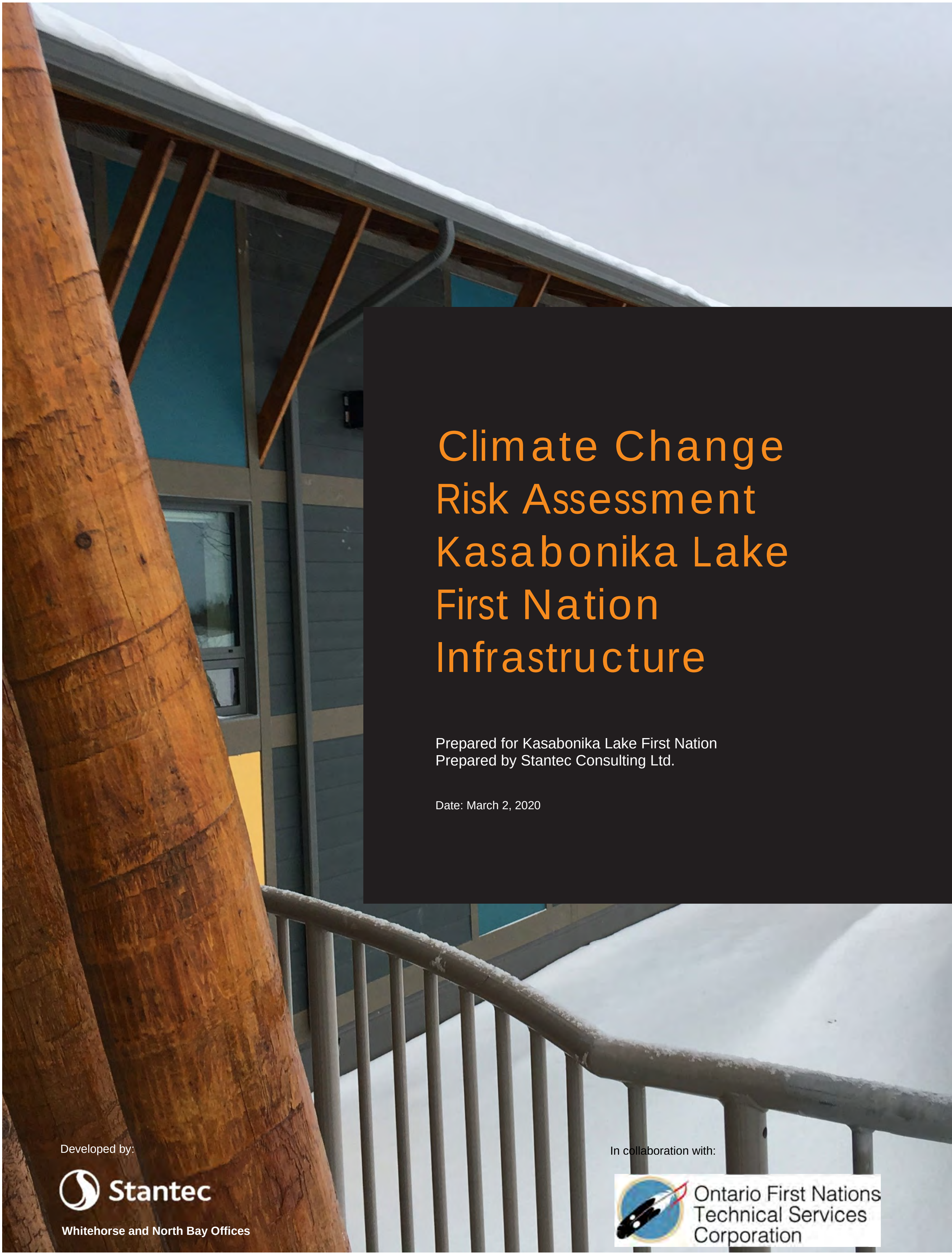

Climate Change Risk Assessment Kasabonika Lake First Nation Infrastructure

Prepared for Kasabonika Lake First Nation
Prepared by Stantec Consulting Ltd.

Date: March 2, 2020

Developed by:

Stantec

Whitehorse and North Bay Offices

In collaboration with:

Ontario First Nations Technical Services Corporation

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EXECUTIVE SUMMARY

Kasabonika Lake First Nation (KLFN) is a remote, fly-in access Oji-Cree community situated on an island on Kasabonika Lake of the Asheweig River watershed of Northwestern Ontario, located approximately 460 kms northeast of Sioux Lookout, Ontario. The land base of Kasabonika Lake reserve is 101.5 km^2. Population is 848 with a total of 212 private residences in the community. (Source: Kasabonika Lake Indian Reserve, Census Profile, 2016 Census https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3560096&Geo2=PR&Code2=35&SearchText=Kasabonika%20Lake&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3560096&TABID=1&type=0)

Year-round access is by aircraft using a 1,100 m gravel air strip operated and maintained by Ministry of Transportation (MTO). There is regular scheduled passenger service between Sioux Lookout and Thunder Bay/Winnipeg. The MTO also maintains a bailey bridge, which provides the only road access between the island and the mainland.

