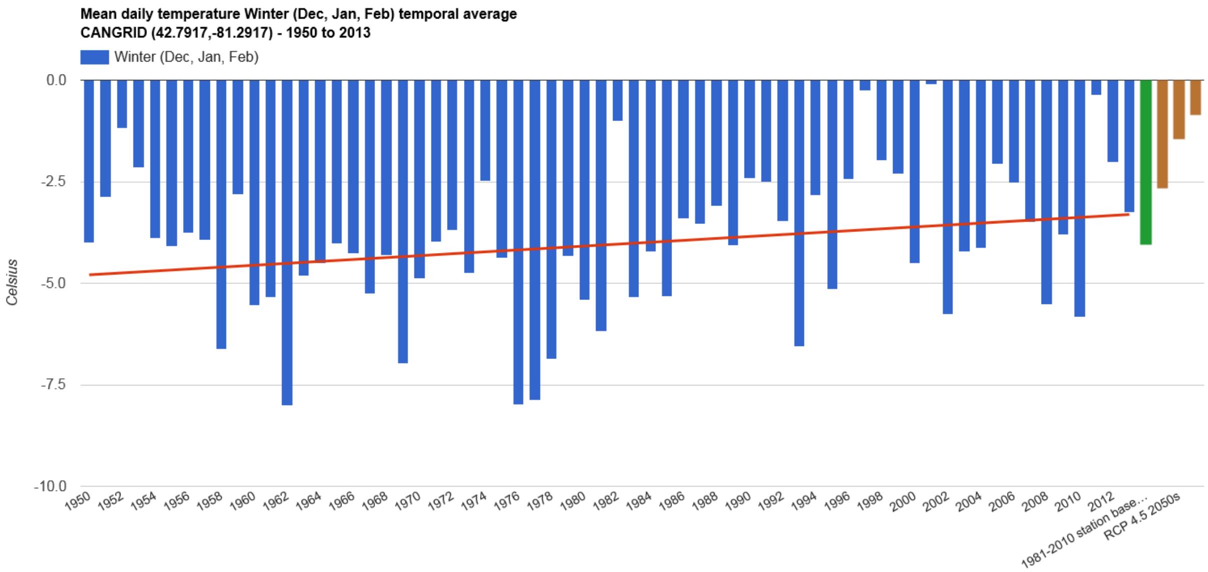

Figure 20. Mean Daily Temperature for Winter - Historical Trend and Future Climate Projection (St. Thomas Weather Station, RCP 4.5)

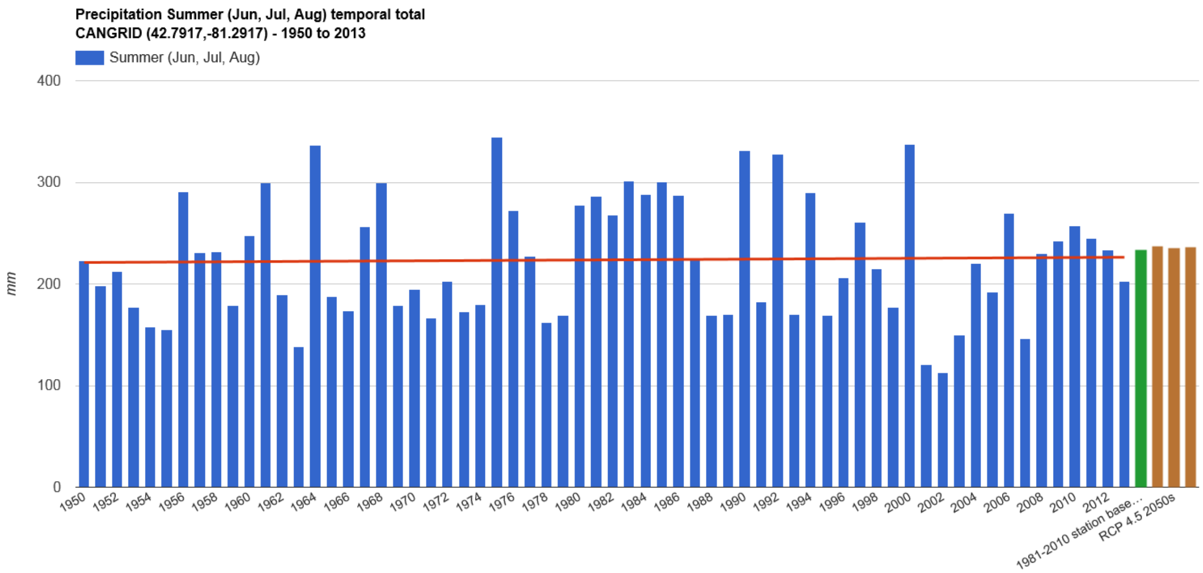

Figure 21. Summer Precipitation - Historical Trend and Future Climate Projection (St. Thomas Weather Station, RCP 4.5)

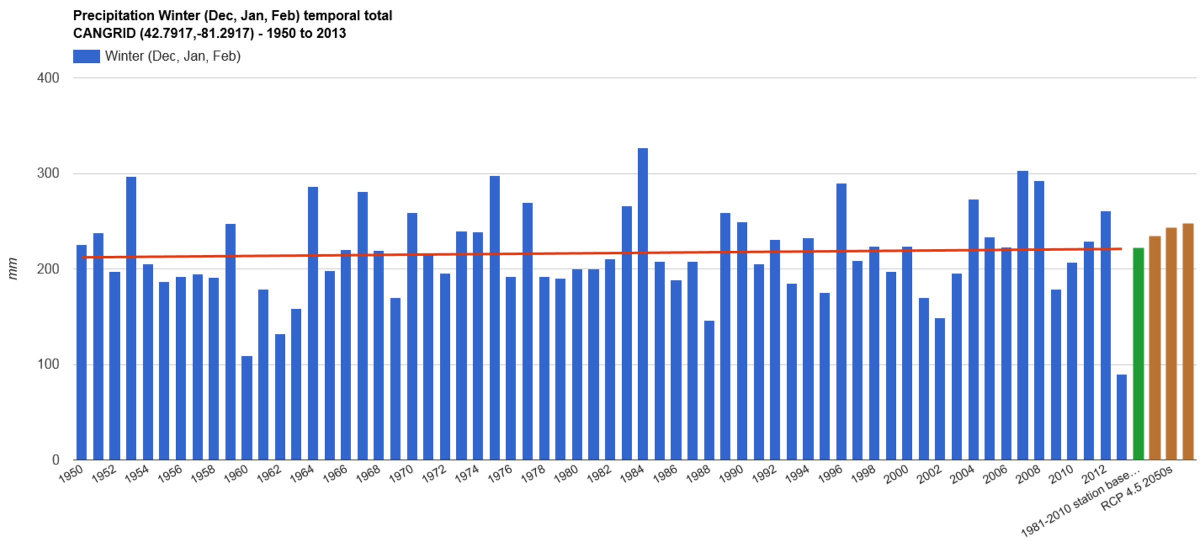

Figure 22. Winter Precipitation - Historical Trend and Future Climate Projection (St. Thomas Weather Station, RCP 4.5)

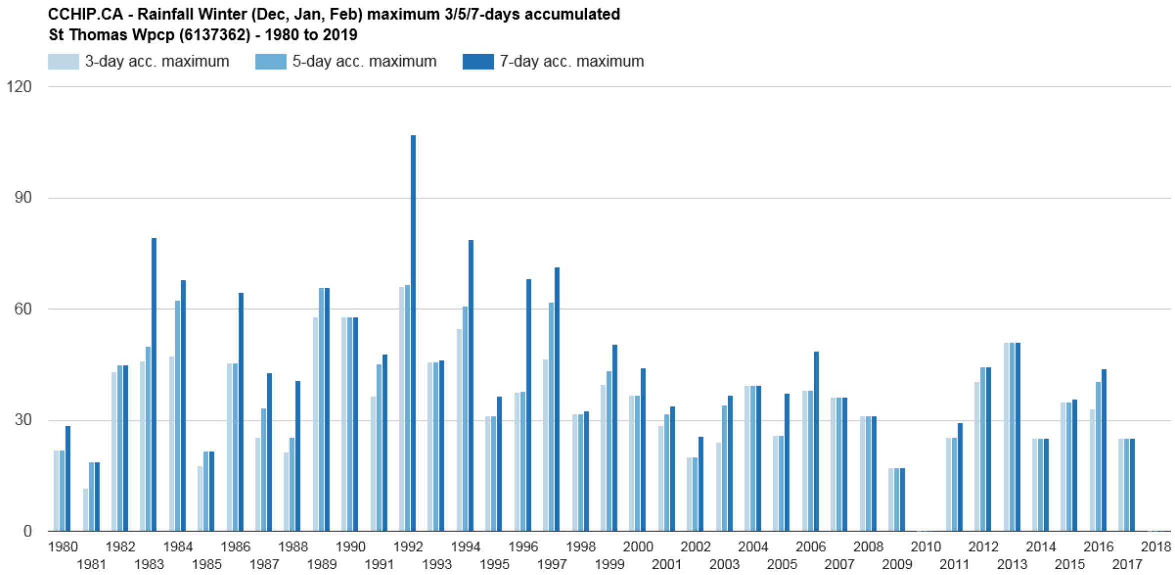

Figure 23. Winter Rain Events

Tables 3 and 4 below present historical and projected rainfall intensity, duration and frequency (IDF) data. Rainfall IDF information is used, for example, in stormwater management design. The information presented in Tables 3 and 4 are for the St. Thomas weather station; the data was obtained from the University of Western Ontario Institute for Catastrophic Loss Reduction (ICLR) Computerized Tool for the Development of Intensity-Duration-Frequency Curves under Climate Change – Version 3.0 at http://www.idf-cc-uwo.ca/ .

Table 3. Historical IDF - Accumulated Precipitation (mm)

T (years)	2	5	10	25	50	100
5 min	8.25	11.02	13.04	15.82	18.07	20.47
10 min	12.26	16.28	18.85	22	24.28	26.47
15 min	14.87	19.91	23.13	27.08	29.92	32.67
30 min	20.12	26.99	31.48	37.1	41.21	45.27
1 h	25.59	34.75	40.58	47.69	52.79	57.71
2 h	29.7	41.19	49.44	60.65	69.58	78.99
6 h	37.78	51.28	61.63	76.58	89.2	103.19
12 h	43.67	58.81	69.82	84.95	97.14	110.11
24 h	49.29	66.81	79.34	96.31	109.77	123.92

Table 4. Projected 2050s IDF (2025 - 2075 average) – Accumulated Precipitation (mm)

T (years)	2	5	10	25	50	100
5 min	10.14	14.13	16.78	21.22	24.59	28.23
10 min	15.04	20.88	24.22	29.82	33.58	37.37
15 min	18.25	25.53	29.71	36.69	41.4	46.13
30 min	24.7	34.62	40.45	50.19	56.9	63.71
1 h	31.41	44.56	52.1	64.66	73.12	81.6
2 h	36.52	52.81	63.54	81.39	94.89	109.37
6 h	46.48	65.76	80.55	102.24	120.39	140.67
12 h	53.69	75.44	89.84	113.93	132.24	151.97
24 h	60.59	85.66	102.05	129.34	149.8	171.66

The Tables show that for the 1:100 return period rainfalls, the future projected accumulated rainfall will increases ranging from 36.3% (6-hour rainfall) to 41.4% (1-hour event), with an average increase of 19.3% for all 1:100 rainfalls. The data in Tables 3 and 4 can also be used to establish the increased frequency of particular rainfall events. For example, the current climate 1:100 year, 24hr rainfall is project to have a return period of less than 25 years.

Figures 24 and 25 show the current and projected cooling and heating degree days respectively. A cooling [heating] degree day is a measurement that quantifies the demand for energy needed to cool [heat] a building; it is the number of degrees that a day's average temperature is above [below] 18º Celsius, which is the temperature above [below] which buildings need to be cooled [heated].

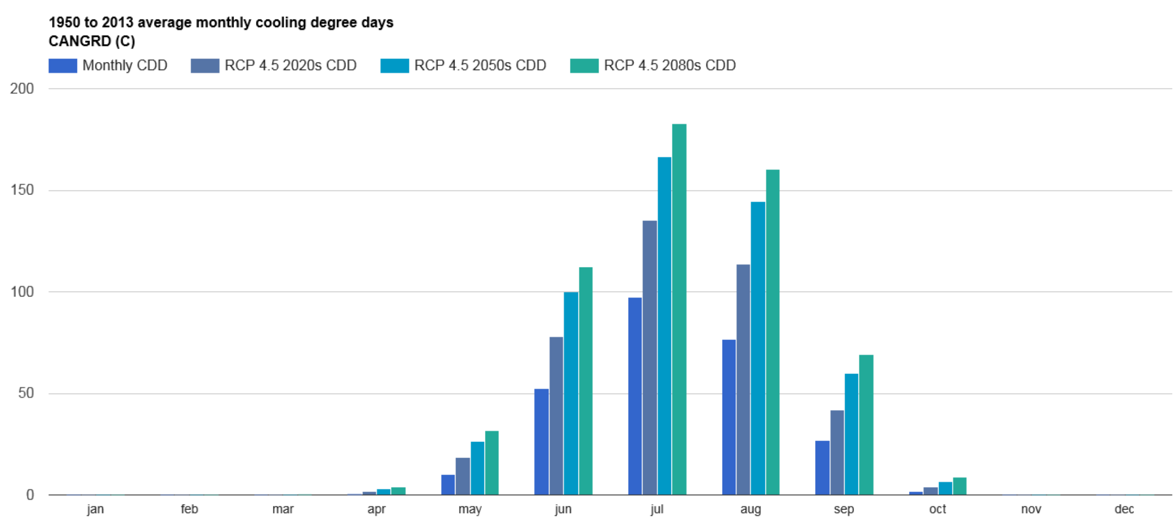

Figure 24. Cooling Degree Days - Current and Future Climate Projection (St. Thomas Weather Station, RCP 4.5)

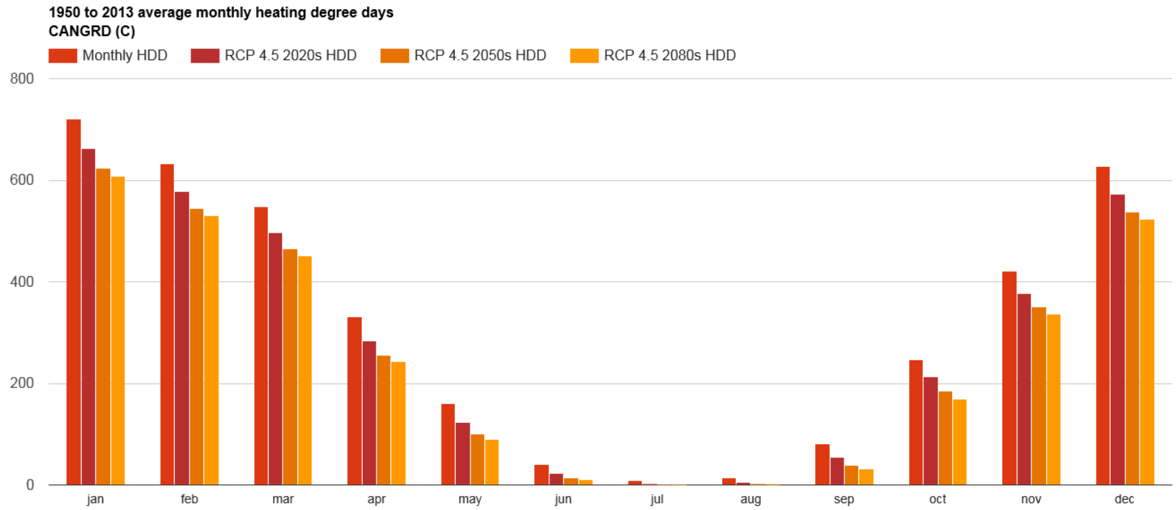

Figure 25. Heating Degree Days - Current and Future Climate Projection (St. Thomas Weather Station, RCP 4.5)

Figure 26 below shows there have been more than 40 tornadoes on record within a 50-km radius of the St. Thomas weather station. The Oneida Nation of the Thames has not experienced a tornado within its community, but is located in South-West Ontario's "Tornado Alley".

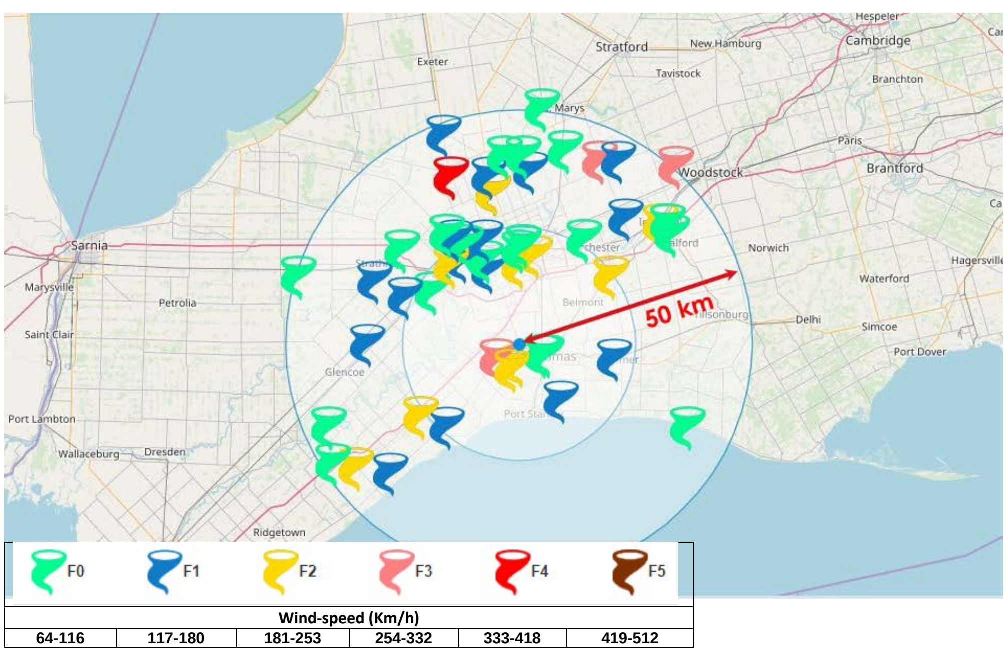

Figure 26. Tornado Records within 50km of St. Thomas

3.3.2 Climate Elements Considered to Affect the Infrastructure

The selected climate elements for the exposure, vulnerability, and risk assessments are shown in Table 5 below. They were selected by the Project Team as representative of events that have caused or are likely to cause structural, operational or functional disruptions or failures to the infrastructure considered in this study.

Table 5: Principal Climate Elements Selected by the Project Team for the Analysis

Type of Climate Element	Description	Comment
Temperature	Extreme High Temperatures	Days (per year) with Max Temps > 36°C
	High Temperatures	Occurrences of days with temperature greater than 30°C (10 or more days)
	Seasonal temperature variations	Heating and cooling degree days
Precipitation	Short duration - High Intensity rainfall	50mm in 30 minutes Type of rainfall that has caused localized flooding in the community
	Freezing rain	Estimated 15 mm causing local power line damage
	3 consecutive days of winter rain	Southern Ontario Threshold for weather warning causing flood of 25 mm
Winds	Exceeding 100 km/h	Damage to asphalt shingle roofs, trees and power lines 5 events with wind gusts > 100km/h in London (ON) between 1981 and 2010
	Tornado	

4.0 STEP 3: RISK ASSESSMENT

Step 3 of the FN PIEVC Protocol instructs the Project Team to perform the following steps, illustrated in Figure 27.