A winter road is constructed annually in the late winter months for access by members using personal vehicles and for the mobilization of large volumes of fuel, foods, construction materials, heavy equipment, and other bulk goods. The duration of the winter road is typically 4-6 weeks from February to March - subject to weather conditions (temperatures, snowfall, ice thicknesses).

Kasabonika Lake has experienced the effects of climate changes on its community. Increasing average temperatures are resulting in noticeably shorter ice roads seasons and increasing variability and unpredictability of weather patterns. Increasing precipitation combined with warmer spring temperatures result in increased threat of flooding – floods have occurred twice since 2010 resulting in restricted access to the island. Warmer summer temperatures and prolonged periods of low precipitation have resulted in increased forest fire threat to the community – forest fires have occurred twice since the late 1990s with 1 full scale evacuation of the community.

Stantec Consulting Ltd. (Stantec) was requested to complete a climate risk assessment (CRA) of the Kasabonika Lake community infrastructure using the First Nation Infrastructure Resilience Toolkit (FN-IRT), developed in partnership with Ontario First Nations Technical Service Corporation (OFNTSC). The objectives of the study are to:

- Identify Kasabonika Lake infrastructure vulnerabilities to current and future weather events associated with the impacts of climate change.
- Establish a climate risk profile for the infrastructure selected by the community.
- Develop community-based adaption strategies and recommendations for mitigating climate risks with the highest potential consequences and impacts to the community's infrastructure assets.

KASABONIKA LAKE CLIMATE

The main source of current and future projected climate data for the Kasabonika Lake First Nation climate risk assessment was the NRCANmet dataset. NRCANmet was produced by Natural Resources Canada (NRCan) and provides daily maximum and minimum temperature and total precipitation data at 300 arc second spatial resolution (~10 km) over Canada for the 1950-2017 time period (Hopkinson et al., 2011; McKenney et al., 2011).

Future climate projections are based on the Intergovernmental Panel on Climate Change (IPCC) RCP[1] 8.5 scenario, which is considered the global “business as usual” greenhouse gas emissions track (IPCC, 2018).

Temperature

Between 1948 and 2016, Ontario has experienced an average annual mean temperature changes of 1.3°C and seasonal mean changes ranging from 1.0°C in the autumn to 2.0°C in the winter (Bush and Lemmen, 2019). Temperature changes reflected across the province are more pronounced in the North, with up to 4.3°C of warming in winter months. Regional projections under RCP 8.5 anticipate a further increase in annual mean temperature of 2.3°C and 6.3°C for 2031-2050 and 2081-2100 respectively for Ontario (Bush and Lemmen, 2019). Projections show that all seasons are likely to warm into the future, with a warming of average daily temperatures in all seasons of between 3-5 °C. It is noted that climate changes in the region are expected to be more pronounced during the winter months than through the summer (Bush and Lemmen, 2019). These climate changes and predicted trends for the climate in the Kasabonika Lake area are reflected in the projection information presented in the following tables.

Occurrence of Maximum Temperatures, NRCANmet (Location: -88.65, 53.58)

Maximum Temperature Threshold	Annual Occurrence of Days above Max. Temp (Days/year)						
	Historical 1981-2010	RCP 8.5					
		2020s	Trend	2050s	Trend	2080s	Trend
30°C	1.6	3.7	↗	9.1	↗	21.2	↗
35°C	0.2	0.2	→	1.1	↗	5.4	↗

Occurrence of Minimum Temperatures, NRCANmet (Location: -88.65, 53.58)

Minimum Temperature Threshold	Annual Occurrence of Days below Min. Temp (Days/year)						
	Historical 1981-2010	RCP 8.5					
		2020s	Trend	2050s	Trend	2080s	Trend
-30°C	32.5	21.8	↘	9.4	↘	2.2	↘

The warming of the climate system has also led to important changes in extreme temperatures. Historical occurrences of extreme heat periods (max. temp > 30 °C) have increased since 1950 and are projected to increase nearly nine times the current frequency by the 2050s, with increases from 1-2 events per year to approximately 9 events per year. Winter months show opposing trends, with decreases in the number of extreme cold days projected to decrease from a little over a month of the year to just over a week on average by the 2050s. Nevertheless, extreme cold events continue to occur and are still likely to occur in a warming climate, primarily in association with stuck and persistent weather patterns (e.g. polar vortex

[1] 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.

events) such as those seen in recent winters (2012-13, 2013-14, 2017-18, and 2018-19). Even with warming winter temperatures, it is likely that cold air outbreaks (or cold snaps) will continue to occur.

Increasing temperatures in the cold season are already causing impacts on the reliability of winter road seasons, with shortened and less reliable winter road seasons showing up year to year. Projections show a decrease in the number of freezing days (as measured by the freezing index) from a historical average of approximately 150 days to a new average of 130 days by the 2050s. This represents nearly a month of lost freezing potential for winter road access.