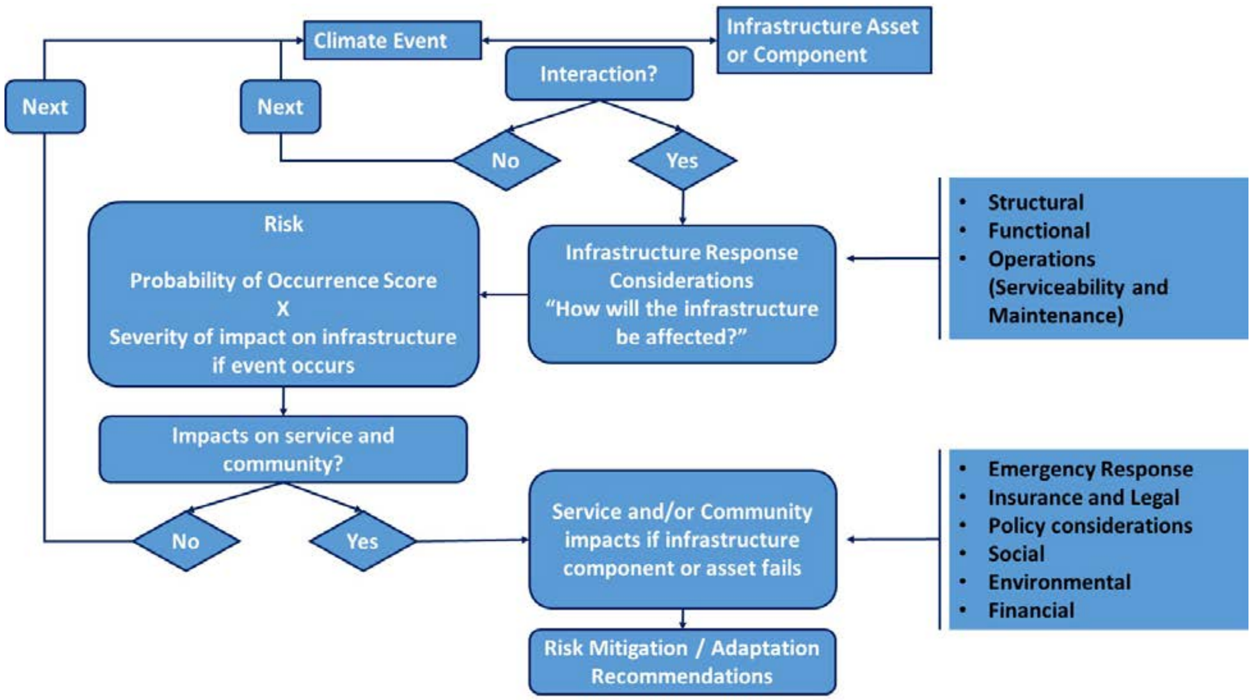

Figure 27: FN PIEVC Protocol Risk Assessment Process Flowchart

4.1 RISK THRESHOLDS

Risk is defined as the product of the **Probability** score multiplied by the **Severity** score. Since the probability and the severity scores are each rated from 0 to 5, the maximum risk score will be 25 as illustrated below. For this project, the Project Team selected the risk thresholds shown in Table 6 below.

Table 6: Risk Thresholds

Score	Description
< 5	**Low:** No action required
6 to 14	**Moderate:** Monitoring recommended; action may be required if threat materialises; a more detailed analysis may be needed
≥ 15	**Hight:** Action required; immediate attention if risk occurs in current climate; adaptation planning necessary if risk occurs in future climate projections
Special Cases	• Frequently recurring events, low single event impacts but accumulated effects • Low probability, high impact events (for example, tornados)

4.2 INFRASTRUCTURE RESPONSE

During Workshop 2, the Project Team members selected the infrastructure response criteria against which the infrastructure-climate interactions and risks would be evaluated. The reader is encouraged to study the details of the infrastructure responses selected in Workshop 3, that are provided in Appendix A. They are summarized below:

Infrastructure response:

1. Structural capacity
2. Functionality
3. Operations, maintenance, and materials performance

Community impacts:

1. Emergency response
2. Insurance and legal considerations
3. Policy considerations
4. Social and cultural effects
5. Impacts on the environment
6. Financial/fiscal impacts

4.3 CLIMATE PROBABILITY SCORING

The FN PIEVC Protocol rates the probability of the climate events occurring (current and future climate) as follows:

Table 7: FN PIEVC Probability Scoring

Score	Description
0	Negligible Not applicable
1	Highly unlikely Improbable
2	Remotely possible
3	Possible Occasional
4	Somewhat likely Normal
5	Likely Frequent

The following table presents the results of the climate analysis (current trends and future projections), and the corresponding FN PIEVC probability scores used in the risk assessment. The scores were produced by the Protect Team considering climate trends and future projections, individual knowledge and experience of past events, and news records of events that caused infrastructure damage in the area.

Table 8: Probability Scores for Selected Climate Events

Type of Climate Element	Description	Comment	Rating	
			Current Climate	Future Climate
Temperature	Extreme High Temperatures	Days (per year) with Max Temp. >36°C (Current climate average = 0.1 days/year)	2	3
	High Temperatures	Occurrence of 10 days/year with Temp. >30°C. (Current climate average = 8.7 days/year)	4	5
	Seasonal temperature variations	Heating and cooling degree days (Current climate: cooling 293 days)	4	5
Precipitation	Short duration - High Intensity rainfall	50mm in 30 minutes: Corresponds approximately to a 1:100 year event Type of rainfall that has caused localized flooding in the community – projected to occur more often (1:30 year event or less)	2	4
	Freezing rain	Estimated 15 mm causing local power line damage	3	4
	3 consecutive days of winter rain	Southern Ontario Threshold for weather warning causing flood of 25 mm Has occurred 26 times in last 30 years (St. Thomas station; 1 year missing data)	4	5
Winds	Exceeding 100 km/h	Damage to asphalt shingle roofs, trees and power lines 5 events with wind gusts > 100km/h in London (ON) between 1981 and 2010. Source Environment Canada[15]	3	4
	Tornado	40 Tornadoes on record within 50km of Oneida. Difficult to project whether the number and intensity of tornados will increase or decrease in the future	2	N/A

[15] http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=london&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=4789&dispBack=1

4.4 INFRASTRUCTURE SEVERITY SCORING

The following rating system was used for the assessment of the severity of impacts on the infrastructure should a selected climate event occur. Figure 28 below shows a photo of the Project Team having completed the Infrastructure Severity Scoring.

Figure 28. Photo to Project Team having completed the Infrastructure Severity Scoring table at Workshop 3 on November 16, 2017 (Photo by Guy Félio)

Table 9: Infrastructure Severity Scoring Developed by the Project Team

Score and Description	Consequence [Structural, Functional, Operations]
0 No effect	• No damage • Continues to perform as intended • Fully operational – normal
1 Insignificant	• Can be corrected through the regular maintenance cycle
2 Minor	• Requires sending repair crew • No replacement of asset necessary • May need further assessment
3 Moderate	• Needs attention • Requires sending repair crew • Needs replacement of components • Might need to order parts • Will need further assessment
4 Major	• Collapse/total loss of asset or components • Little or no impacts on other elements
5 Catastrophic	• Collapse • Total loss of equipment and service that requires full replacement of asset, several assets and major components • Will require relocating people/function • Impacts on other elements of asset or other assets • May have impacts on the public health and safety

4.5 RISK ASSESSMENT

This section of the report presents the infrastructure components that were evaluated, describes the risk screening process, summarizes the results of the risk assessment, and discusses the influence of the infrastructure condition on the risk assessment.

4.5.1 Infrastructure Components Evaluated

The infrastructure assets considered in this assessment were divided into components to evaluate the impacts from the selected climate events. Table 10 shows the detailed lists of assets/components.

The Green Lane landfill and adjacent communities' activities (agricultural areas bordering the Oneida Nation of the Thames community) were included in the list of infrastructure that can potentially be impacted by current or future weather extremes, which may result in impacts on the Oneida community. The Project Team understands these infrastructures are not controlled by the Oneida Nation, but felt including them in the assessment would be useful to initiate discussions with relevant stakeholders to address potential impacts on the community.

Table 10: Infrastructure Assessed

Seniors Complex (16 units) Building envelope Building structure Roof Foundations Heating/Cooling Fuel (propane) Access roads Backup generator Wastewater treatment **Quadplex** Building envelope Building structure Roof Foundations Heating/Cooling Fuel Roads Drainage Wastewater treatment (On-site)	**Duplex** Building envelope Building structure Roof Foundations Heating/Cooling Fuel Roads Drainage Wastewater treatment **Single family dwellings** Building envelope Building structure Roof (asphalt shingles) Roof (steel) Foundations Heating/Cooling Fuel Roads Drainage Wastewater treatment	**School** Building envelope Building structure Roof Roof equipment Foundations Heating/Cooling Fuel (propane) Access road Wastewater treatment **Services** Electricity Water Community Wastewater treatment Propane supplier Diesel supplier Operations personnel **Regional Landfill (Green Lane)** **Adjacent communities' activities** Agriculture drainage

4.5.2 Risk Screening Process

The first step in the production of the risk matrix (steps illustrated in Figure 18) is to evaluate whether there is an interaction between an infrastructure component and a climate event, also referred to as establishing the exposure of the infrastructure to the climate hazards. Where an interaction exists, the Project Team identifies with respect to which infrastructure performance considerations the potential risk might exist (e.g. impacts on the structural capacity or the functionality of the asset or component) - see Section 4.2 of this report for a description of the infrastructure performance considerations selected for this study.

4.5.3 Summary of Risk Results

Table 11 presents a summary of the risk counts for the number of infrastructure-climate interactions in each risk threshold category (Moderate, and High). The table also presents the infrastructure assets or components affected, and the performance impacted if the risks occur. The general risk matrices created for this project consider infrastructure in a good state of repair, operating at the performance level for which it was designed. Finally, the risk summary only considers the infrastructure that is owned and maintained by the Oneida Council, or its supplier. The impacts of the Green Lane Landfill and adjacent lands' agricultural activities, and the risks associated with tornadoes are not included in the table.

The highest risks to the infrastructure and community identified by the study are:

1. **Observed and projected strong winds:** they impact asphalt shingle roofs, vinyl siding, tree branches and power lines. Strong winds have caused damages to different assets in the past and are projected to increase in intensity and frequency. These winds can also blow debris, light equipment or material in yards that is not tied down, creating risks of damage to property and safety concerns to people.

2. **Short duration, high intensity rainfall events:** the selected threshold (rainfall of 50mm in 30 minutes) has caused localized flooding in the community in the past. Projections show that this type of event will happen more often, and more intensely in the future. Short duration, high intensity rainfall can cause road flooding, overflowing of drainage ditches, carry debris that block culverts, flood septic beds, etc.

3. **Freezing rain:** freezing rain of 15mm or more is currently common in Oneida, and projected to occur more often. Direct damage to trees and power-lines can occur due to ice accumulation. Freezing rain can impact personnel travelling on foot or in vehicles, as well as the tools they use and the equipment they are sent to maintain or repair. Freezing rain requires immediate attention to ensure the safety of the public on roads, parking lots and entrances to public buildings.

The results show a slight increase in Moderate risks from current climate to the 2050s (54 to 57) but a substantial increase (16 to 37) in High risks. This is mainly due to projected future increases in the number of days with temperatures greater than 36ºC, the change in seasonal temperatures (increased cooling requirements), and the rise in rainfall events (short duration/high intensity and consecutive days with rain).

Table 11: Summary of Moderate and High Risks

Risk Score Counts			Main Climate Events	Principal Infrastructure Affected
Risk Threshold Category	**Current Climate**	**Future (2050s) Climate**		
Moderate	54	57	• Maximum temperatures and seasonal changes • Freezing rain • Precipitation (Rain) – short duration/high intensity • Strong winds (> 100 km/h)	• Heating and cooling systems in buildings • Operations personnel • Buildings (envelope, roof, surface and external equipment) • Third party services (electricity, fuel suppliers) • Access roads and drainage • On-site sewage treatment • Roofs and roof mounted equipment • Trees and power lines • Buildings (envelope and structure)
High	16	37	• Maximum temperatures and seasonal changes • Freezing rain • Precipitation (Rain) – short duration/high intensity • Precipitation (Winter rain) • Strong winds (> 100 km/h)	• Heating and cooling systems in buildings • Operations personnel • Buildings (envelope, roof, surface and external equipment) • Third party services (electricity, fuel suppliers) • Access roads and drainage • On-site sewage treatment • Access roads and drainage • On-site sewage treatment • Roofs and roof mounted equipment • Trees and power lines • Buildings (envelope and structure)

4.6 COMMUNITY IMPACTS FROM INFRASTRUCTURE RISKS

Infrastructure loss of performance or function affects the whole community. Resilient infrastructure is necessary to provide resilient services that, in turn, contribute to the resilience of the community. The community impacts selected for this study are as follows:

1. **Emergency response services** can be impacted in following manners:
    a. Increased demand due to higher number of emergencies or broad area covered by the event;
    b. Impacts to the facilities, equipment and personnel that are used to provide emergency services; and
    c. Loss of functionality of roads or other routes to access the locations where emergencies occur
2. **Insurance and legal impacts** may result from a failure in the services or damages from the collapse of public assets. For example: basement flooding due to loss of stormwater system capacity; fallen public trees on private property; failure of wastewater systems resulting in temporary facilities' closures or environmental damage; etc.
3. **Policy considerations** relate to the processes, procedures and guidelines that affect the performance of the infrastructure in providing services. As indicated in the previous section, maintaining and operating the infrastructure in a state of good repair and re-capitalizing the assets in a timely manner can be part of a risk mitigation strategy.
4. **Social and cultural effects** result from the loss of services provided by the infrastructure. In the particular case of water and wastewater services, the impacts are multiple and varied, and can range from mere inconvenience to health and safety issues. These will compound to the hardships experienced by the community in the event of extreme climate events.
5. **Environmental impacts** may result in short or long-term stress to the community, for example, in the event of the loss of key environmental features on a temporary or permanent basis.
6. **Financial impacts** may redirect resources from other planned investments or priority areas in the community. With limited sources of funding available, the Oneida Council may have to take extraordinary measures to address its financial situation. This could be in the form, for example, of lowering levels of services.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Infrastructure in a community exists to provide a service. Since many of the components or assets within infrastructure systems have long service lives, there are many opportunities to introduce climate change adaptation measures throughout this life-cycle.

The housing assets, school and infrastructure that provides services of the Oneida Nation of the Thames are generally well maintained and provide safe services to the community; details are beyond the scope of this assessment but can be found in past recent inspection reports. The Oneida Council, under budget pressures, has managed to maintain these assets in a state of good repair; the maintenance practices they have adopted and implemented have resulted in resilient infrastructure.

The Project Team identified adaptive and risk mitigation measures during Workshop 4. Since the intent of the study is to provide an overall risk profile of the assets owned and managed by the Oneida Council, the recommendations do not address specific infrastructure issues. The recommendations in Table 12 below are not listed in a priority order.

Tornadoes

The Oneida community is located in Southwest Ontario's "Tornado Alley" and there have been more than 40 tornadoes on record within a 50km radius of St Thomas. This type of devastating weather event has not affected the Oneida community; however, the Project Team discussed possible risk prevention and mitigation measures against tornadoes, as follows (please note some of these recommendations also apply to strong wind events):

1. Work with the local radio station to develop a tornado warning and alert system; this could also use social media and local mobile phone services.

2. Review the Community Emergency Plan, possibly updating it considering the results of this climate risks assessment. Communicate relevant sections of the Plan to affected departments and stakeholder.

3. Since 2015, the Oneida Council requires that all new residential construction use metal roofs – a measure that this climate risks assessment confirms has merit to protect community housing and other building assets. The Oneida Council is currently also considering making mandatory the use of hurricane ties[16] (straps) in new construction.

4. Property maintenance: ensure loose material is removed from areas around the assets, and that external light equipment susceptible to strong winds is tied-down. The Project Team suggested a Council Housing Policy for inspections of the properties every 2 years and creating a database to track potential hazards.

Adjacent Communities' Activities

Concerns regarding increased runoff and drainage discharges affecting the Oneida community were discussed throughout this climate risks assessment. Oneida staff mentioned the increase in outfall drainage pipe sizes from

[16] See related article: https://www.insuranceinstitute.ca/en/cipsociety/Articles/Items/2017/10/16/ICLR-researching-wind-damage-on-partiallybuilt-wood-framed-structures

neighbouring agricultural operations which they believe has two negative impacts on the community: 1) increase in potential deleterious substances into the Thames river, and 2) potential flooding of community lands.

Addressing climate risks associated with adjacent community lands and operations is beyond the scope of this assessment. However, in view of the projected increased in precipitation intensity in future climate, this study provides the opportunity to initiate discussions with stakeholders and authorities to mitigate these risks. A review of constructed drains[17] could be performed to establish if improvements can be made to protect the Oneida Nation of the Thames lands.

Green Lane Landfill

The concerns the Oneida Council has with the operations of the Landfill have historically been with odour and rodents (for example, see: https://www.cbc.ca/news/canada/london/green-lane-landfill-oneida-nation-smells-1.4567724). Assessing the climate risks at the Landfill and its potential impacts on the Oneida community was not part of the study. However, in view of the projected climate changes identified, this study provides the opportunity to initiate discussions with the Landfill owner and operator to identify and mitigate as required potential risks to the Oneida community.

Table 12. Risk Mitigation and Adaptation Measures recommendations

Climate Event	Risk Mitigation and Adaptation Measures
Maximum temperatures	Senior Citizens Complex • A/C is only provided in common areas (some tenants have their own A/C units in their quarters) – in the event of central A/C capacity problems, consider rotating cooling areas in the Complex. • Check and adjust as necessary, based on projected future climate, the capacity and specification of the A/C system at the time of retrofit or major repairs. • Inform residents about heat waves and extreme temperatures; prepare measures to help residents remain cool and hydrated. Housing units • Explore costs and benefits to install A/C in existing furnaces for projected future temperature increases. This would also improve the indoor air quality. • Develop a “Home Owners Manual” guide to educate and help tenants and property owners with best practices to deal with current extreme weather and project future climate extremes, for example: cleaning the propane exhaust pipes to prevent air quality issues in the house. Other infrastructure • Water demand during high temperature periods increases which may result in supply risks (for example, aquifer drawdown). Consider water conservation measures including a public education campaign on the importance of conserving water during these periods. • Explore arrangements with neighbouring communities for emergency water supply in cases of low water supply. • Work with local and regional authorities, industry (for example, golf courses) and stakeholders to protect the raw water sources (river and aquifer) during periods of drought and high temperatures.

[17] See: http://www.omafra.gov.on.ca/english/landuse/gis/condrain.htm

Climate Event	Risk Mitigation and Adaptation Measures
Rain (short duration, high intensity)	Housing • Explore gravity-fed sump pumps in case of power failures. Communicate benefits to the public; explore working with suppliers. • Explore slab-on-grade construction to avoid basement flooding risks due to rain events and the high groundwater levels in the area. School (recommendations also applies to winter rain) • Maintain the drainage system of the flat roof free of debris. Inspect after each severe weather event. • Assess the capacity of the roof drainage system based on the current severe and projected more intense future rainfall events. • Inspect and possibly replace the old septic system.
Rain (consecutive days of winter rain)	Drainage • Ensure drainage system (ditches, culverts) is clear of debris and performs at its design capacity. • Conduct a stormwater management study to assess the drainage system capacity under current and projected future climate conditions.
Freezing Rain	Buildings • Inspect after freezing rain events. • Clear debris and branches that can pose safety hazards. • Use environmentally friendly de-icing salts around the Senior Citizens complex, the school and administration buildings to reduce damage to concrete and other materials. Personnel: • Provide personnel with proper safety equipment. • Apply sand and salt in working areas. • Train/refresh training staff in safe operating practices. Third party services • Include potential loss of service in emergency planning. Back-up electricity • Ensure portable back-up generators are available for essential services in case of power failure. • Maintain backup generators including fuel conditioning to ensure service when required.
Wind	Buildings: • Continue requirement of metal roofs for new residential construction. • Implement policies to protect housing against strong wind events, such as requiring hurricane ties in all new construction.

Appendix A WORKSHOP PRESENTATIONS

Ontario First Nations Technical Services Corporation

Climate Change Vulnerability Assessment of the Oneida Housing Assets and Infrastructure

Workshop 1 - Project Definition, Infrastructure Data, and Climate Considerations

Oneida Nation of the Thames

Thursday October 26, 2017

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Safety Moment

STOP & TALK: EXTREME WEATHER

Health, Safety, Security and Environment

From hail and heat waves, to thunderstorms and tornadoes, severe weather takes many different forms in the summer months. It is by knowing what to expect and how to prepare for it that you will be able to protect yourself, your family and your property from summer weather hazards.

Plan ahead:

- Choose the best shelter ahead of time and a meeting place to gather after the storm to ensure everyone is safe and accounted for
- Put together the proper emergency preparedness kit

Take shelter:

- When there are high winds that could result in a severe thunderstorm or tornado, your first priority is to take shelter, close all windows and doors, and secure loose outdoor objects or move them inside
- Go to the basement or to a small interior room in the centre of the house (such as a closet, bathroom, or hallway) on the lowest floor
- If this is not an option, take cover under a stairway or sturdy table and use a cushion or mattress to protect your head
- Stay away from all windows, doors, and exterior walls, in particular those facing the storm, and avoid buildings with large, unsupported roofs such as arenas, supermarkets, and barns

If you have questions, please contact your supervisor, Office Safety and Environment Coordinator (OSEC), or local HSSE representative

HSSE Stop & Talk are written for educational purposes and are not intended to replace safe work practices or procedures.
ver. July 2017

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Workshop #1 - Project Definition, Infrastructure Data and Climate Considerations

Ontario First Nations Technical Services Corporation

The workshop is intended to provide:

- An overview to the First Nations PIEVC vulnerability assessment process
- Description of the housing assets and related infrastructure in the community and past weather related performance issues and concerns
- Definition of the global project parameters and boundary conditions for the vulnerability assessment.
  - Which assets and infrastructure is being assessed;
  - Locations;
  - General climatic, geographic considerations; and
  - Uses of the infrastructure.
- Roles and responsibilities of the team members.
- Identify participants for the Project Advisory Committee
- Next steps

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Workshop #1 - Agenda

Ontario First Nations Technical Services Corporation

Time	Description	
9:30am – 9:45am	Welcome and introductions	Oneida Nation of the Thames and OFNTSC
9:45am – 10:45am	Description of the FN PIEVC vulnerability assessment process	Stantec
10:45am – 11:00am	Health break	
11:00am – 12:00am	Description of Oneida housing assets and related infrastructure and WW	Oneida Nation of the Thames
12:00pm – 12:30pm	Discussion: current / future housing assets and related infrastructure concerns	All participants
12:30pm – 1:15pm	Lunch	

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Ontario First Nations Technical Services Corporation

Workshop #1 - Agenda

Time	Description	
1:15pm – 2:15pm	Facilitated discussion: selection of the assets and related infrastructure for vulnerability assessment	All participants
2:15pm – 3:15pm	Presentation on climate trends and future climate projections	Stantec
3:15pm – 3:30pm	Health Break	
3:30pm – 4:15pm	Discussion: past climate events that have caused disruptions or damage to the housing assets and related infrastructure	All participants
4:15pm – 4:45pm	Roles and responsibilities of the team members Next steps.	
4:45pm	Adjourn	

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Mohawk Council of Akwesasne

Canada

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OCCIAR Ontario Centre for Climate Impacts and Adaptation Resources

Project Objectives

Moose Cree First Nation

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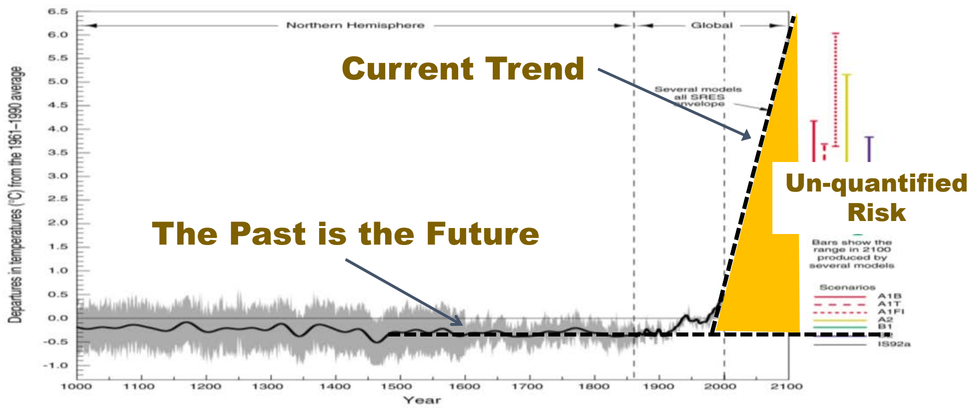
- **Phase 1:** Vulnerability to climate change assessment of the W/WW infrastructure at Akwesasne (completed)
- **Phase 2a:** Development of draft FN PIEVC/Asset Management (AM) toolkit (current)
- **Phase 2b:** Pilot testing draft FN PIEVC/AM Toolkit (Fall 2017):
  - Moose Cree FN (W/WW infrastructure – Moose Factory)
  - Oneida Nation of the Thames (Housing)
- **Phase 2c:** Revise FN PIEVC/AM Toolkit; develop training material; offer training at 2 locations in Southern and Northern Ontario (Early 2018)
- **Phase 3 (to be confirmed):** deployment of FN PIEVC/AM Toolkit to other First Nations in Canada

Climate Change Risks Assessment Methodology

Infrastructure Vulnerability to CC

From planning, design, operations and maintenance …



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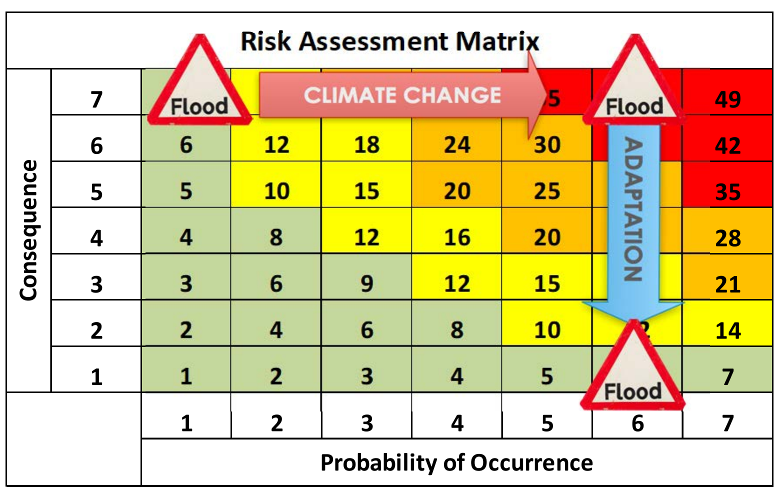

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Public Infrastructure Engineering Vulnerability Committee (PIEVC)

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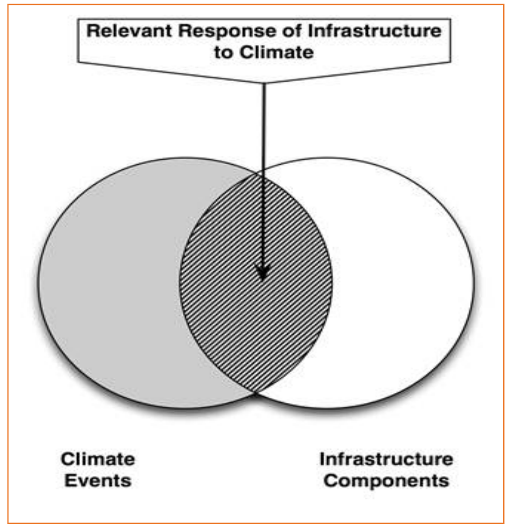
Ontario First Nations Technical Services Corporation

The PIEVC Protocol

- Five step evaluation process
- A tool derived from standard risk management methodologies
- Intended for use by qualified engineering professionals
- Requires contributions from those with pertinent local knowledge and experience
- Focused on the principles of vulnerability and resiliency



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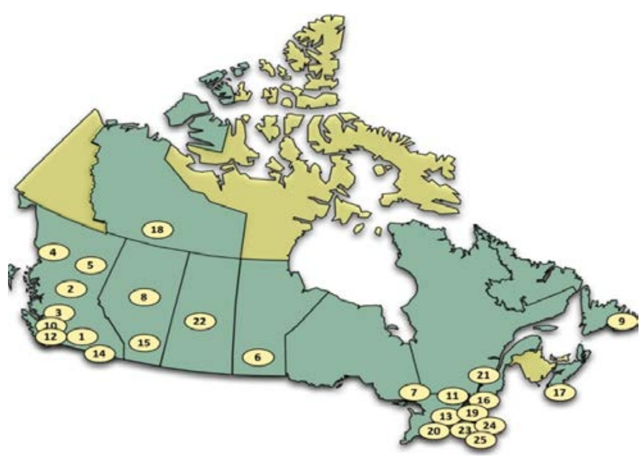
Public Infrastructure Engineering Vulnerability Committee (PIEVC)

Not a theoretical methodology

Has been or currently applied to 45+ projects in Canada:

- Water resources systems
- Storm & waste water systems
- Roads & bridges
- Buildings (residential, ICI)
- Urban transportation infrastructure
- Energy Infrastructure
- Airport infrastructure
- Hospital
- Three projects in central America



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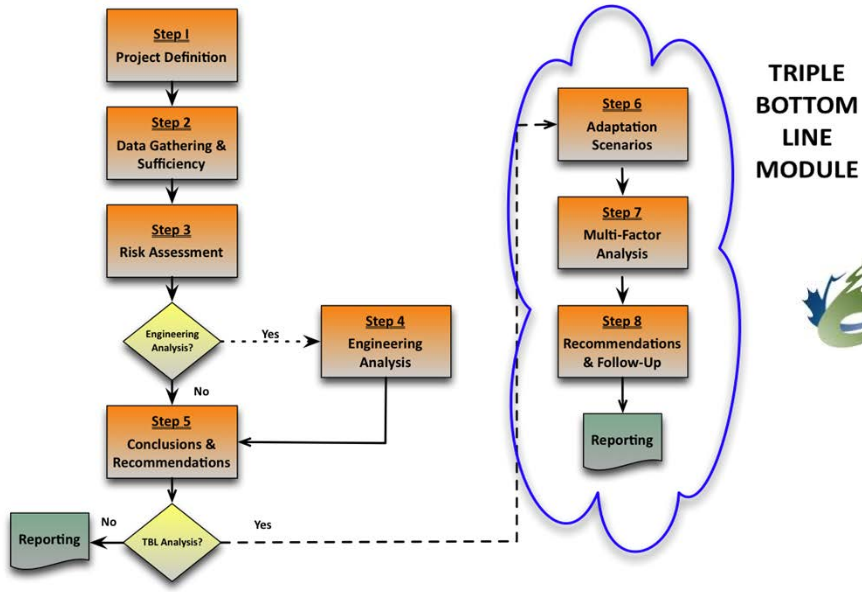
General description of the PIEVC process



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Mohawk Council of Akwesasne

Phase 1 - PIEVC Protocol Vulnerability Assessment of Akwesasne's W/WW Infrastructure

Funded by

Canada

Stantec

Ontario First Nations Technical Services Corporation

Mohawk Council of Akwesasne

Akwesasne W/WW Climate Change Vulnerability Assessment Objectives

- Identify **nature and severity of risks to components in a life-cycle context** – compatible with asset management plans
- **High level assessment of the predominant vulnerabilities** to climate change and optimize more detailed engineering analysis
- **Recommendations** for adjustments to design, operations and maintenance to maintain / improve levels of service
- Provide a **structured, documented approach** that ensures consistency and accountability.

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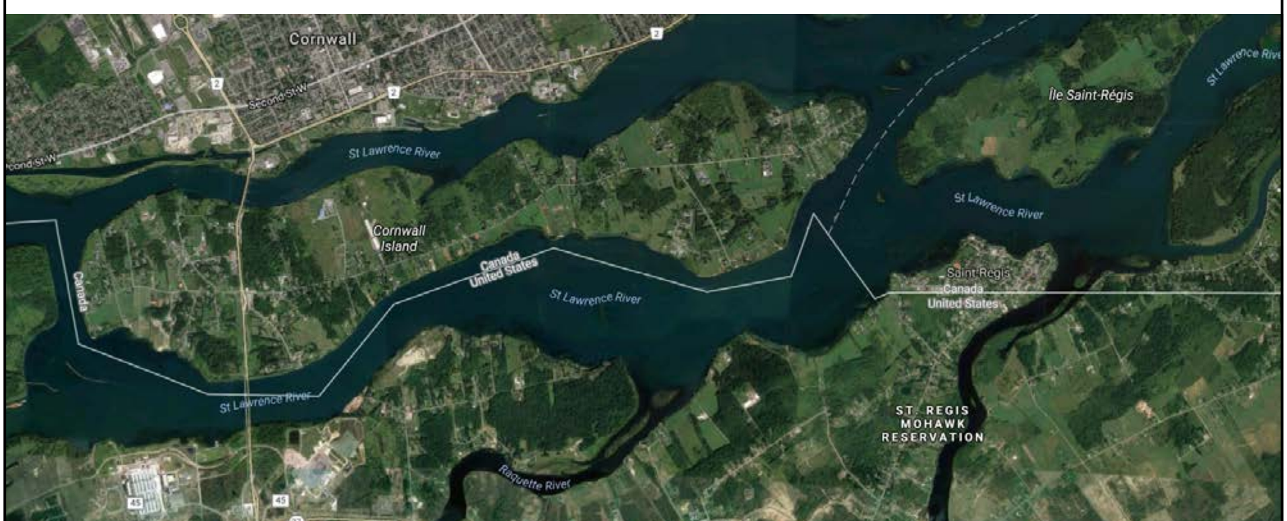

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Mohawk Council of Akwesasne

Project Team

Ontario First Nations Technical Services Corporation
- Elmer Lickers, Senior O&M Advisor (Project Director)
- Bill Maloney, Climate Change Officer

Mohawk Council of Akwesasne
- Jay Benedict, Director Technical Services
- Dr. Henry Lickers, Director Environmental Services
- John Tate Lazore, W/WW Manager
- Leslie Papineau, Technical Project Manager

Consulting Team
- Dr. Guy Félio, Senior Advisor, Stantec (Project Manager)
- Amanda Lynch, Water Resources Engineer, Stantec
- Eric Dunford, Sustainability Consultant, Stantec
- Alexandre Mineault-Guitard, Environmental Engineering Intern, Stantec
- Heather Auld, Climatologist, RSI Inc

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Project Advisory Committee

- Stephanie Allen, OFNTSC
- Ashley Dawn Bach, COO
- Marla Desat, SCC
- Tom Duncan, INAC
- Al Douglas, OCCIAR
- Andréanne Ferland, FNQLSDI
- Caroline Larrivée, Ouranos
- David Lapp, Engineers Canada
- Jamie Ricci, Engineers Canada
- Jacqueline Richard, OCCIAR

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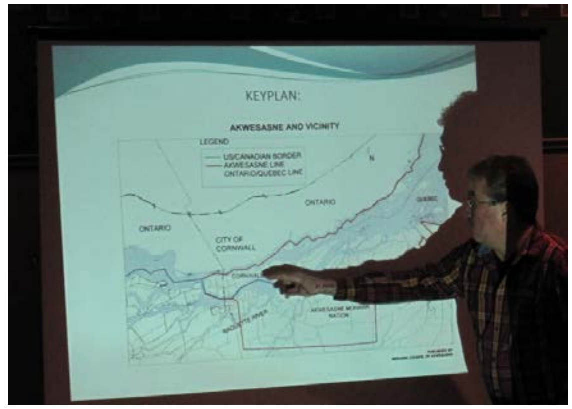
Project Definition - Infrastructure Components

- Three Districts
  - Cornwall Island
  - St. Regis
  - Snye
- All W/WW infrastructure in each district
- Infrastructure Information:
  - MCA Technical Services
  - ACRS and ICMS Data



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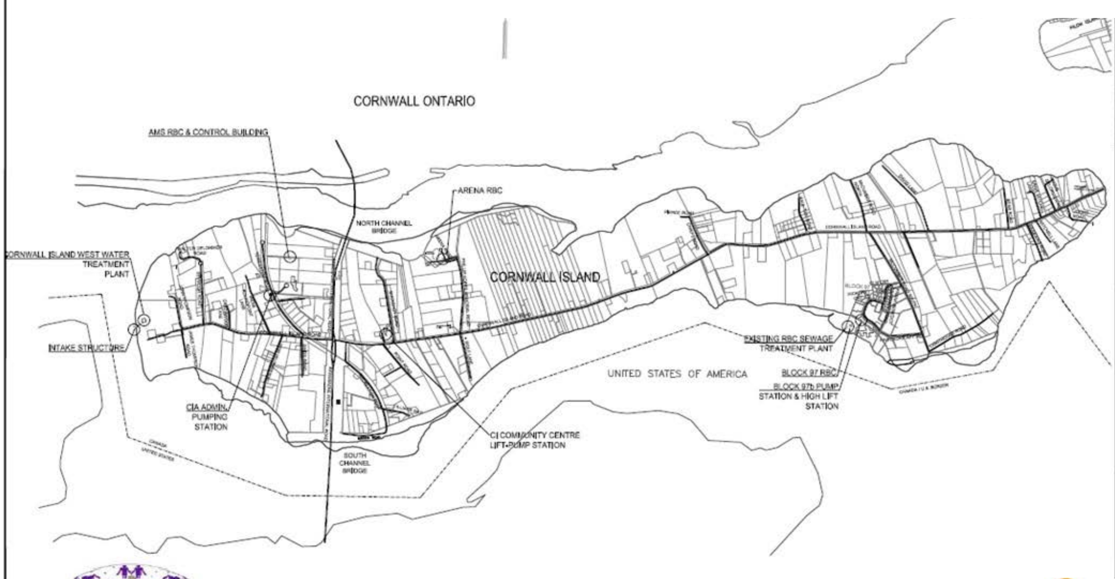

KEY PLAN : CORNWALL ISLAND, ONTARIO

FEBRUARY

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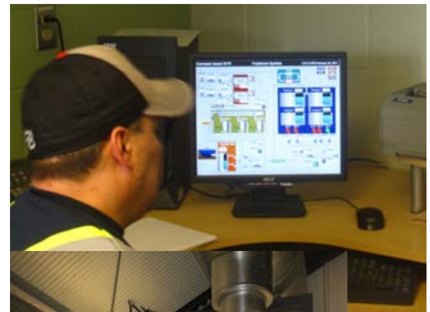

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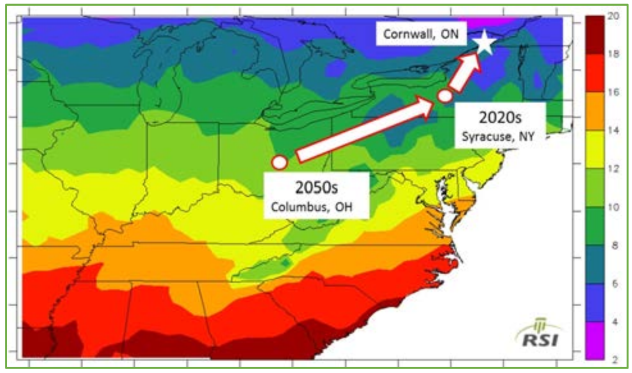
Climate Elements

- Sources of information:
  - Environment Canada – Cornwall Weather Station; Climate ID: 6101872
  - US National Oceanic and Atmospheric Administration
    - Massena (NY) Weather Station
    - Storm Events Data Base for St. Lawrence County (NY)
  - Ontario Tornado Watch



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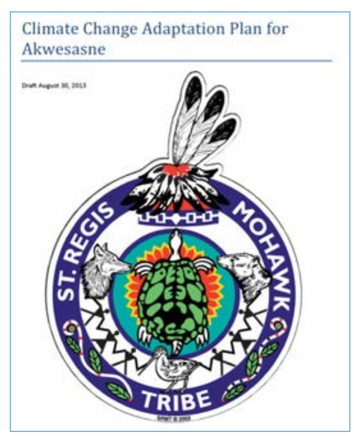
- Observed climate trends over the past few decades indicate a changing climate. Since 1970, trends that have been observed include **rising temperatures, more frequent hot days, longer growing seasons, less snowfall and more winter rain, reduced snowpack, and earlier ice and snowmelt resulting in earlier peak river flo**ws.
- At Akwesasne, the **drought of summer 2012** affected many of nature's cycles on all of creation. The changes came about in the way of hot and humid temperatures, high winds, heavy rainfall, hail, low water levels, and fish and wildlife reproductive cycles were out of sync. The downpour of rainfall, hail, and strong high winds destroyed gardens at a time when it was late to restart gardens to get a good crop. Some areas had 6 inches of hail in July. Thunderstorm warnings were also issued.