Precipitation

Precipitation trends in the Kasabonika Lake area are likely changing, though are harder to detect than temperature trends due to the distance to nearby stations (> 50 km) and overall data availability issues. Historical trends from NRCANmet have been relatively steady over the 63-year time series. There is potential for increasing precipitation (both rain and snow) annually and in nearly all seasons under a warming climate by the 2050s. Summer precipitation is likely steady historically, with projected changes indicating mid-century increases followed by end-of-century decreases. This pattern is similar to patterns observed and projected in the Prairies, where the variability of summer precipitation has increased. Winter and spring precipitation show little change historically, though missing data is likely a large factor in any trends reflected in the historical data.

Average Percent Change in Total Annual and Seasonal Precipitation from 1981-2010 Baseline, NRCANmet (Location: -88.65, 53.58)

Season	Historical 1981-2010 (mm)	Average Percent Change in Total Precipitation from 1981-2010 Baseline (%)					
		RCP 8.5					
		2020s	Trend	2050s	Trend	2080s	Trend
Annual	542.4	7	↗	14	↗	18	↗
Winter	67.6	7	↗	20	↗	36	↗
Spring	89.9	11	↗	20	↗	32	↗
Summer	212.8	2	→	5	↗	2	→
Autumn	164.4	7	↗	13	↗	18	↗

Drought and Wildfire

In the Kasabonika Lake region, there is an increasing likelihood of forest fires due to increases in overall summer precipitation variability (e.g. prolonged dry periods). This effect, coupled with increasing summer temperatures, increases the amount of evaporation in the area and increases the probability of drought conditions. This has led to increases in the length of the fire season, stemming from increases in lightning, stuck and persistent weather patterns, and smoke intrusions into the region from distant fires.

Historically, five wildfire evacuations have occurred for Kasabonika Lake and the surrounding region since 1989. This is likely to increase into the future, as climate projections show that the likelihood of forest fire occurrence will increase by up to 300%. This stems in part from the relationship that every 1 °C of warming results in an increase in lightning strikes by up to 12%.

Wind

Due to the lack of data in the immediate vicinity of Kasabonika Lake First Nation, the closest weather monitoring station with published wind data is the Big Trout Lake weather monitoring station, located approximately 85 km away. Extreme winds observed at Big Trout Lake may not be completely reflective of the winds for Kasabonika Lake, but climate data indicates that similar patterns of general weather have occurred in the region.

Estimates from Big Trout Lake indicate that wind gusts exceeding 100 km/hr occur approximately once every ten years (1:10 return period) while gusts of 90 km/hr or greater occur once every three to four years (1:3 to 1:4). Extreme wind events are often filtered out of historical databases by automated quality control techniques, so the historical frequency of events may be underestimated for the most extreme events. One Ontario study (Zhang, 2014) suggests the number of events with wind speeds of over 90 km/hr has the potential to increase by up to 50% by the mid-21st century.

FN-IRT CLIMATE RISK ASSESSMENT

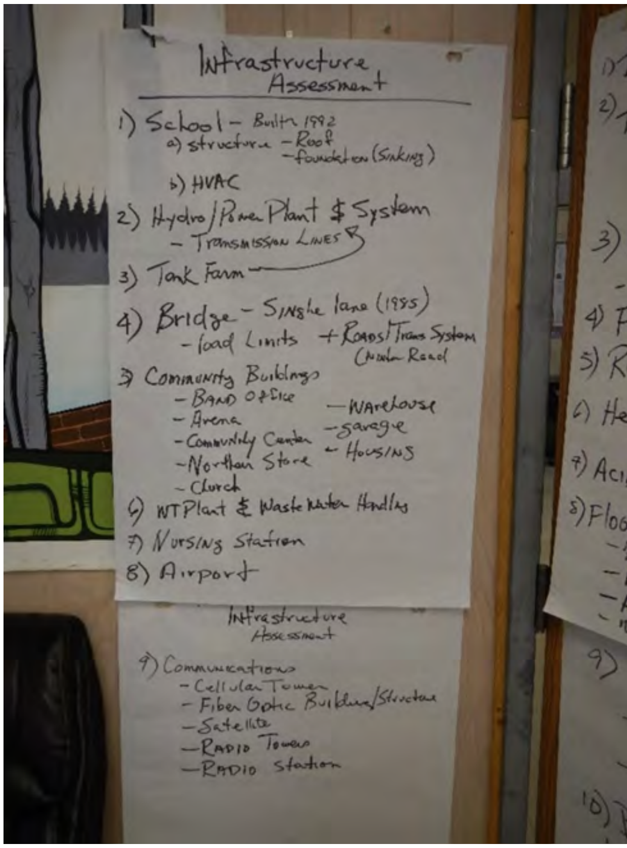
The climate risk assessment was completed using four community-based workshops. Workshops 1 and 2 were held at the band office from November 13 – 15, 2018. Workshops 3 and 4 were completed June 11 – 13, 2019, at the fourplex, which was recently converted into training rooms. Participants in the workshops included Kasabonika Lake community members, councillors, operations and maintenance staff, and Project Team members from Stantec.