Climate Change Adaptation Plan for Akwesasne

Draft August 30, 2013

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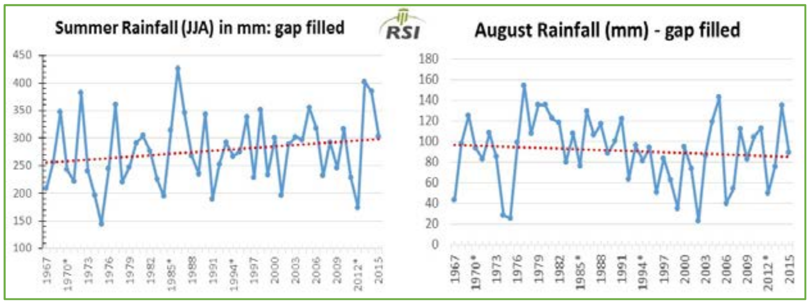

Type of Climate Element	Description	Comment
Fog	Visibilities below ½ statute mile	Reference impacts to shipping
Wind	Days with gusts > 90 kph	i.e., NBC 50 year return period design steady wind
	Days with gusts > 125 kph	i.e., NBC 50 year return period climatic design gust with wind gust factor applied
	Days with gusts > 140 kph	Massena A, 50 year return period wind gust
	Tornado frequency within 25 km radius	Only have data for Canadian territory. Probability 2x if considering US side
	Tornado frequency – within 50 km radius	Only have data for Canadian territory. Probability 2x if considering US side

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Ontario First Nations Technical Services Corporation

Mohawk Council of Akwesasne

Influence of Infrastructure Condition

Risk Rating	Future Climate Risk Score Counts Cornwall Island Infrastructure: Infrastructure replaced at end of design life	Future Climate Risk Score Counts Cornwall Island Infrastructure: Infrastructure deteriorated (not replaced)	Percentage change in risk count
Moderate	88	59	- 33%
High	135	143	+ 6%
Extreme	34	44	+29%

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Mohawk Council of Akwesasne

Some recommendations

- **Review and improve O&M practices and policies** as required. This could include inspection cycles, maintenance to maintain the performance of the assets, etc.
- **Install weather stations on Cornwall Island and in St. Regis** to ensure relevant local data. These stations should have the capability of hourly records, a gap in the data from the Cornwall station which only provides daily averages, thus missing short duration/high intensity events.
- **Ensure lightning protection** for sensitive equipment, particularly the SCADA systems.
- **Plan for reduced mobility** of operators and suppliers due to severe or extreme events, including warning, stock-piling, etc.

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Mohawk Council of Akwesasne

"The Protocol is straight forward but detailed. While the instruments of protocol look complicated, they could be utilized by many different peoples at various levels of understanding with a little assistance from a more knowledgeable expert.

As the protocol is used, it becomes apparent to the community that this will be very useful for evaluating the adaptability of the community infrastructure. It also helps to clarify gaps and shortcomings of the community infrastructure and processes."

Henry Lickers
Director, Environmental Services
Mohawk Council of Akwesasne

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Phase 2 - Development of the FN PIEVC/AM Toolkit

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Ontario Centre for Climate Impacts and Adaptation Resources

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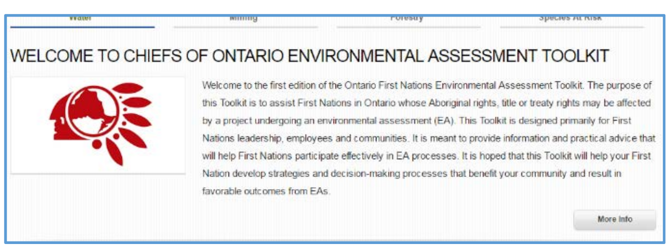
FN PIEVC/AM Toolkit

Ontario First Nations Technical Services Corporation

- Adapt the current PIEVC Protocol and develop a FN CC Vulnerability Assessment Toolkit
  - Link to asset management
  - Use local and existing resources (e.g., Elders' knowledge, ACRS and ICMS data, etc.)



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FN PIEVC/AM Toolkit Framework

Ontario First Nations Technical Services Corporation

- Work in progress
- Common elements to PSAB 3150 Asset Accounting requirements, Asset Management, and Risk Management:
  - Asset inventory
  - Condition
  - Service life/remaining life
  - Value of assets
- Considerations over the life-cycle of the asset

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TCA Reporting (PS 3150)	**Asset Management**	**Risk Management**
Inventory	Inventory	Inventory
Condition Assessment (Physical Condition)	Condition Assessment (Physical Condition, Capacity, Functionality)	Condition Assessment (Physical Condition, Capacity, Functionality)
Residual Life Prediction	Residual Life Prediction	Residual Life Prediction
Valuation (Historical)	Valuation (Replacement)	Valuation (Replacement)
	Analysis: Needs: Capacity, Physical Condition, O&M Cost-Benefit	Analysis: Threats Exposure Vulnerability Risks
	Life-cycle Management Plans Additions and Upgrades Replacement and Refurbishment Operations and Maintenance Risk Management	
TCA Report	Investment Plan (Capital, O&M)	Risk Management plan
	Monitor, Report, Revise	Monitor, Report, Revise

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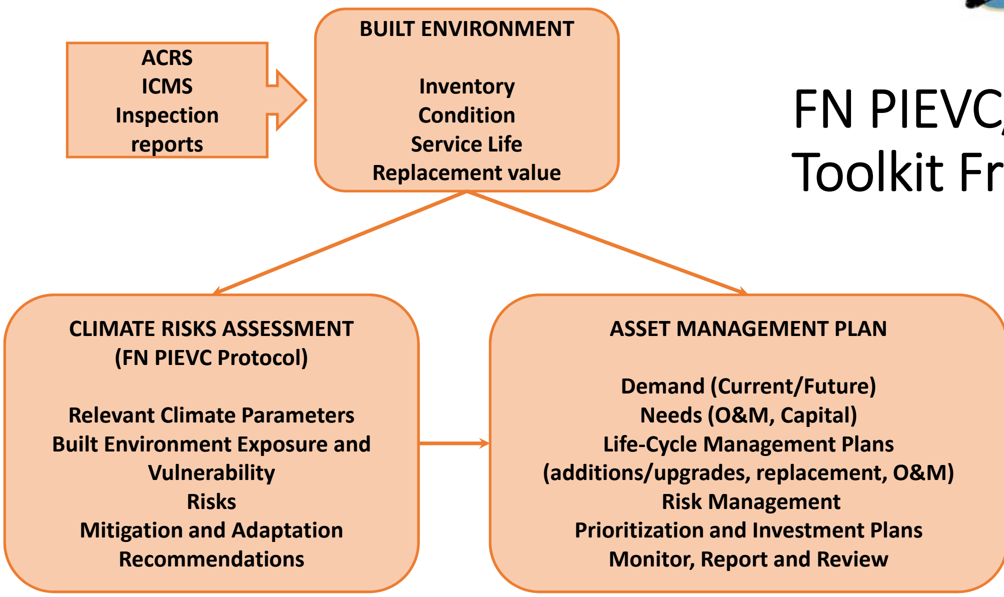
FN PIEVC/AM Toolkit Framework



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ONEIDA OF THE THAMES

Application of the Draft FN PIEVC/AM Toolkit:

Oneida Nation of the Thames
Housing Assets and Infrastructure

Funded by
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Process

Ontario First Nations Technical Services Corporation

- Work in progress
- Common elements to PSAB 3150 Asset Accounting requirements, Asset Management, and Risk Management:
  - Asset inventory
  - Condition
  - Service life/remaining life
  - Value of assets
- Considerations over the life-cycle of the asset

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Infrastructure Components	ACRS	Performance Considerations					Climate Elements																			
		Structural	Operational	Functionality	Environment (Land)	Environment (Water)	Temperature 5 consecutive days with temp. > 30 deg.				Temperature 10 consecutive days with temp. < -35 deg.				Blizzard > 50cm snow in 24 hour period				Rain 3 consecutive days with total rainfall of > 100mm				Climate event 5			
							Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Water Treatment Plant																										
- Building structure																										
- Building envelope																										
- Roof																										
- Foundations																										
- Process equipment																										
- HVAC system			✓	✓			Y				Y				N				N							
- SCADA																										
- Communications																										
- Electricity																										
- Site services																										
- Access road																										
- Third party supplies																										
Administration and Operations																										

Rating scales

Ontario First Nations Technical Services Corporation

Climate

Score	Probability Method A	Probability Method B
0	Negligible Not Applicable	< 1 in 1,000
1	Highly Unlikely Improbable	1 in 100
2	Remotely Possible	1 in 20
3	Possible Occasional	1 in 10
4	Somewhat Likely Normal	1 in 5
5	Likely Frequent	>1 in 2.5

Impacts on Infrastructure

Score	Descriptor	Provide Example
0	No Effect	
1	Insignificant	
2	Minor	
3	Moderate	
4	Major	
5	Catastrophic	

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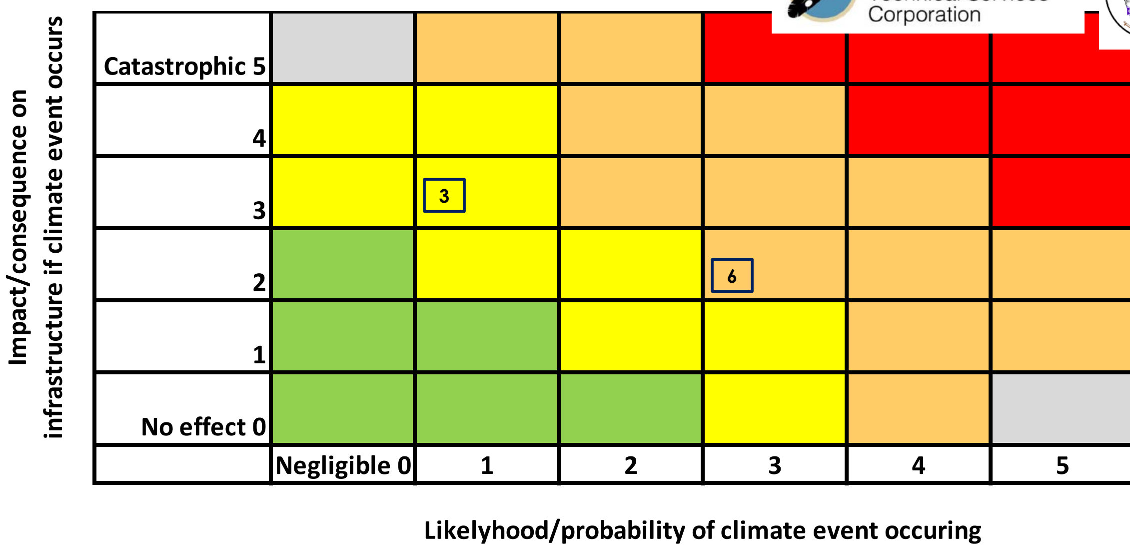
Infrastructure Components	ACRS	Performance Considerations					(Current) Climate Elements																			
		Structural	Operational	Functionality	Environment (Land)	Environment (Water)	Temperature 5 consecutive days with temp. > 30 deg.				Temperature 10 consecutive days with temp. < -30 deg.				Blizzard > 50cm snow in 24 hour period				Rain 3 consecutive days with total rainfall of > 100mm				Climate event 5			
							Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Water Treatment Plant																										
- Building structure																										
- Building envelope																										
- Roof																										
- Foundations																										
- Process equipment																										
- HVAC system			✓	✓			Y	1	3	3	Y	3	2	6	N				N							
- SCADA																										
- Communications																										
- Electricity																										
- Site services																										
- Access road																										
- Third party supplies																										
Administration and Operations																										

Current Climate

Ontario First Nations Technical Services Corporation



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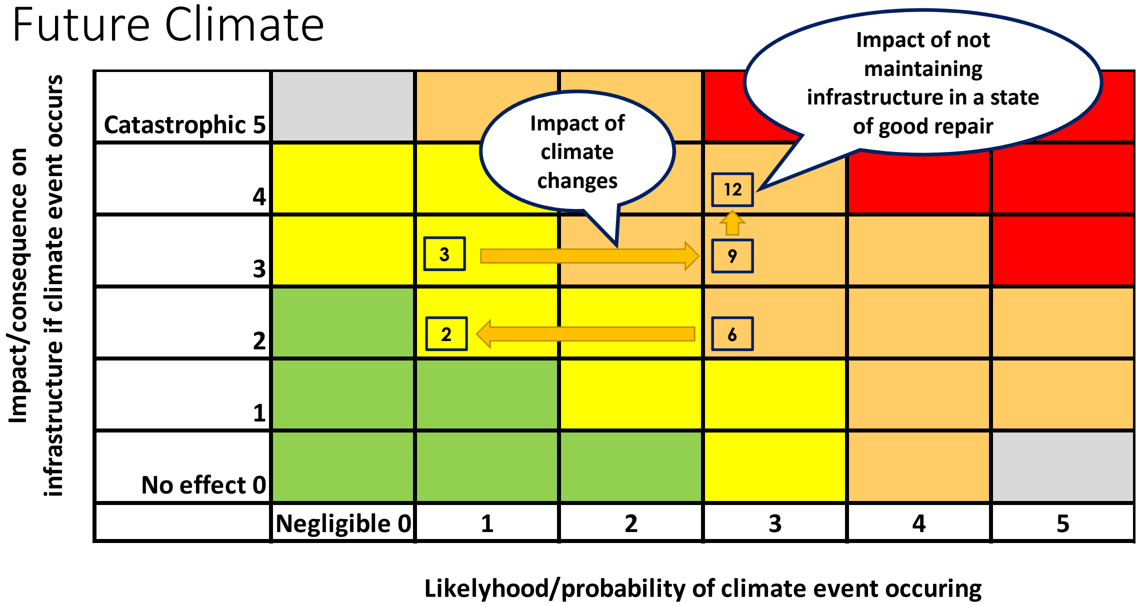
Infrastructure Components	ACRS	Performance Considerations					(Future) Climate Elements																			
		Structural	Operational	Functionality	Environment (Land)	Environment (Water)	Temperature 5 consecutive days with temp. > 30 deg.				Temperature 10 consecutive days with temp. < -30 deg.				Blizzard > 50cm snow in 24 hour period				Rain 3 consecutive days with total rainfall of > 100mm				Climate event 5			
							Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Water Treatment Plant																										
- Building structure																										
- Building envelope																										
- Roof																										
- Foundations																										
- Process equipment																										
- HVAC system			✓	✓			Y	3	3	9	Y	1	2	2	N				N							
- SCADA																										
- Communications																										
- Electricity																										
- Site services																										
- Access road																										
- Third party supplies																										
Administration and Operations																										

Future Climate



The FN PIEVC Risk Matrix

Infrastructure Components	Infrastructure Response Considerations: Structural Design	Functionality	Serviceability	Watershed, Surface Water & Groundwater	Operations, Maintenance & Materials Performance	Environmental Effects	Max. Daily Temp. – Days (per year) with Max Temps > 36°C: Y/N	P	S	R	Hotest Month (Aug.) Temp. – Very warm August Temps Mean >22.5°C (warmer than August 2012): Y/N	P	S	R
	Mark Relevant Responses with ✓													
Cornwall Island								5				6		
Water Supply System														
Water Treatment Plant														
Building structure	✓	✓	✓		✓									
Building envelope	✓	✓	✓		✓									
Roof	✓	✓	✓		✓									
Process equipment		✓	✓		✓									
HVAC system	✓	✓	✓		✓								3	18
Foundations	✓													
Site services	✓	✓	✓		✓	✓								
Storage and/or alternate use	✓	✓	✓		✓									
Access road	✓	✓	✓		✓									
Environment (plants, trees, animals)						✓							3	18
Environment (soil conditions)														
Backwater disposal	✓	✓	✓	✓	✓									
Biosolids/sludge disposal			✓		✓									
Communications / SCADA/Telemetry	✓	✓	✓		✓									
Back-up power (generator, fuel storage)	✓	✓	✓		✓									
WTP - High Lift Pumps	✓	✓	✓		✓									
WTP - Reservoir		✓												
WTP - Intake	✓	✓	✓		✓									
WTP - Low Lift Pump	✓	✓	✓		✓									

Infrastructure Components	Low Precipitation (Aug.) – Days with August total precipitation ≤ ~50mm (equal to or less than August 2012): Y/N	P	S	R	Combination - Aug. High Temp. with Low – Combination August Warm Temperatures & low rainfalls: Y/N	P	S	R	Fog – Fog visibilities below ½ statute mile (for shipping): Y/N	P	S	R	Rain - 7 day period – > 120 mm rainfall in 7 days: Y/N	P	S	R
Cornwall Island		5				4				3				3		
Water Supply System																
Water Treatment Plant																
Building structure																
Building envelope																
Roof																
Process equipment			4	20			5	20								
HVAC system							3	12								
Foundations															1	3
Site services																
Storage and/or alternate use															3	9
Access road																
Environment (plants, trees, animals)			5	25			6	24								
Environment (soil conditions)			2	10			3	12							3	9
Backwater disposal																
Biosolids/sludge disposal																
Communications / SCADA/Telemetry																
Back-up power (generator, fuel storage)																
WTP - High Lift Pumps																
WTP - Reservoir			5	25			5	20								
WTP - Intake																
WTP - Low Lift Pump																