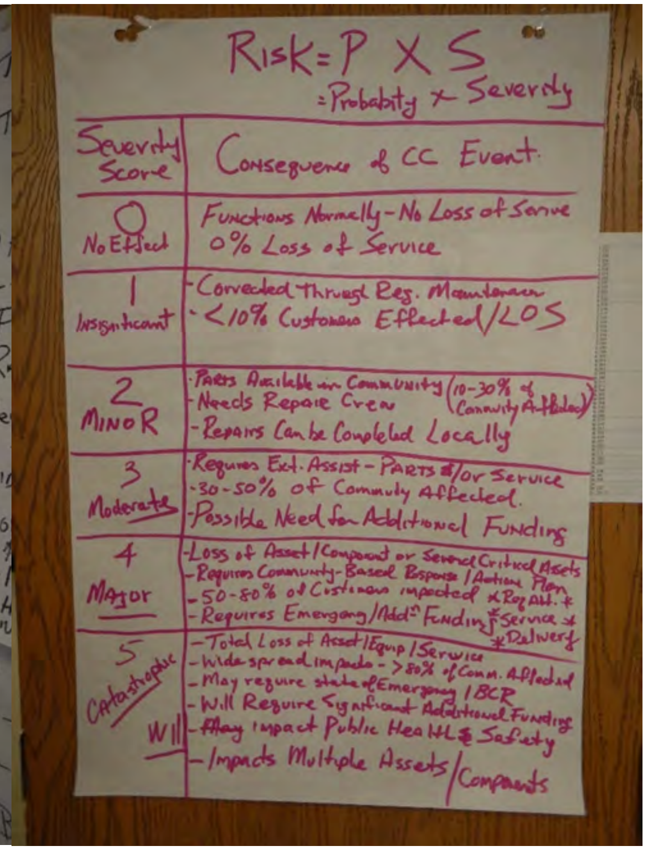
Workshops 1 and 2 focused on identifying the Kasabonika Lake community infrastructure to be assessed for current and future climate risks. The Project Team selected the following infrastructure to assess:

- Community Buildings – School and Nursing Station;
- Water and Wastewater Treatment Systems -Water Treatment Plant, Sewage lagoon, lift/pump stations;
- Roads – Ditches and culverts; and
- Third Part Services – HORCI Power Generation Station, airport, telecommunications (TBayTel, Bell), airport, fuel tank farm, bridge.

The balance of workshops 1 and 2 focused on defining specific inputs required to use with the FN-IRT and complete the climate risk assessment. These included:

- Discussion of weather-related impacts on infrastructure;
- Review and agreement of proposed probability scale for climate events;
- Review/selection of climate data (past climate events and impacts on infrastructure) to use in the CRA and introduction to climate thresholds;
- Introduction of infrastructure performance considerations (structural, operational, functional) as they relate to the impacts of current and future climate events;
- Introduction of the FN-IRT climate vulnerability assessment process and the Risk Matrix worksheet; and
- Development of the Kasabonika Lake First Nation (KLFN) Severity of impacts scale.





The Project Team and workshop participants further reviewed current meteorological/climate events that may have impacted or affected Kasabonika Lake FN infrastructure by causing infrastructure and operations disruptions and/or failures. This also included defining the threshold or intensity level of the climate events that would possibly cause damage or service disruptions should a component of the infrastructure be adversely affected by the event.

Workshop 3 focused on further defining the climate events to complete the CRA, and with the assistance of the project climatologist (who provided a presentation on current and future climate in the Kasabonika Lake area), the threshold which if exceeded could result in impacts to the infrastructure. Using previous climate data for the Kasabonika Lake area, the group determined the probability score for each climate event, for both current and future climate, as shown in the following table. Workshop 3 also included a special session where several community elders presented the changes and associated impacts that they have witnessed to the community related to climate change.

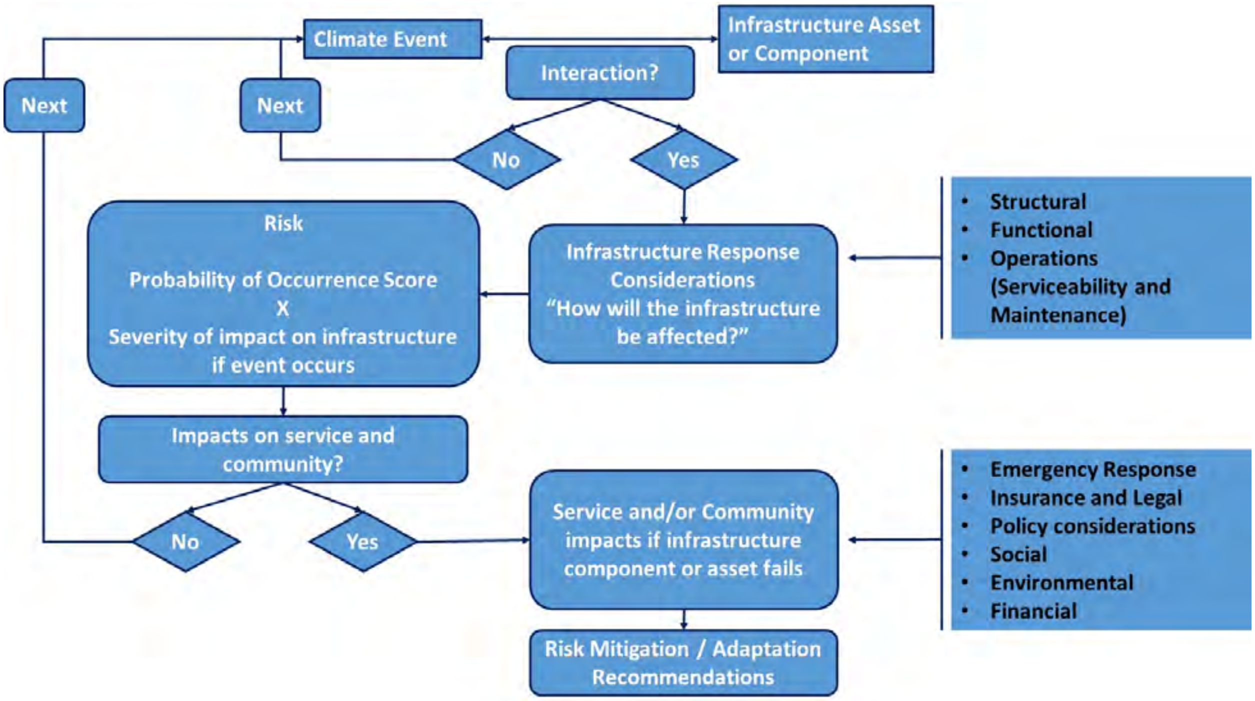
Workshop No. 3 – Community Elders Session

Type of Climate Element	Description	Comment	Probability	
			Current Climate	Future Climate
Temperature	Heat Wave	Temperature >30C in day and >15C at Night. Min 3 consecutive days. Heat stress on operators, workers, elders.	4	5
	Cold Snap	Temperatures below -35C for 3-5 Consecutive days	4	5
	Declining Freezing Index	How much cold weather to make ice and frost in the ground.	2	4
Precipitation	Rainfall - High Intensity	>25mm in 1 Hour	2	3
	Drought	Temperature >20C during day and No measurable rain for >14 Days	2	4
	Freezing Rain	Ice accretion of 10mm.Makes roads/runway slippery; may break branches on trees.	3	5
	Snowfall	Annual accumulation >200cm/Yr	2	5
Wind	High Winds	Gusts >100 km/hr	3	4
Other Events	Fog	Affects visibily at airport. Restricts access.	1	2
	Forest Fires	Evacuation threat, smoke issues, impacts on power infrastructure	3	5

The remainder of workshop 3 was spent competing the climate risk matrix. The project team first assessed which infrastructure components would be affected if exposed to the selected climate events, and then assigned a severity score for the applicable structural, operational and functional impacts. The structural, operational and functional risks were calculated by multiplying the severity scores by the probably of the climate event occurring (probability score). The outcome of workshop 3 produced two risk matrices, one for current climate and one for future climate, which are located in **Appendix E** for reference.

FN PIEVC RISK ASSESSMENT

The FN-IRT risks assessment process is illustrated in the decision tree model below.



The first step in completing the risk matrix worksheet is to determine if there is an interaction between an infrastructure component and the climate event selected for the analysis. Only those infrastructure asset components that are determined by the Project Team to be exposed or interact with a selected climate event are assessed for risks. If the infrastructure component is determined to interact with the climate event, then the Project Team evaluates the type of performance response (structural, functional, operations) the climate event will have on the component and assigns a severity score (1 to 5) using the Kasabonika Lake Severity of impacts scale for each type of performance response. Severity scores are assigned for three types of possible infrastructure responses — structural integrity, functional and operations.

Once the severity of the impact of the climate event is determined for each performance response, the risk to the infrastructure component is determined by multiplying the severity score for each performance response by the probability of the climate event occurring.

RISK = SEVERITY OF IMPACT X PROBABILITY OF OCCURRENCE OF CLIMATE EVENT

The probability/likelihood and impact/severity scores are each ranked on a 1 to 5 scale. For the Kasabonika Lake climate risk assessment, the risk scores or threshold have been further divided and colour coded as shown in the risk matrix below.

Impact/Consequence on Infrastructure if Climate Event Occurs

Catastrophic 5	Special				EXTREME
4				HIGH	
3			MODERATE		
2		LOW			
Insignificant 1	NEGLIGIBLE				Special
	1 Highly unlikely	2	3	4	5 Likely / Frequent

Probability/Likelyhood of Climate Event Occuring

	RISK SCORE	ADAPTATION RESPONSE
Extreme:	≥ 20	Immediate control required
High:	10 - 16	High priority control measures required
Moderate:	8 - 9	Some control measures required to reduce risks to lower levels
Low:	3 - 6	Control likely not required
Negligible:	< 3	Risk events do not require further consideration
Special Case:		Further analysis may be required; monitor
	• P=1 & S=5	Special Case - Very low probability but high Severity
	• P=5 & S=1	Special Case - High probability of occurring but insignificant impact or severity

The moderate to extreme risk scores for the Kasabonika Lake FN PIEVC risk assessment are summarized in the following table. There were no extreme risks under current climate and future climate projections. However, if infrastructure is not replaced at the end of the asset's service life, the number of extreme risks increases to 4 (400% increase - largely associated with the winter road and the impact of a declining freezing index) and moderate risks increased to 34. The moderate risk increases were more widespread, having an impact on the nursing station, school, water treatment plant and several third-party services (airport, bridge and fuel tank farm) under several climatic events.