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ONEIDA OF THE THAMES

Application of the Draft FN PIEVC/AM Toolkit: Oneida Nation of the Thames

Identify the Assets and Infrastructure to Assess

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ONEIDA OF THE THAMES

Application of the Draft FN PIEVC/AM Toolkit: Oneida Nation of the Thames

Climate Considerations – Weather Station Data and Projections

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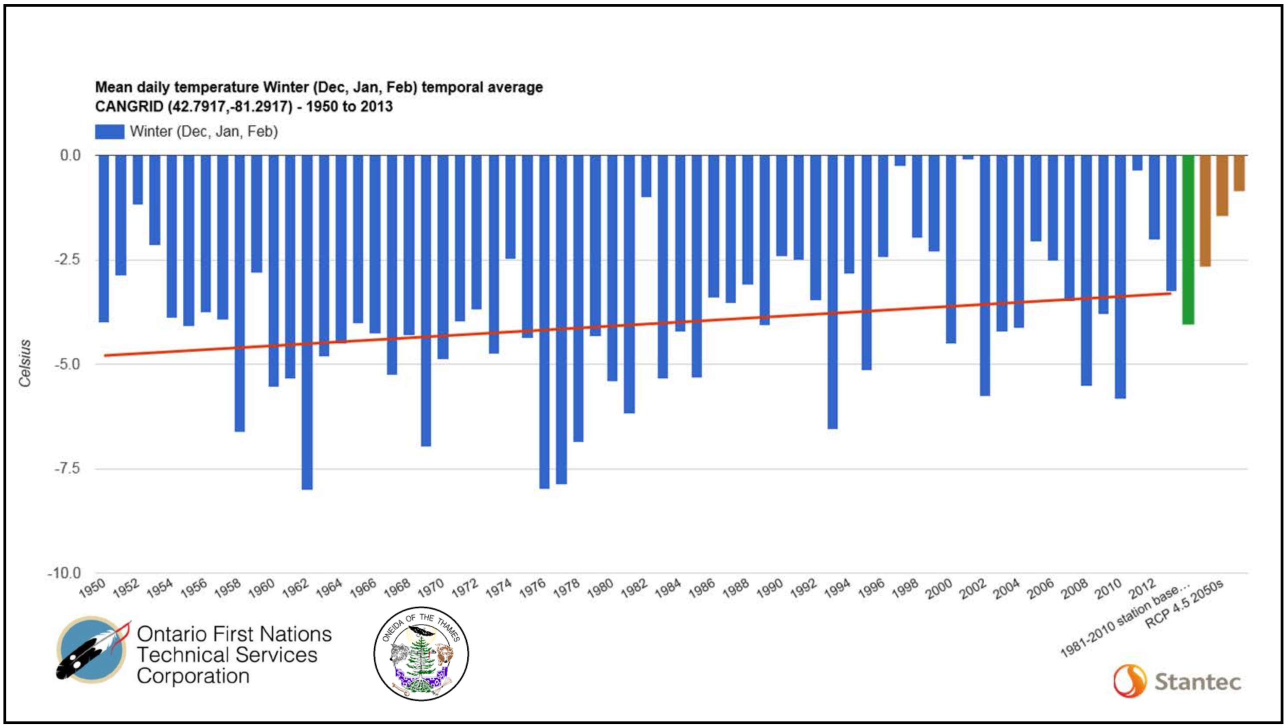
Mean daily temperature Winter (Dec, Jan, Feb) temporal average
CANGRID (42.7917,-81.2917) - 1950 to 2013
Winter (Dec, Jan, Feb)
Celsius
0.0
-2.5
-5.0
-7.5
-10.0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
1981-2010 station base...
RCP 4.5 2050s
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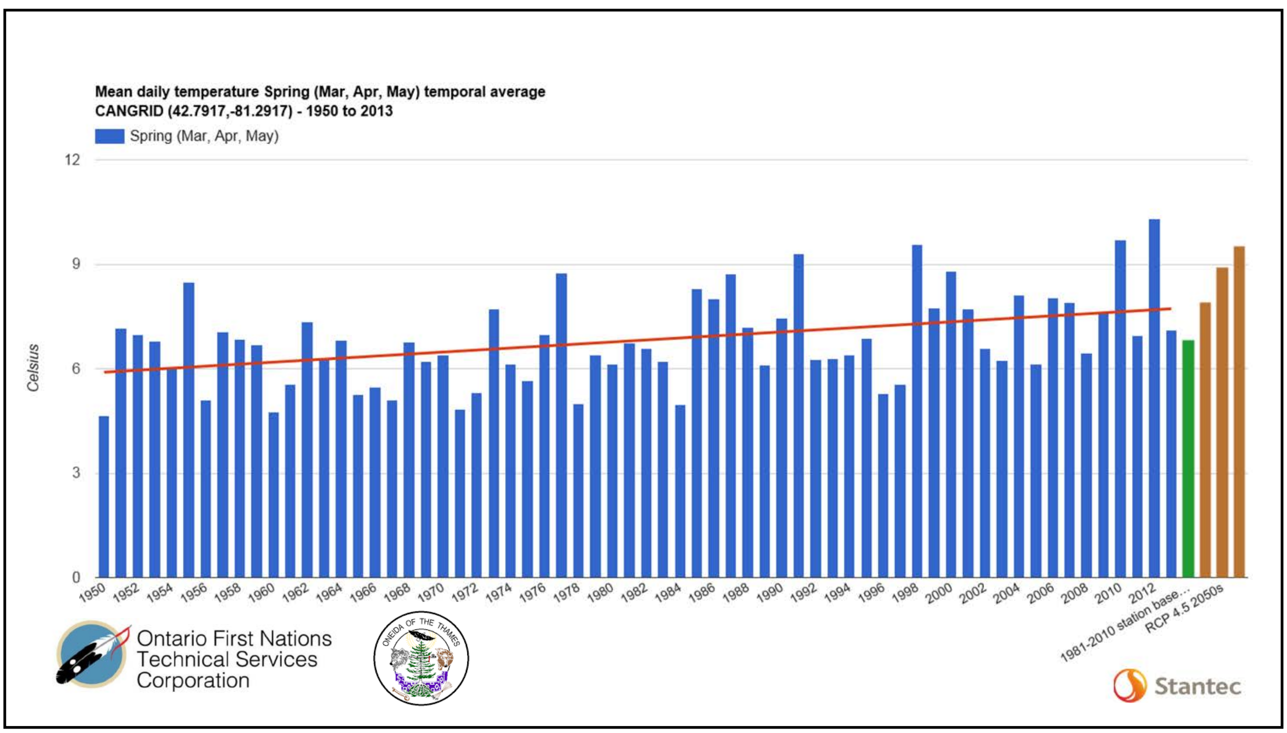
Mean daily temperature Spring (Mar, Apr, May) temporal average
CANGRID (42.7917,-81.2917) - 1950 to 2013
Spring (Mar, Apr, May)
Celsius
12
9
6
3
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
1981-2010 station base...
RCP 4.5 2050s
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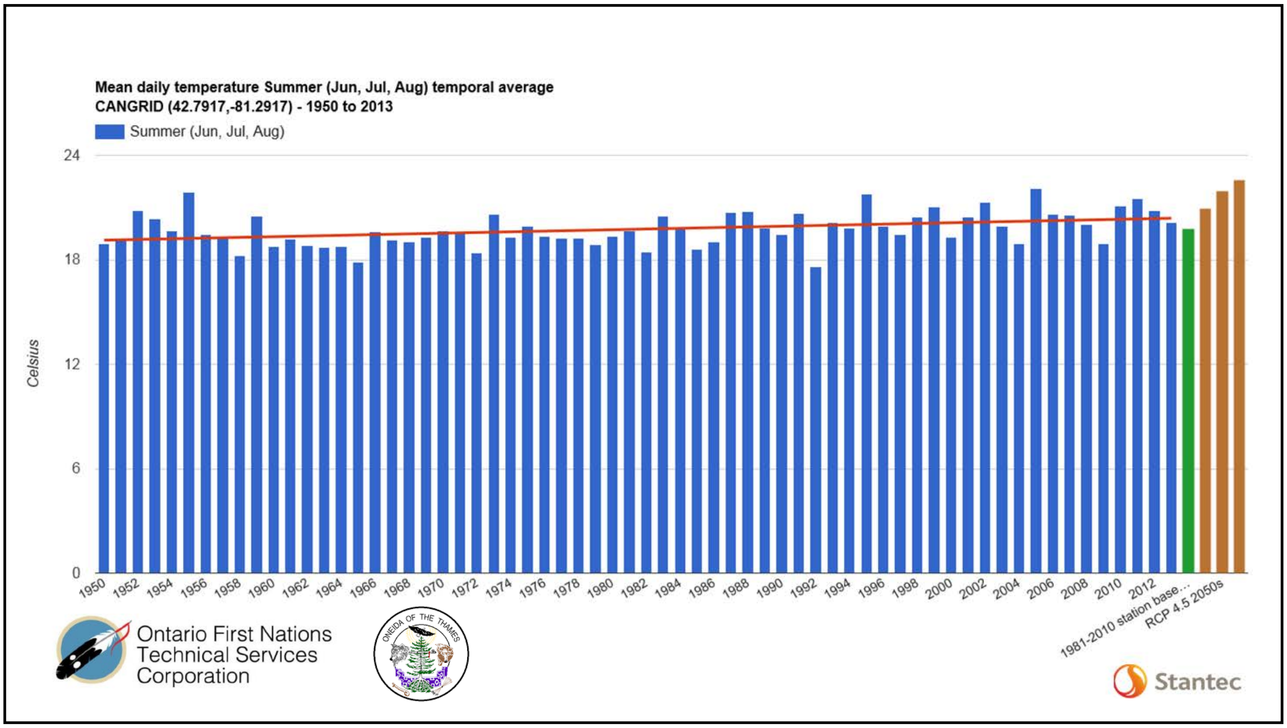
Mean daily temperature Summer (Jun, Jul, Aug) temporal average
CANGRID (42.7917,-81.2917) - 1950 to 2013
Summer (Jun, Jul, Aug)
Celsius
24
18
12
6
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
1981-2010 station base…
RCP 4.5 2050s
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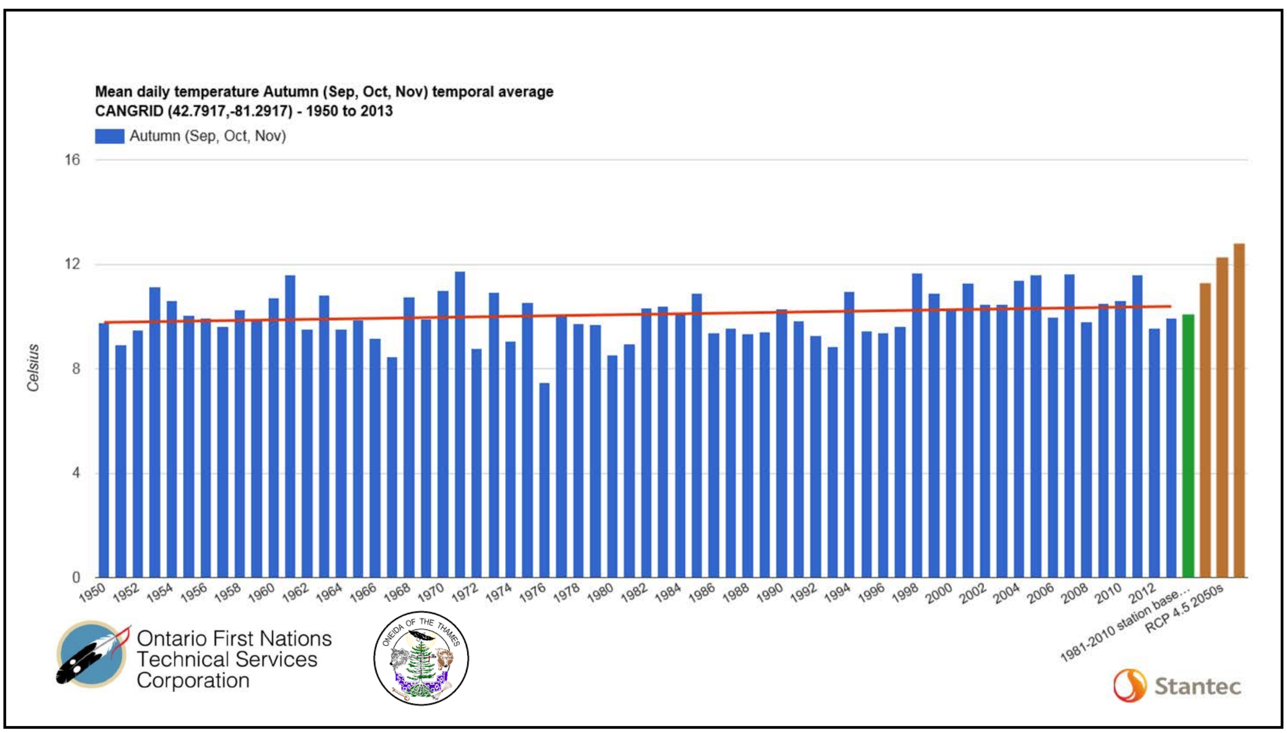
Mean daily temperature Autumn (Sep, Oct, Nov) temporal average
CANGRID (42.7917,-81.2917) - 1950 to 2013
Autumn (Sep, Oct, Nov)
Celsius
16
12
8
4
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
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2012
1981-2010 station base…
RCP 4.5 2050s
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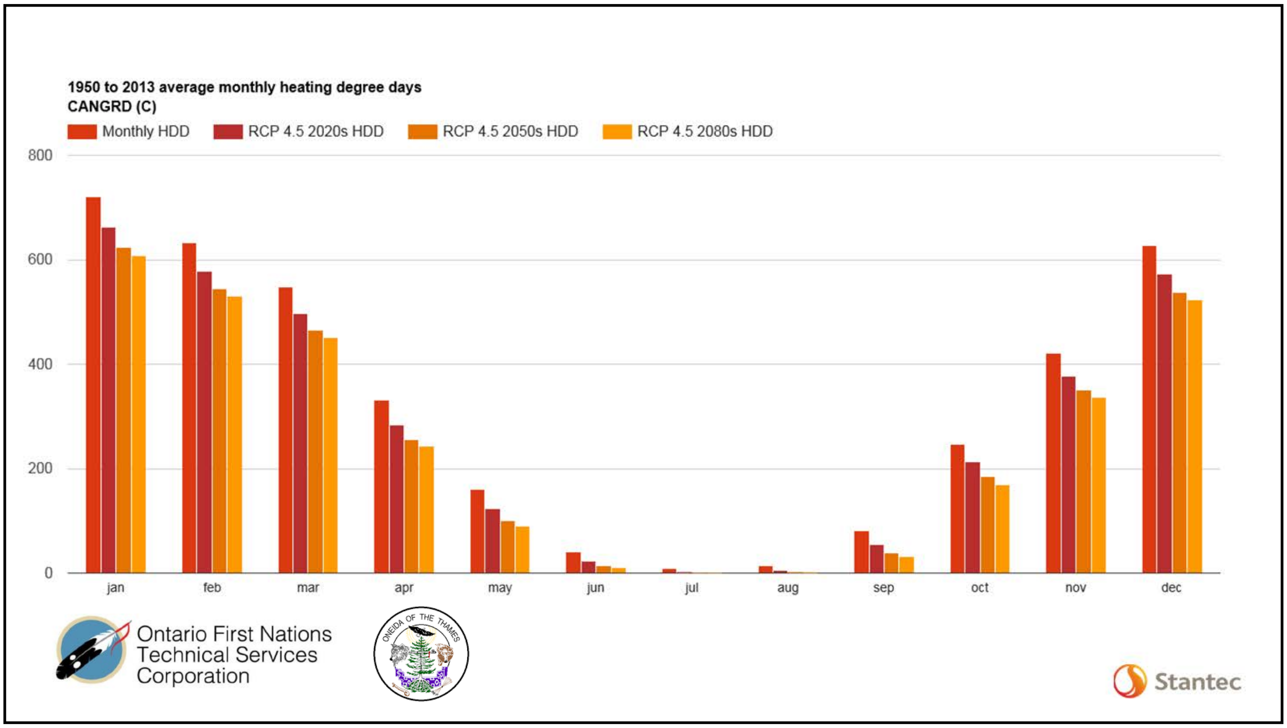
1950 to 2013 average monthly heating degree days
CANGRD (C)
Monthly HDD
RCP 4.5 2020s HDD
RCP 4.5 2050s HDD
RCP 4.5 2080s HDD
800
600
400
200
0
jan
feb
mar
apr
may
jun
jul
aug
sep
oct
nov
dec
Ontario First Nations Technical Services Corporation
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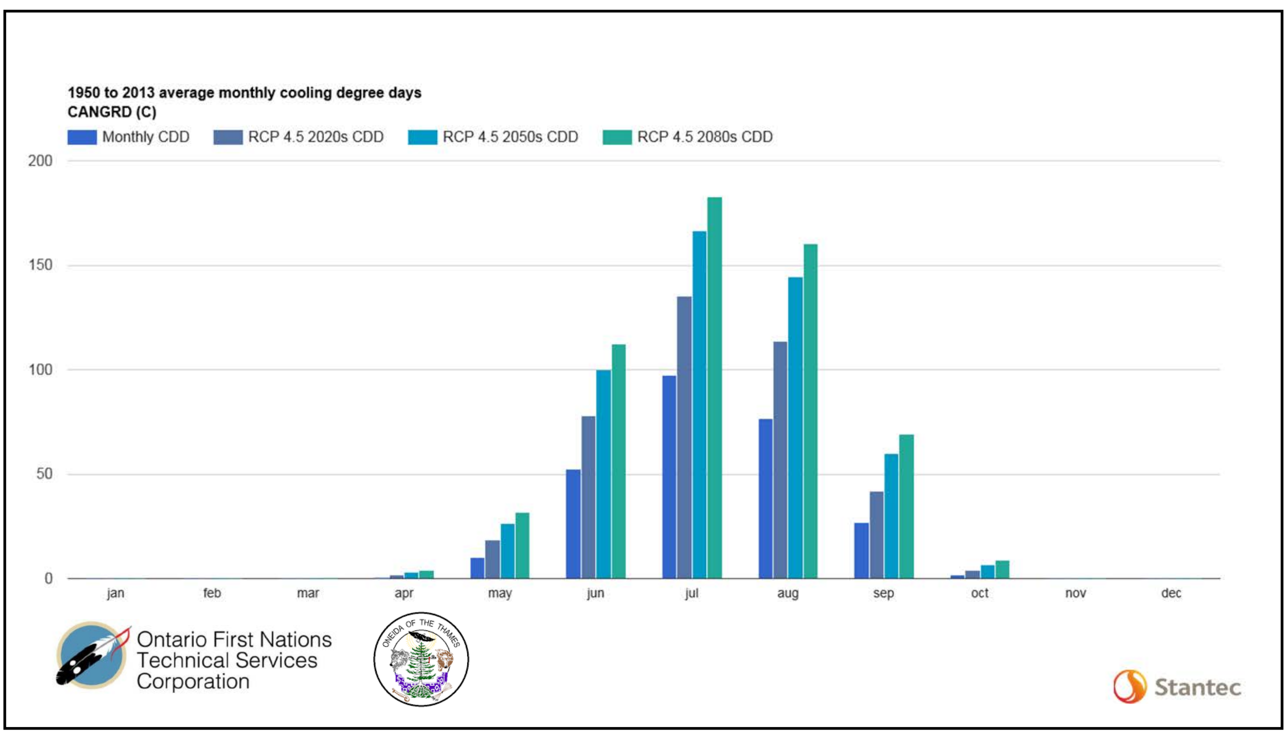
1950 to 2013 average monthly cooling degree days
CANGRD (C)
Monthly CDD
RCP 4.5 2020s CDD
RCP 4.5 2050s CDD
RCP 4.5 2080s CDD
200
150
100
50
0
jan
feb
mar
apr
may
jun
jul
aug
sep
oct
nov
dec
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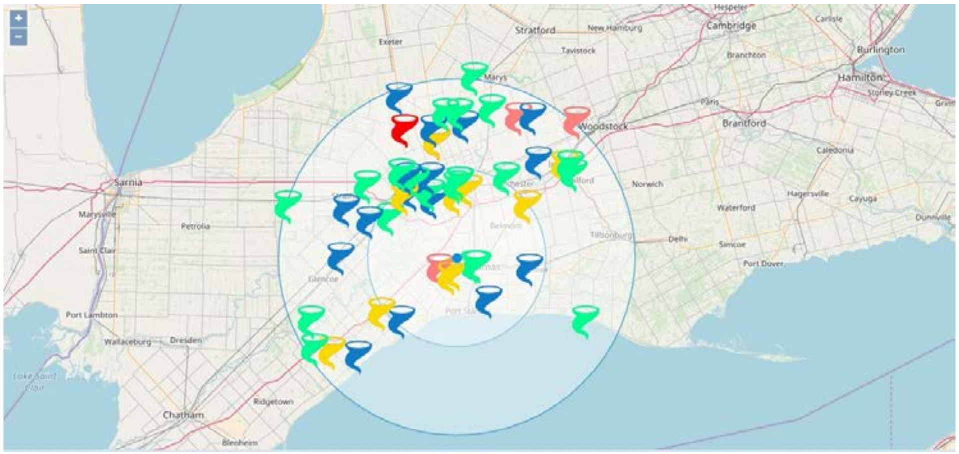

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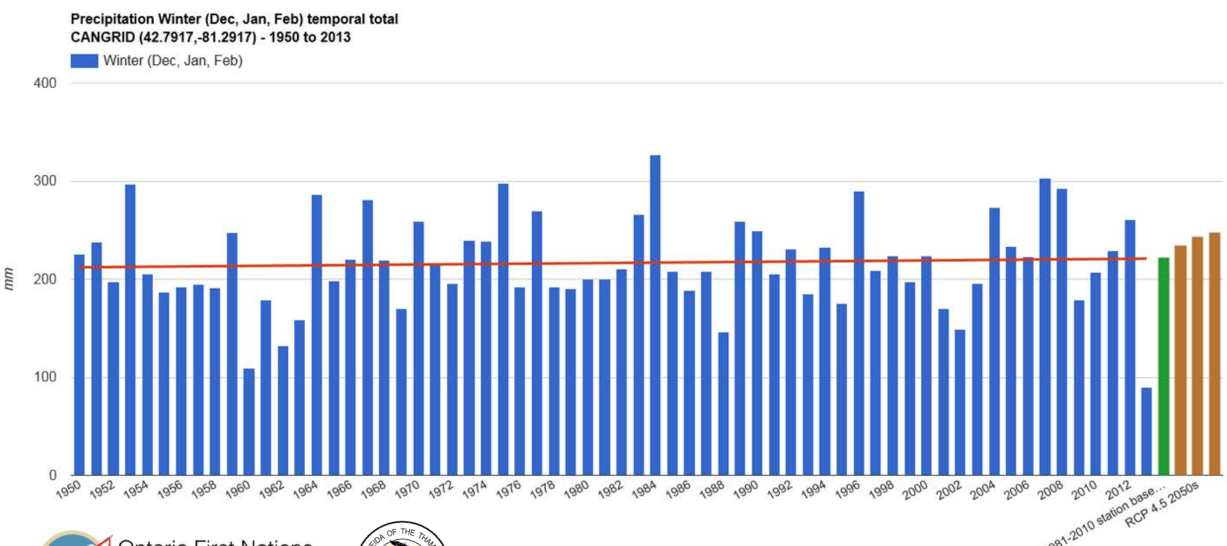

Ontario First Nations Technical Services Corporation

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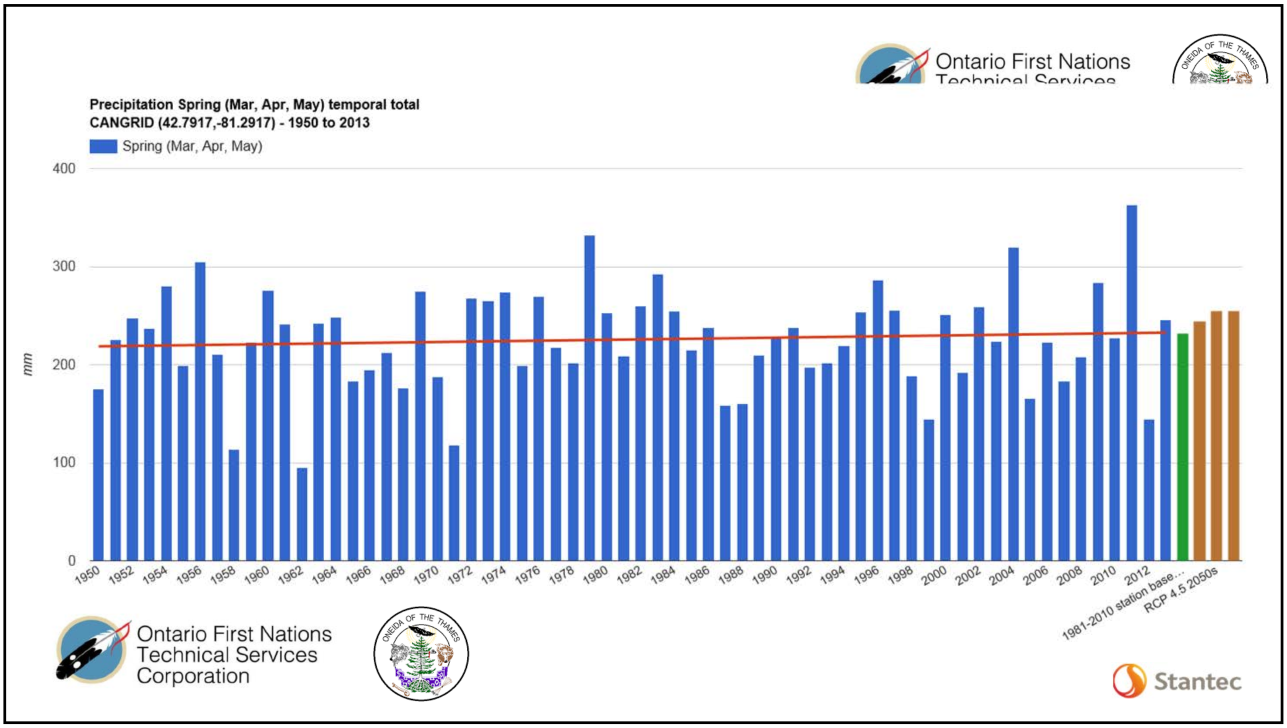

Ontario First Nations
Technical Services
Precipitation Spring (Mar, Apr, May) temporal total
CANGRID (42.7917,-81.2917) - 1950 to 2013
Spring (Mar, Apr, May)
mm
1981-2010 station base...
RCP 4.5 2050s
Ontario First Nations
Technical Services
Corporation
ONEIDA OF THE THAMES
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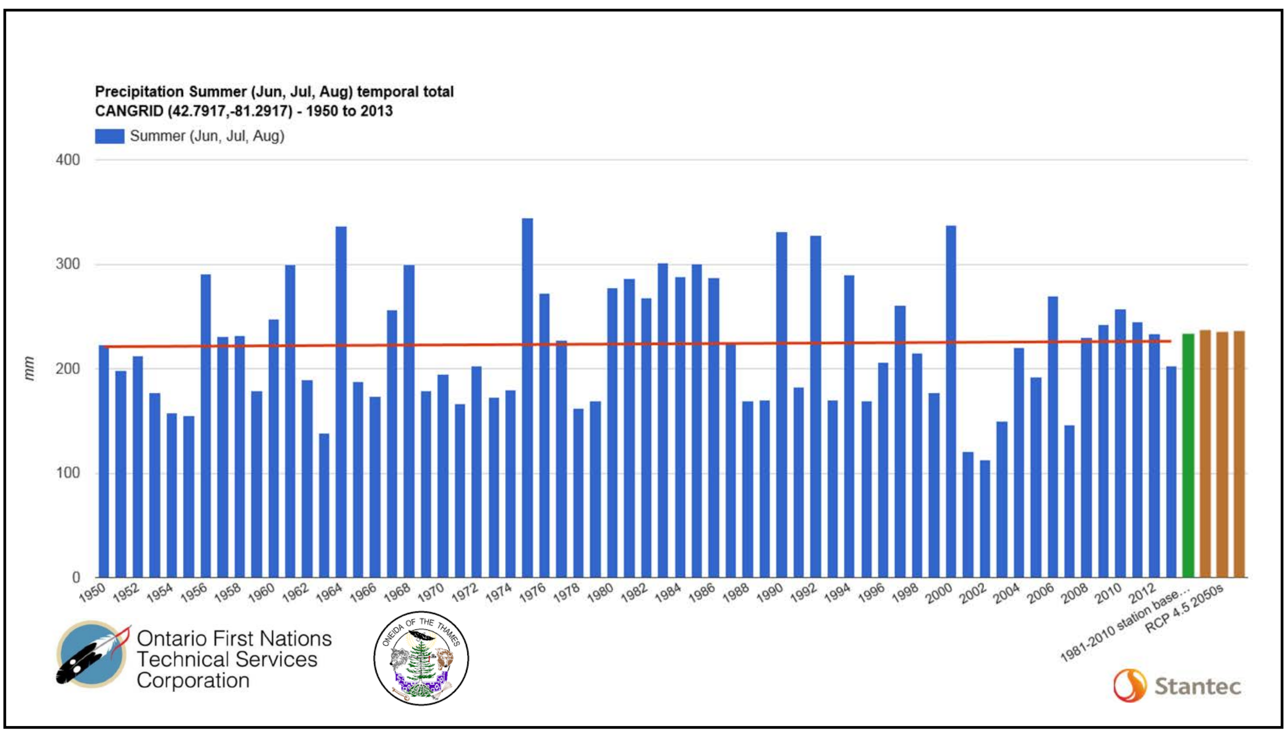

Precipitation Summer (Jun, Jul, Aug) temporal total
CANGRID (42.7917,-81.2917) - 1950 to 2013
Summer (Jun, Jul, Aug)
mm
1981-2010 station base...
RCP 4.5 2050s
Ontario First Nations
Technical Services
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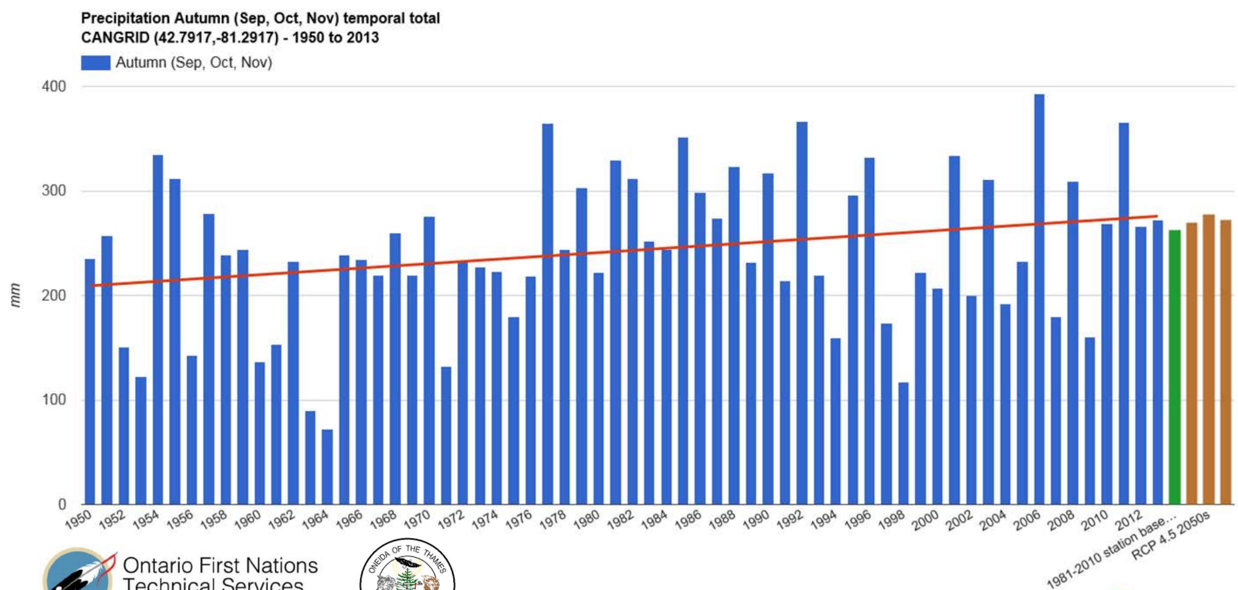

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Oneida of the Thames

Application of the Draft FN PIEVC/AM Toolkit: Oneida Nation of the Thames

Climate Considerations – Local Experience

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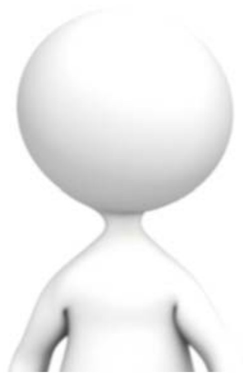

ELickers@OFNTSC.org

Guy.Felio@Stantec.com

Ontario First Nations Technical Services Corporation

ONEIDA OF THE THAMES

Climate Change Vulnerability Assessment of the Oneida Housing Assets and Infrastructure

Workshop 3 – Risk Assessment

Oneida Nation of the Thames

Thursday November 16, 2017

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Safety Moment

STOP & TALK: GET PREPARED

Health, Safety, Security and Environment

If a disaster occurs in your community, it may take emergency workers some time to get to you as they are helping others in need. That is why it is important to always be prepared to take care of yourself and your family for a minimum of 72 hours.

Things to have in your Emergency Preparedness Kit:

- Water(6L/l.5 gal. per person)
- Food that won't spoil(canned good, energy bars, etc.)
- Manual can opener
- Flashlight and batteries
- Battery powered radio
- Extra batteries
- First aid kit
- Cash
- Emergency plan and legal documents
- Special needs items (e.g., prescription medications, baby formula)
- Whistle
- Blankets
- Change of clothing
- Candles and matches or a lighter

If you have questions, please contact your supervisor, Office Safety and Environment Coordinator (OSEC), or local HSSE representative

HSSE Stop & Talk are written for educational purposes and are not intended to replace safe work practices or procedures.
ver. November 2017

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Workshop #3 - Project Risk Assessment

Ontario First Nations Technical Services Corporation

The workshop is intended to provide:

- Identification and validation of the climate parameters for the study
- Risk matrix: infrastructure-climate interactions
- Risk Matrix: climate probability ratings, severity of impacts scores and risk calculations
- Summary and next steps

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Workshop #3 - Agenda

Ontario First Nations Technical Services Corporation

Time	Description	
9:30am – 9:45am	Welcome and introductions	Oneida Nation of the Thames and OFNTSC
9:45am – 10:30am	Review of Workshop # 2 findings and PIEVC Protocol steps and discussion	Consultant
10:30am – 10:45am	Health break	
10:45am – 11:30am	Presentation of preliminary climate parameters and selection	Consultant; All
11:30am – 12:00noon	Risk matrix: infrastructure and climate interactions	All participants
12:00pm – 12:45pm	Lunch	
12:45pm – 3:30pm	Risk matrix: climate events' probabilities, severity rating and risk scores	All participants
3:30pm – 3:45pm	Review and next steps	Consultant
3:30pm	Adjourn	

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Ontario First Nations Technical Services Corporation

ONEIDA OF THE THAMES

Application of the Draft FN PIEVC/AM Toolkit:

Oneida Nation of the Thames
Housing Assets and Infrastructure

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Infrastructure Components	ACRS	Performance Considerations					Climate Elements																			
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Water Treatment Plant																										
- Building structure																										
- Building envelope																										
- Roof																										
- Foundations																										
- Process equipment																										
- HVAC system			✓	✓			Y				Y				N				N							
- SCADA																										
- Communications																										
- Electricity																										
- Site services																										
- Access road																										
- Third party supplies																										
Administration and Operations																										

Rating scales

Climate

Score	Probability Method A	Probability Method B
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Impacts on Infrastructure

Score	Descriptor	Provide Example
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3	Moderate	
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5	Catastrophic	

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Infrastructure Components	ACRS	Performance Considerations					(Current) Climate Elements																			
		Structural	Operational	Functionality	Environment (Land)	Environment (Water)	Temperature 5 consecutive days with temp. > 30 deg.				Temperature 10 consecutive days with temp. < -30 deg.				Blizzard > 50cm snow in 24 hour period				Rain 3 consecutive days with total rainfall of > 100mm				Climate event 5			
							Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Water Treatment Plant																										
- Building structure																										
- Building envelope																										
- Roof																										
- Foundations																										
- Process equipment																										
- HVAC system			✓	✓			Y	1	3	3	Y	3	2	6	N				N							
- SCADA																										
- Communications																										
- Electricity																										
- Site services																										
- Access road																										
- Third party supplies																										
Administration and Operations																										

Current Climate

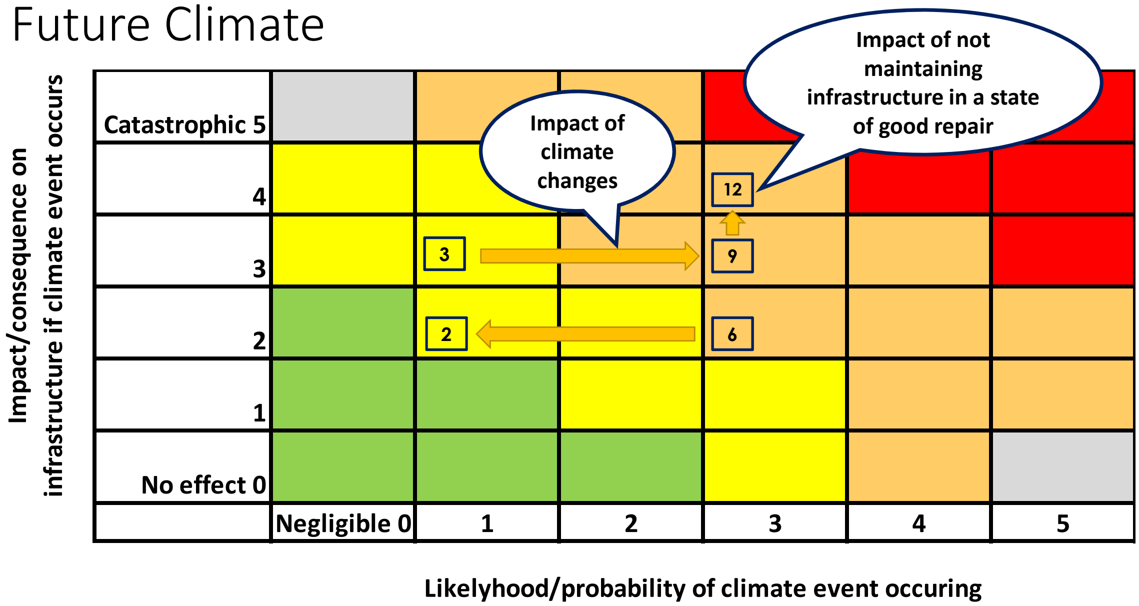
Impact/consequence on infrastructure if climate event occurs (rows) vs. Likelyhood/probability of climate event occuring (columns)