<table>
<tr><th rowspan="2">Category</th><th colspan="2">Risk Score Counts</th><th rowspan="2">Climate Events</th><th rowspan="2">Principal Infrastructure/Components Affected</th></tr>
<tr><th>Current Climate Count</th><th>Future (2050s) Climate</th></tr>
<tr><td>EXTREME</td><td>0</td><td>0</td><td></td><td></td></tr>
<tr><td rowspan="8">HIGH</td><td rowspan="8">4</td><td rowspan="8">26</td><td>• SNOWFALL – Total Accumulation of snow >200cm</td><td>• School – Structural risk (Rs=10) to the building structure and roof</td></tr>
<tr><td>• FREEZING RAIN – Accretion of 10mm of ice</td><td>• Staff – Operational risk (Ro=10/15) to staff servicing the Nursing Station, water and wastewater treatment systems.
• Airport – Operational impact (Ro=15) on the airport Runway/Taxiway.
• Telecommunication – Structural Risks (Rs=15) to Bell wires.</td></tr>
<tr><td>• HEAT WAVE – Temperatures >30^{0}C during the day and >15C during the night for minimum of 3 consecutive nights</td><td>• Nursing Station and School - Operational risk (Ro=10/15) for school and nursing station staff.
• Nursing Station - Operational risk (Ro=10) to HVAC system.
• Sewage Lagoon – Functional risk (Rf=15) to the lagoon (bacteria affected by high temperatures?)</td></tr>
<tr><td>• COLD SNAP – Temperatures <-35^{0}C for 3-5 consecutive days</td><td>• Staff - Operational risk (Ro=10/15) for school and nursing station staff.
• Nursing Station, School, Water Treatment Plant – Functional risk (Rf=10/15) with HVAC systems in each building (Rf=15 for nursing station).</td></tr>
<tr><td>• RAINFALL (HIGH INTENSITY) - >25 mm in 1 Hour</td><td>• Roads – Functional Risk (Rf=9) to ditches and culverts.</td></tr>
<tr><td>• HIGH WINDS Winds-Gusts > 100 km/h</td><td>• Nursing Station – Structural risk (Rs=12) to roof (Shingles damaged).</td></tr>
<tr><td>• FOREST FIRES – Fire and smoke concerns</td><td>• Staff – Operational risk (Ro=10/15) to staff servicing the Nursing Station, school, water and wastewater treatment systems.
• Airport – Operational risk (Ro=15) on the airport Runway/Taxiway (smoke reducing visibility)</td></tr>
<tr><td>• FREEZING INDEX</td><td>• Winter Road – Structural risk (Rs=16) and Functional risk (Rf=16) to winter road.</td></tr>
<tr><td>MODERATE</td><td>15</td><td>3</td><td>See Current and Future Risk Matrices in Appendix E</td><td>See Current and Future Risk Matrices in Appendix E</td></tr>
</table>

CLIMATE RISK ADAPTATION MEASURES

Climate change and the associated climate risks are being realized as a significant tangible threat to First Nation community infrastructure. Community infrastructure that is kept in a state of good repair through proper operations and maintenance practices will often be able to withstand additional loading associated with most current climate events. However, the increasing frequency and intensity of future climate events will require communities to take actions to create more resilient infrastructure and develop adaptation strategies to reduce climate related risks to their infrastructure now and into the future.

Climate mitigation measures are actions taken to reduce and curb greenhouse gas (GHG) emissions, which are the single most important cause of climate change. Mitigation measures like reducing GHG emissions need to be addressed on a global scale to have any hope of reversing the current trend in global warming. On the other hand, climate adaptation acknowledges that even if GHG emissions were to be substantially reduced or stopped today, the current atmospheric concentration of carbon dioxide and other greenhouse gases would remain well above normal levels for years and potentially decades to come. Mitigation therefore looks at addressing the causes of climate change, while adaptation is about building resilience in community infrastructure by reducing the vulnerability and addressing the impacts of climate change on community infrastructure.

Workshops 1, 2 and 3 of the Kasabonika Lake First Nation PIEVC climate risk assessment, examined selected community infrastructure and determined the risk scores for infrastructure components for both current and future climate scenarios. During Workshop 4, the Project Team and community members developed adaptation and resiliency strategies to mitigate the highest risk to community infrastructure from current and future climate. The results of the workshop adaptation and resilience discussions are shown in the table below.