	Negligible 0	1	2	3	4	5
Catastrophic 5						
4						
3		3				
2				6		
1						
No effect 0						

Likelyhood/probability of climate event occuring

Infrastructure Components	ACRS	Performance Considerations					(Future) Climate Elements																			
		Structural	Operational	Functionality	Environment (Land)	Environment (Water)	Temperature 5 consecutive days with temp. > 30 deg.				Temperature 10 consecutive days with temp. < -30 deg.				Blizzard > 50cm snow in 24 hour period				Rain 3 consecutive days with total rainfall of > 100mm				Climate event 5			
							Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Water Treatment Plant																										
- Building structure																										
- Building envelope																										
- Roof																										
- Foundations																										
- Process equipment																										
- HVAC system			✓	✓			Y	3	3	9	Y	1	2	2	N				N							
- SCADA																										
- Communications																										
- Electricity																										
- Site services																										
- Access road																										
- Third party supplies																										
Administration and Operations																										

Future Climate



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ONEIDA OF THE THAMES

Application of the Draft FN PIEVC/AM Toolkit: Oneida Nation of the Thames

Assets and Infrastructure.
Performance Considerations

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Infrastructure Selected

Housing:

- Seniors Complex
- Quadplex
- Duplex

Single family homes

- Supporting Infrastructure
- Water
- Wastewater
- Roads




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1. Structural Capacity

With respect to the infrastructure or infrastructure component being assessed, climate loading may affect:

- Load carrying capacity
- Fracture / Collapse
- Fatigue
- Access
- Deflection / Permanent deformation
- Cracking and deterioration
- Foundations

2. Functionality

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With respect to the infrastructure or infrastructure component being assessed, climate loading may affect:

- Effective Capacity of the infrastructure to provide the intended service
  - Short term
  - Medium term
  - Long term

3. Operations

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With respect to the infrastructure or infrastructure component being assessed, climate loading may affect:

- Occupational safety
- Access to worksite
- Equipment performance
- Maintenance and replacement cycles
- Electricity demand
- Fuel use
- Materials Performance
- Changes from design expectation

4. Environment (Land)

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With respect to the infrastructure or infrastructure component being assessed, climate loading may affect:

- Vegetation cover
- Absorption properties
- Trees
- External elements (not attached to building)
- Erosion

5. Environment (Water)

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With respect to the infrastructure or infrastructure component being assessed, climate loading may affect:

- Erosion along streams, rivers, and ditches
- Erosion scour of associated or supporting earthworks
- Slope stability of embankments
- Sediment transport and sedimentation
- Channel realignment / meandering
- Water quality
- Water quantity
- Run off

6. Impacts from Neighbouring Communities

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[To be confirmed] With respect to the infrastructure or infrastructure component being assessed, climate loading may have impacts on neighbouring communities which may affect:

- Water source
- Drainage
- Regional Landfill
- Other

Confirm Rating scales

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Climate

Score	Probability	
	Method A	Method B
0	Negligible Not Applicable	< 1 in 1,000
1	Highly Unlikely Improbable	1 in 100
2	Remotely Possible	1 in 20
3	Possible Occasional	1 in 10
4	Somewhat Likely Normal	1 in 5
5	Likely Frequent	>1 in 2.5

Impacts on Infrastructure

Score	Descriptor	Provide Example
0	No Effect	
1	Insignificant	
2	Minor	
3	Moderate	
4	Major	
5	Catastrophic	

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Application of the Draft FN PIEVC/AM Toolkit: Oneida Nation of the Thames

Climate Considerations – Weather Station Data and Projections

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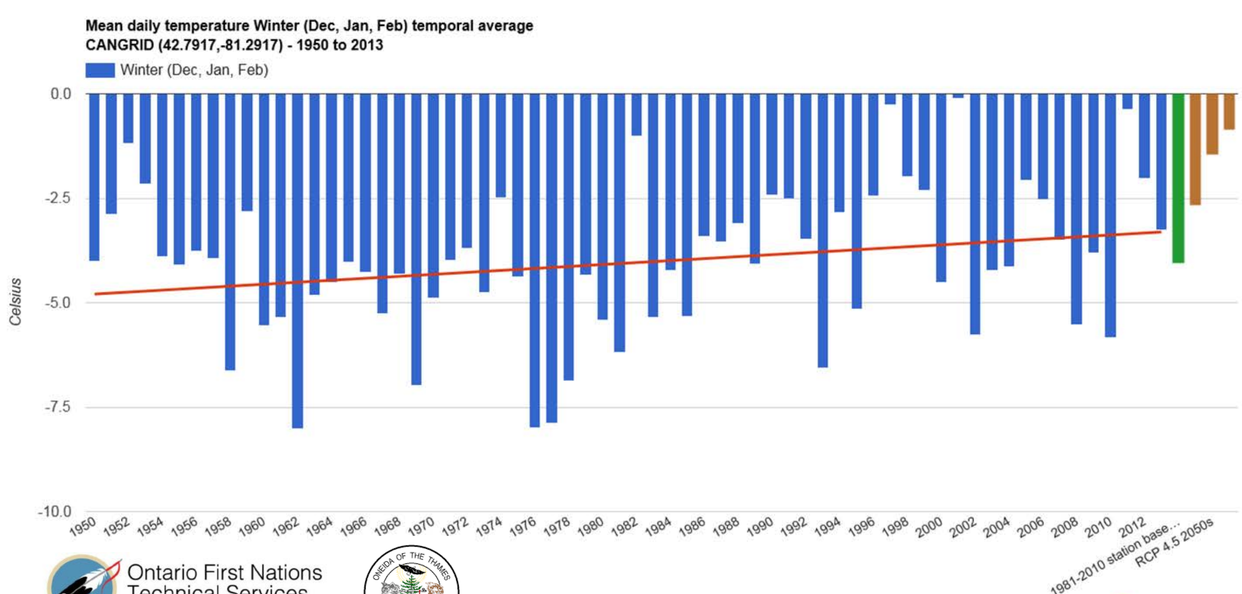

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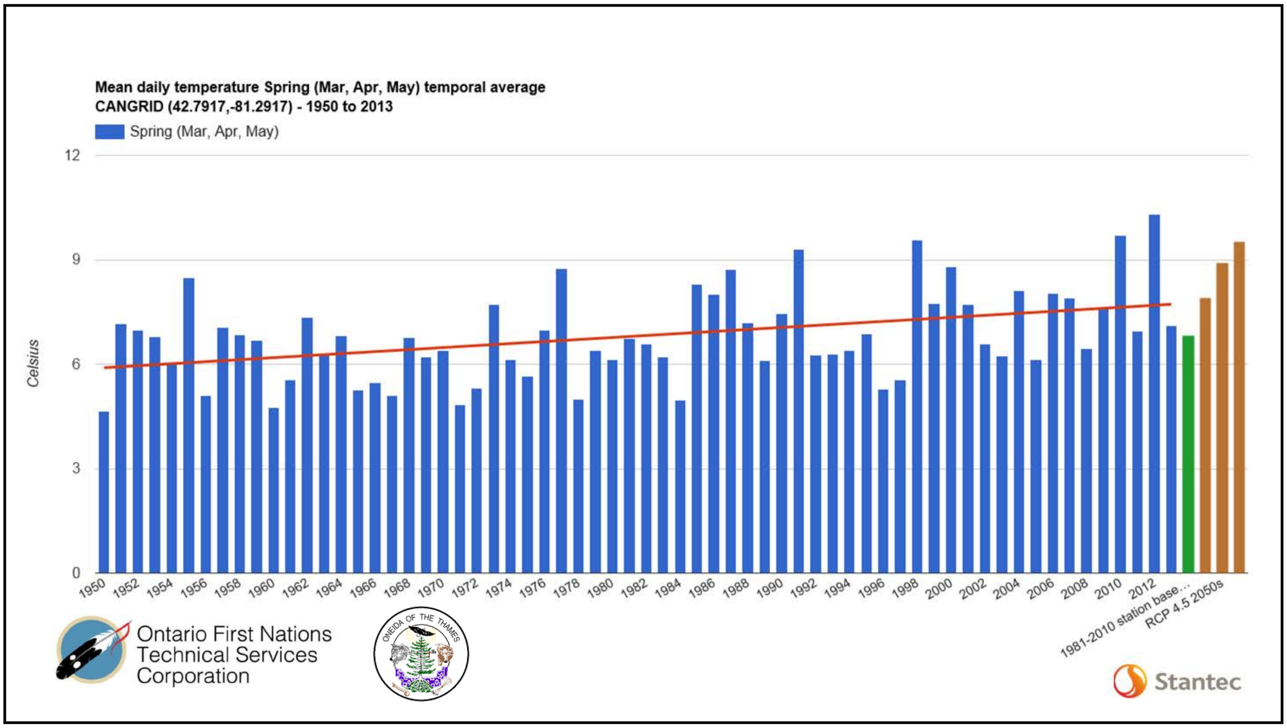
Mean daily temperature Spring (Mar, Apr, May) temporal average
CANGRID (42.7917,-81.2917) - 1950 to 2013
Spring (Mar, Apr, May)
Celsius
12
9
6
3
0
1950 1952 1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
1981-2010 station base...
RCP 4.5 2050s
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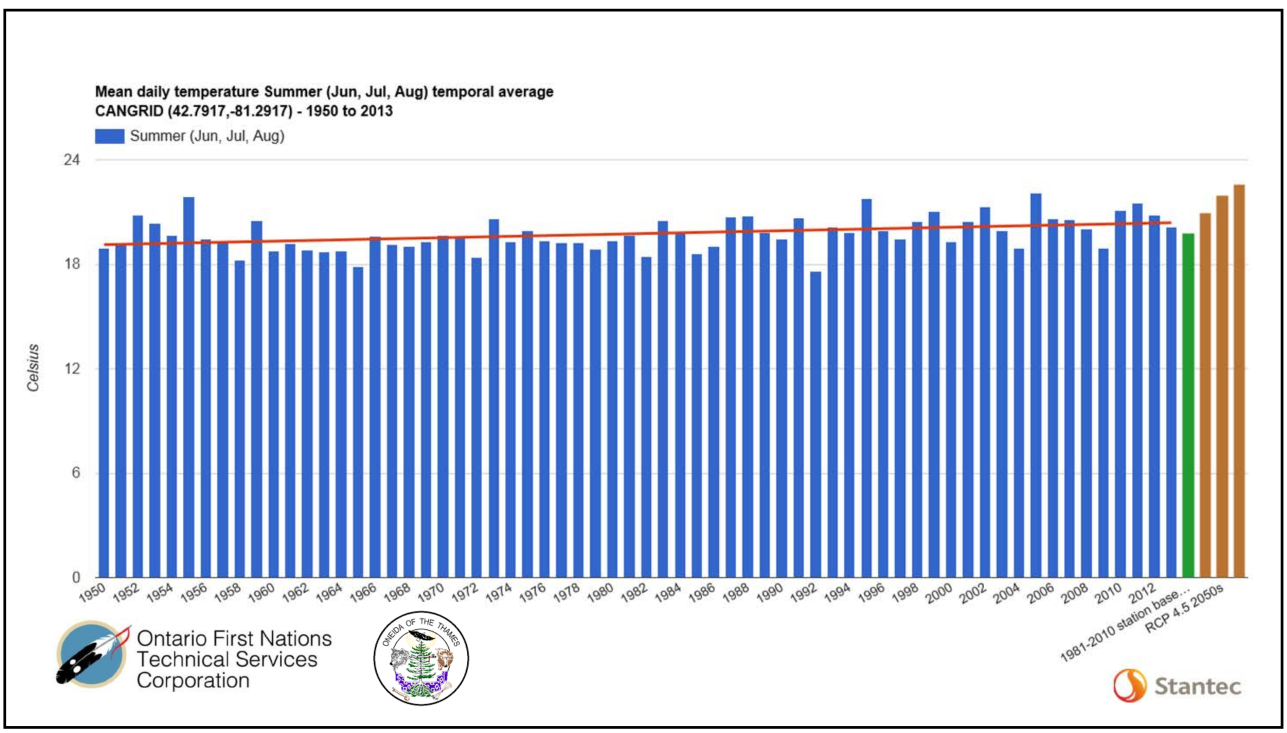
Mean daily temperature Summer (Jun, Jul, Aug) temporal average
CANGRID (42.7917,-81.2917) - 1950 to 2013
Summer (Jun, Jul, Aug)
Celsius
24
18
12
6
0
1950 1952 1954 1956 1958 1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
1981-2010 station base...
RCP 4.5 2050s
Ontario First Nations Technical Services Corporation
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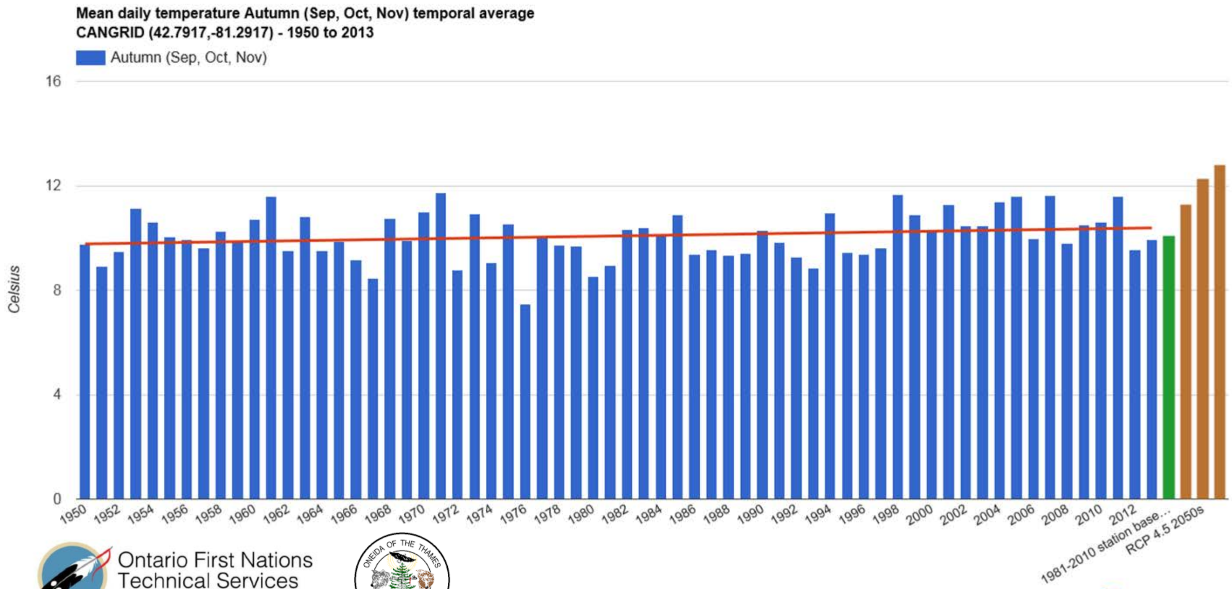

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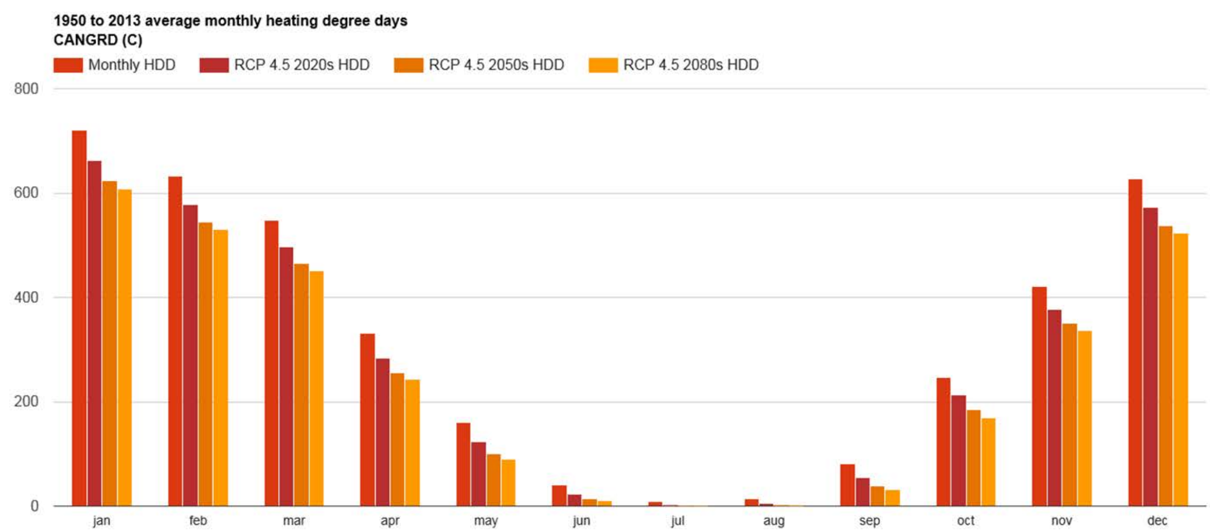

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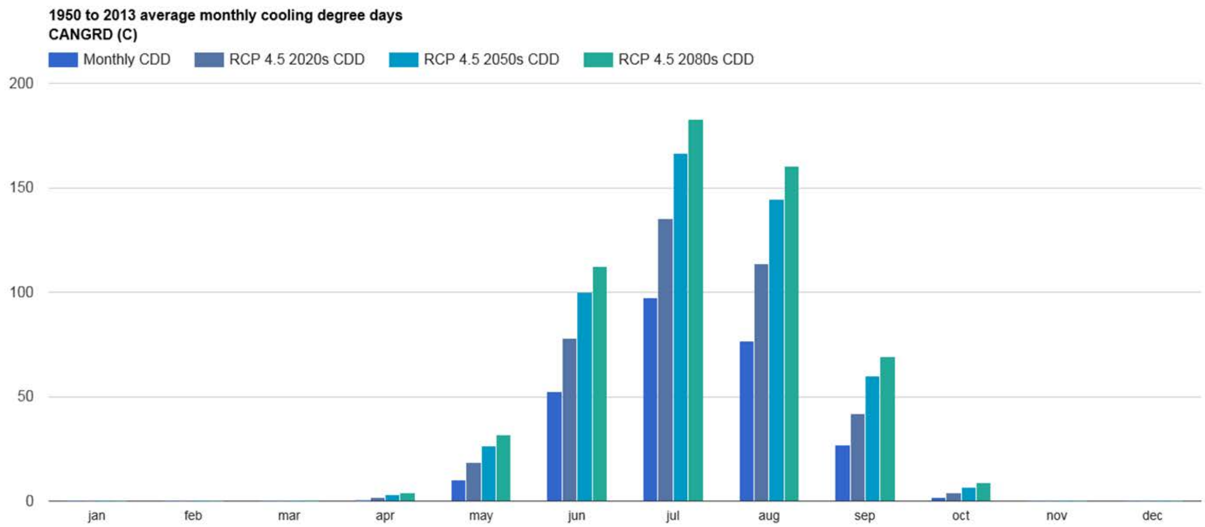

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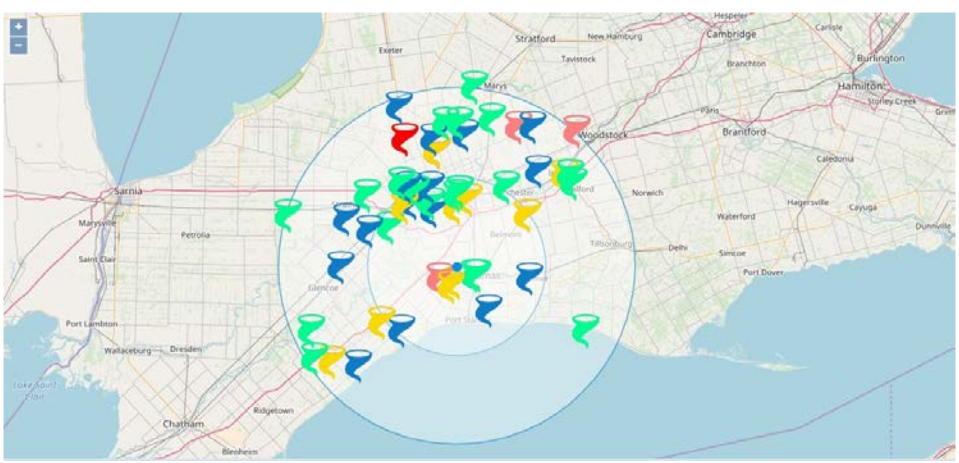

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Technical Services
Corporation

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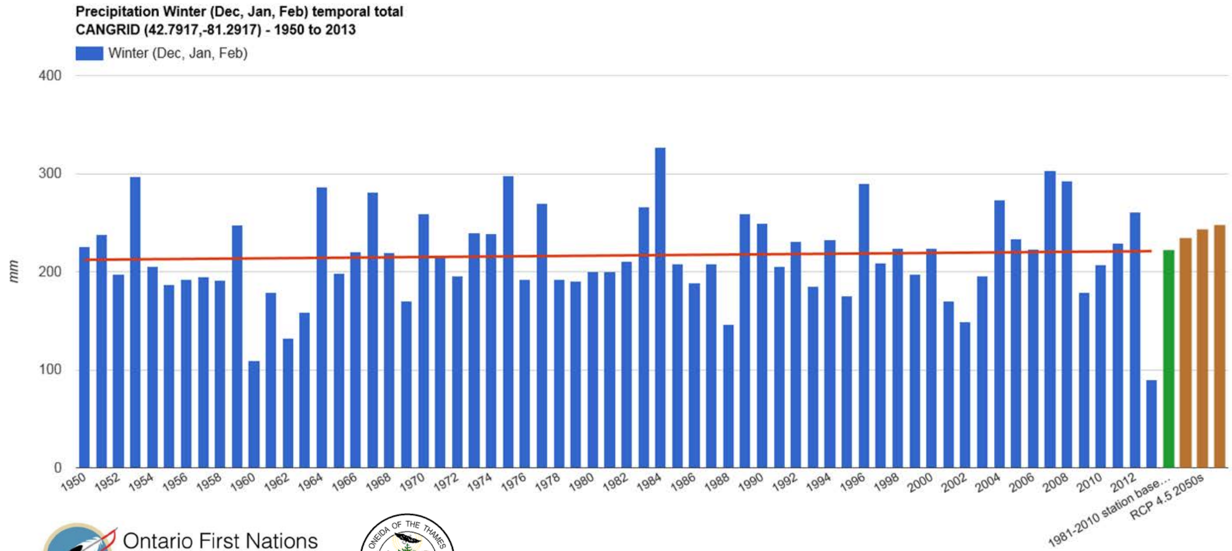

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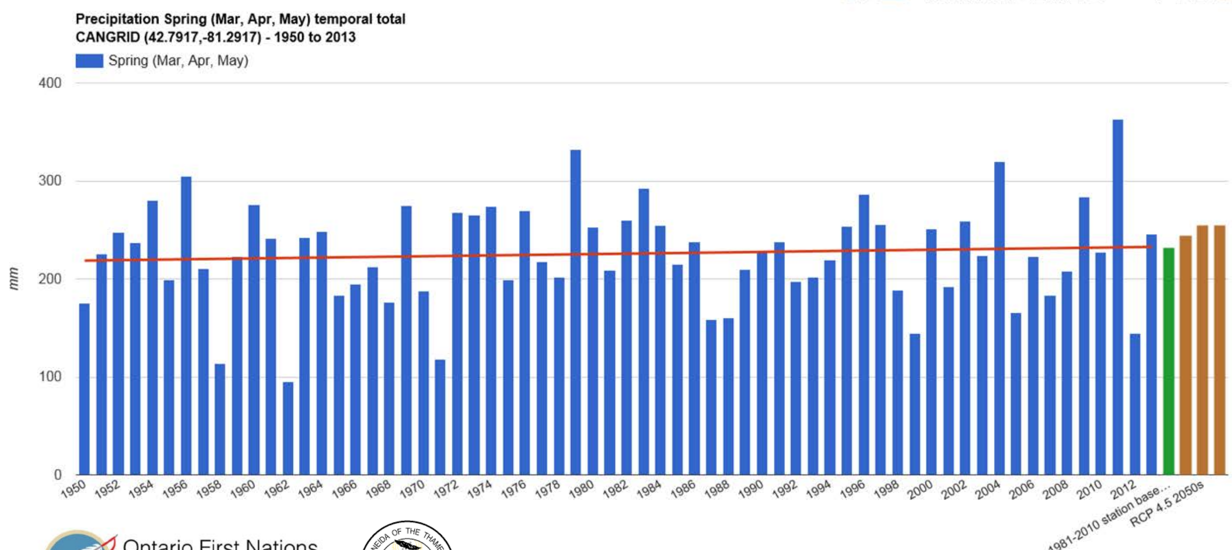

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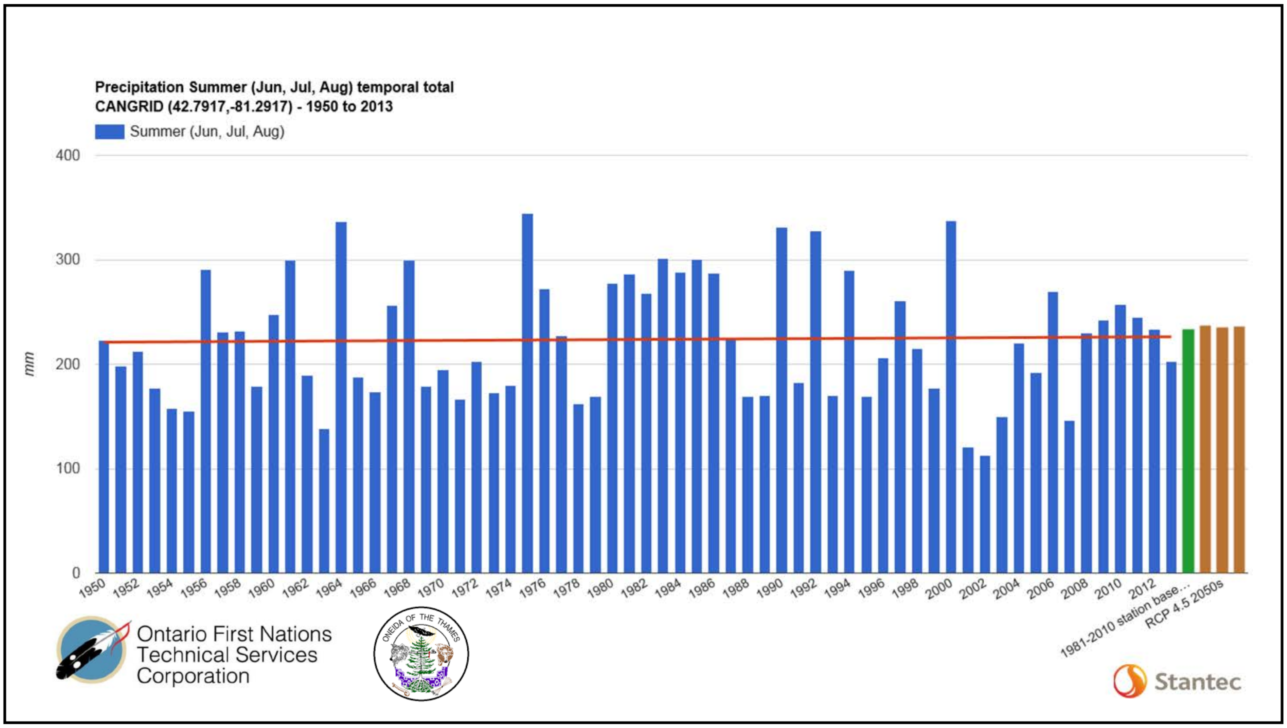
Precipitation Summer (Jun, Jul, Aug) temporal total
CANGRID (42.7917,-81.2917) - 1950 to 2013
Summer (Jun, Jul, Aug)
mm
400
300
200
100
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
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1986
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1998
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2004
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2010
2012
1981-2010 station base...
RCP 4.5 2050s
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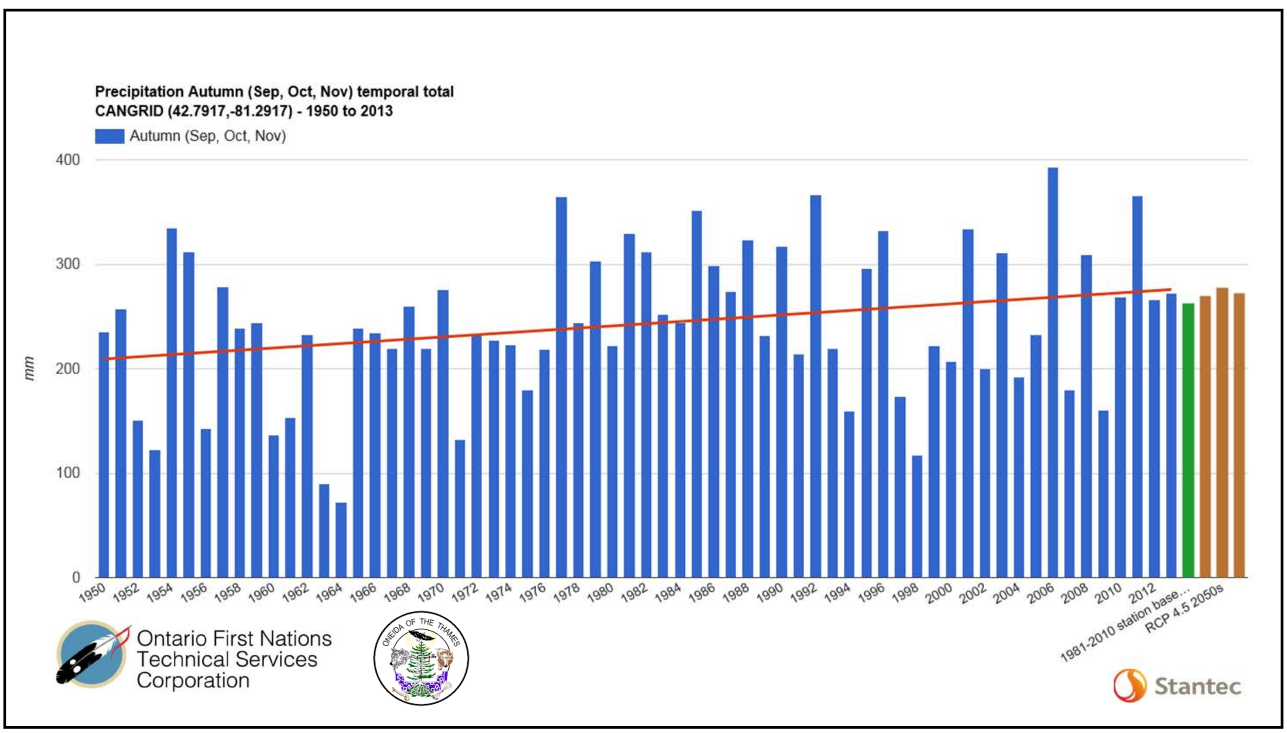
Precipitation Autumn (Sep, Oct, Nov) temporal total
CANGRID (42.7917,-81.2917) - 1950 to 2013
Autumn (Sep, Oct, Nov)
mm
400
300
200
100
0
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
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2010
2012
1981-2010 station base...
RCP 4.5 2050s
Ontario First Nations Technical Services Corporation
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IDF for: ST THOMAS WPCP ID:6137362 Historical

T (years)	2	5	10	25	50	100
5 min	8.25	11.02	13.04	15.82	18.07	20.47
10 min	12.26	16.28	18.85	22.00	24.28	26.47
15 min	14.87	19.91	23.13	27.08	29.92	32.67
30 min	20.12	26.99	31.48	37.10	41.21	45.27
1 h	25.59	34.75	40.58	47.69	52.79	57.71
2 h	29.70	41.19	49.44	60.65	69.58	78.99
6 h	37.78	51.28	61.63	76.58	89.20	103.19
12 h	43.67	58.81	69.82	84.95	97.14	110.11
24 h	49.29	66.81	79.34	96.31	109.77	123.92

Source: ICLR

IDF for: ST THOMAS WPCP ID:6137362 2035 – 2065 – RCP 4.5

T (years)	2	5	10	25	50	100
5 min	9.21	12.59	15.48	19.06	21.66	24.66
10 min	13.95	18.71	22.48	26.52	29.20	32.17
15 min	16.92	22.88	27.58	32.63	35.99	39.69
30 min	22.90	31.02	37.52	44.70	49.51	54.94
1 h	29.12	39.94	48.41	57.49	63.54	70.12
2 h	33.18	47.10	58.76	73.10	83.49	95.31
6 h	42.27	58.53	72.95	92.30	106.91	123.63
12 h	48.79	67.20	82.91	102.36	116.44	132.69
24 h	55.06	76.38	94.28	116.04	131.63	149.62

Source: ICLR

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Climate Considerations – Local Experience

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Events Causing Disruptions

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- Snow storms (1975 – 1978) verify
- Localized weather events
- Wind damage – Sept and Oct 2017 applications for renovations + reports of high winds and tree damage
- Tornado – 1965?
- Ice storm (March 2007)

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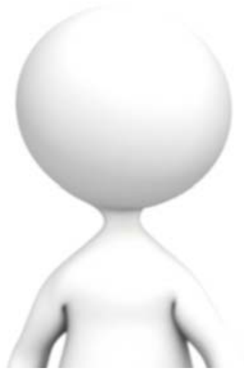

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Climate Change Vulnerability Assessment of the Oneida Housing Assets and Infrastructure

Workshop 4 – Risk Assessment and Adaptation Measures

Oneida Nation of the Thames

Friday December 8,2017

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Safety Moment

Carbon Monoxide Safety

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Workshop #3 - Project Risk Assessment

The workshop is intended to provide:

- Complete Risk Matrix (morning):
  - Infrastructure-climate interactions
  - climate probability ratings
  - Severity of impacts scores and risk calculations
- Discussion: adaptation measures (afternoon)

Application of the Draft FN PIEVC/AM Toolkit: Oneida Nation of the Thames

Assets and Infrastructure. Performance Considerations

Infrastructure Selected

Housing:
- Seniors Complex
- Quadplex
- Duplex

Single family homes
- Supporting Infrastructure
- Water
- Wastewater
- Roads

• School
• Support services
• Adjacent communities' activities




Performance Considerations

With respect to the infrastructure or asset being assessed, climate loading may affect:

- Structural performance
- Operations
- Functionality
- Environment (land)
- Environment (Water)

Rating Scale - Climate

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Score	Probability Method A	Probability Method B
0	Negligible Not Applicable	< 1 in 1,000
1	Highly Unlikely Improbable	1 in 100
2	Remotely Possible	1 in 20
3	Possible Occasional	1 in 10
4	Somewhat Likely Normal	1 in 5
5	Likely Frequent	>1 in 2.5

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Rating Scale - Infrastructure

Score and Description	Consequence [Structural, Functional, Operations]
0 No effect	• No damage • Continues to perform as intended • Fully operational – normal
1 Insignificant	• Can be corrected through the regular maintenance cycle
2 Minor	• Requires sending repair crew • No replacement of asset necessary • May need further assessment
3 Moderate	• Needs attention • Requires sending repair crew • Needs replacement of components • Might need to order parts • Will need further assessment
4 Major	• Collapse/total loss of asset or components • Little or no impacts on other elements
5 Catastrophic	• Collapse • Total loss of equipment and service that requires full replacement of asset, several assets and major components • Will require relocating people/function • Impacts on other elements of asset or other assets • May have impacts on the public health and safety

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Climate Considerations – Weather Station Data and Projections

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Climate Considerations – Local Experience

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Events Causing Disruptions

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- Ice storm (March 2007)

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Risk Matrix

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Adaptation Measures

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Climate Change Vulnerability Assessment of the Oneida Housing Assets and Infrastructure

Adaptation Measures

Oneida Nation of the Thames

Tuesday January 16, 2018

Risk Assessment Summary

Workshop on December 8, 2017 was intended to provide:

- Complete Risk Matrix (morning):
  - Infrastructure-climate interactions
  - climate probability ratings
  - Severity of impacts scores and risk calculations
- Discussion: adaptation measures (afternoon)

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Assets and Infrastructure. Performance Considerations

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Infrastructure Selected

Housing:
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  - Quadplex
  - Duplex

Single family homes
  - Supporting Infrastructure
  - Water
  - Wastewater
  - Roads

- School
- Support services
- Adjacent communities' activities

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Performance Considerations

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With respect to the infrastructure or asset being assessed, climate loading may affect:

- Structural performance
- Operations
- Functionality
- Environment (land)
- Environment (Water)

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Rating Scale - Climate

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Score	Probability	
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4	Somewhat Likely Normal	1 in 5
5	Likely Frequent	>1 in 2.5

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Climate Parameters (Current Climate)

Max. Temp				Max. Temp				Seasonal Temp variaions				Wind				Tornado				Freezing Rain				Rain				3 days consecutive winter rain			
10 Days with Temp >30 deg. C per year				Occurences of Days with Temp. >35C (1-3 days)				Heating and cooling degree days (current: 293)				Exceeding 90 km.p.h				Description				Estimated 15 mm causing local power line damage				Short duration - High Intensity 50mm in 30min				Southern Ontario Threshold for weather warning causing flood of 25 mm			
Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
	4				2				4				3				2				3				1				4		

Rating Scale - Infrastructure

Score and Description	Consequence [Structural, Functional, Operations]
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Oneida of the Thames

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Risk Summary

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High risks

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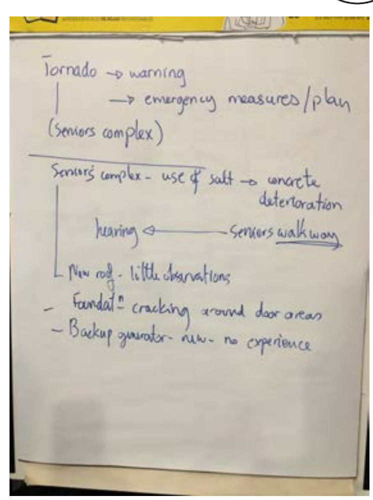
- All facilities:
  - Tornado
  - Wind: loose material around properties
- Seniors complex
  - Maximum Temp. : HVAC
  - Freezing rain: fuel, access road, backup generator
  - Winter rain: access road
- Housing units
  - Asphalt shingles' roofs: wind
  - Freezing rain: fuel, drainage
  - Winter rain: drainage



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High risks (continued)

- School
  - Maximum Temp.: HVAC
  - Freezing rain: fuel, access road, backup generator
  - Winter rain: access road
  - Roof ?
- Old septic systems: saturated -
- Regional Landfill (Green Lane) ?
- Adjacent communities' activities ?

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Adaptation Measures

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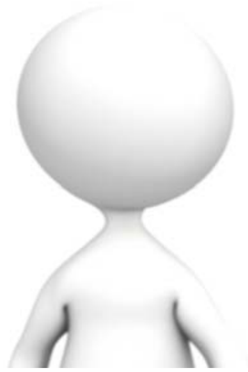

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