The climate adaptation and resilience strategies developed during the Kasabonika Lake FN-IRT climate risks assessment are a first step towards reducing climate-related risks to Kasabonika Lake infrastructure. With present building codes lacking design criteria to address future climate impacts, it is not possible to construct infrastructure to be fully resilient to climate change. However, communities like Kasabonika Lake can narrow the gap between the current resilience capacity of their infrastructure, and the resilience capacity needed to prepare for future climate change impacts by implementing adaptation measures that reduce exposure and vulnerability to climate events, creating more climate resilient communities.

CLIMATE EVENT	INFRASTRUCTURE CLIMATE RISK ADAPTATION MEASURES
HEAT WAVE (Temperature > 30C during Day and >15C Overnight)	**HVAC System (Nursing Station) – The nursing station is operated and maintained by ISC. KLFN /ISC need to develop a coordinated service agreement for maintenance/operation of the nursing station to mitigate the risks to the community associated impacts of service interruptions related to climate risks.** • Perform regular O&M plan to maintain HVAC system in optimal operation condition to provide cooling during periods of high demand. • Develop a community cooling center to relocate patients if required – publish location and times on multiple medias (radio/Facebook/television). Include in emergency response plan. • Install emergency generator. Size the generator to include HVAC system so that it can be operated during power interruptions. • **Staff (Operational Risk)** • Ensure O&M service vehicles are equipped with A/C. • Develop a workplan with safe operating practice to protect workers during extreme heat events. • Create a Health and Safety committee to develop policies related to heat waves, and a plan to protect workers subject to extreme climate events. Provide First Aid training to supervisors/staff to allow early recognition of heat related illness and treatment. **Lagoon (Functional Risk)** • Research the potential impacts of Heat Wave on the lagoon function effectiveness. • Develop a testing program to ensure the lagoon is operating as designed. • Have operators trained at appropriate certification level to recognize problems/provide treatment response to maintain optimal operation of the lagoon in accordance with environmental requirements.
COLD SNAP (Temperature <-35C for 3-5 consecutive days)	**HVAC Systems (Nursing Station, School, Water Treatment Plant)** • Perform regular O&M plan to maintain HVAC system in optimal operation condition to provide heating during periods of high demand. • Test efficiencies of heaters and upgrade/replace to ensure heaters in school can provide sufficient heating during cold snaps. • Develop an emergency response plan (ERP) if heating system fails – include a community communications plan in the ERP so everyone (parents, children, Chief and Council) is aware of what to do in case of an emergency. • Install emergency generator at school (Note: the school also serves as an assembly area for emergency response planning, so should have back-up power). Size to include HVAC system so that it can be operated during power interruptions. **Staff (Operational Risk)** • Ensure O&M service vehicles are well maintained so heating systems operate adequately. • Develop a workplan with safe operating practice to protect workers during extreme cold events. • Create a Health and Safety committee to develop policies related to cold snaps, and a plan to protect workers subject to extreme climate events. Provide First Aid training to supervisors/staff to allow early recognition of heat related illness and treatment.

CLIMATE EVENT	INFRASTRUCTURE CLIMATE RISK ADAPTATION MEASURES
DECLINING FREEZING INDEX	**WINTER ROAD (Structural and Functional risks)** • Consider building a permanent road access to the community. Explore opportunities to get access from roads developed to support the Ring of Fire development. • Work with ISC to develop an emergency response fund to provide financial assistance to bring critical goods and services to the community during periods of reduced winter road access (Need to fly goods into the community). • Consider increasing stockpiles/reserves of long-term non-perishable items in the community – those items that are dependant on the winter road for transport to the community. • Look for possible alternate sources of power for the community, to reduce dependency on power generation by HORCI (reduce or eliminate need to transport diesel fuel for power generation).
RAINFAL – HIGH INTENSITY (25mm in 1 Hour)	**ROADS - DITCHES/CULVERTS (Functional Risk)** • Complete regular maintenance (cleaning/brush cutting) of ditches to promote proper flow of water off road surfaces and prevent ponding along roads. • Complete maintenance of culverts to ensure the design capacity of the culvert is not reduced (Culverts in the town were found to be severely restricted by gravel and materials).
FREEZING RAIN (10mm od ice accretion)	**STAFF (Operational Risk)** • Provide PPE for workers who need to work in freezing rain conditions (i.e. traction aids for boots). • Apply sand/traction aid in work areas to reduce risk of slips and falls. • Develop safe work/operating practices. Review as regular part of health and safety meetings **THIRD PARTY SERVICES -Telecommunications - Wires (Structural Risk)** • Clear trees and branches around wire pathways. • Plan for loss of communications service in community emergency response plan. • Develop a work plan to inspect wires after ice storms, to assess the infrastructure condition and damage. **THIRD PARTY SERVICES – Airport – Runways/Taxiway** • Include possible closure of airport in community emergency response plan. • Install weather station at the airport to provide real time weather reporting. • Explore the potential for all season road access to community to reduce dependency on air travel as only access to community.
HIGH WINDS **(Gusts >100 km/h)**	**NURSING STATION/SCHOOL/HOUSES (Structural Risk)** • Develop community building requirements for new construction requiring the use of hurricane clips on roof structures. • Visually inspect houses and infrastructure roofs for loose shingles and damage, to minimize additional damage due to high winds. • Consider changing community building requirements to use steel roofing.

CLIMATE EVENT	INFRASTRUCTURE CLIMATE RISK ADAPTATION MEASURES
FOREST FIRES	**STAFF (Operational Risk)** • Provide PPE for workers who need to work when smoke is present due to forest fires (i.e. face masks). • Develop health and safety guidelines for risks associated with smoke and fires. • Review/update emergency response plan to include actions plan for evacuation. Develop community communication plan to assist when community threatened by forest fires (See (www.firesmartcanada.ca). • Create a fire break around the community. • Develop community policy to regulate/stop burning when fire risks are high. **THIRD PARTY SERVICES – Airport – Runways/Taxiway** • Include possible closure of airport in community emergency response plan. • Install weather station at the airport to provide real time weather reporting. • Explore the potential for all season road access to community to reduce dependency on air travel as only access to community.

LIST OF ABBREVIATIONS

ACRS	Asset Condition Reporting System
CAIS	Condition Asset Inventory System
CRA	Climate Risk Assessment
COO	Chiefs of Ontario
FN-IRT	First Nations - Infrastructure Resiliency Toolkit
HORCI	HydroOne Remote Communities Inc.
HVAC	Heating, ventilation and air conditioning
ICMS	Integrated Capital Management System
INAC	Indigenous and Northern Affairs Canada
IPCC	Intergovernmental Panel on Climate Change
ISC	Indigenous Services Canada
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
PPE	Personal Protective Equipment
SCADA	Supervisory Control and Data Acquisition

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, economic interests, 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 and frequency of weather events can produce additional loads increasing the risks of asset failure.

Infrastructure vulnerability and risk assessments are the foundations to ensure climate change is considered in engineering design, operations and maintenance of public infrastructure, buildings, and facilities. Early identification of the services and related assets that are highly vulnerable to climate change impacts is important to allow time to plan and implement cost-effective solutions to adapt to these new weather risks.

This report presents the results of the Climate Risk Assessment (CRA) conducted by Stantec Consulting Ltd. ("Stantec") for Kasabonika Lake First Nation (KLFN) using the First Nations Infrastructure Resiliency Toolkit (FN-IRT), a methodology adapted from Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol [https://pievc.ca/protocol] to assess climate risks to infrastructure in First Nation communities.

1.1 COMMUNITY DESCRIPTION

Kasabonika Lake First Nation (KLFN) is a remote, fly-in access First Nation Oji-Cree community of approximately 1,000 members situated on an island on Kasabonika Lake of the Asheweig River watershed of Northwestern Ontario, located approximately 460 kms northeast of Sioux Lookout, Ontario. Year-round access is by aircraft operated by Wasaya Airlines providing regular scheduled passenger service between Sioux Lookout and Thunder Bay/Winnipeg. A 1,100 m gravel air strip is operated and maintained by Ministry of Transportation Ontario (MTO). The MTO also maintains a bailey bridge, which provides the only road access between the island and the mainland.

A winter road is constructed annually in the late winter months providing access by community members using personal vehicles and for the mobilization of large volumes of fuels, foods, construction materials, heavy equipment, and other bulk goods required by the community. The duration of the winter road is typically 4-6 weeks from February to March - subject to weather (temperatures, snowfall, ice thicknesses).

The land base of Kasabonika Lake reserve is 101.5 km^2. Population is 848 with a total of 212 private residences in the community. (Source: Kasabonika Lake Indian Reserve, Census Profile, 2016 Census https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=3560096&Geo2=PR&Code2=35&SearchText=Kasabonika%20Lake&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3560096&TABID=1&type=0)

Figure 1: Satellite view of Kasabonika Lake Community and surrounding area (Source: Bing Maps,

https://www.bing.com/maps?cp=53.525011~-88.624323&lvl=14&q=Kasabonika%20Lake%20Indian%20Reserve%2C%20Ontario%2C%20Canada)

The weather in the region is characterized as having warm summers and cold winters. Summer temperatures range from 10 - 35 degrees Celsius. Winter temperatures can range from -10 to -40 degrees Celsius. Frigid Arctic winds from the north can produce more drastic temperatures due to the wind chill factor. Climate trends for the Kasabonika Lake area are discussed further in Section 3.3 of this report.

1.2 SCOPE OF THE STUDY

The objectives of the study are to:

- Identify Kasabonika Lake infrastructure vulnerabilities to current and future severe weather events associated with the impacts of climate change. Kasabonika Lake infrastructure considered in the study is discussed further in Section 3.1.

- Establish a climate risk profile for the infrastructure considered at risk by the community.
- Provide adaption strategies and recommendations for mitigating climate risks for the identified highest consequences and impacts to the community's infrastructure assets.

1.3 PROJECT TEAM

The Project Team included key band staff, Chief and Council and community members from Kasabonika Lake First Nation, OFNTSC, supported by subject matter experts from Stantec Consulting Ltd. The members of the Project Team are listed in **Table 1.**

Table 1: Project Team

Project Team	
Kasabonika Lake First Nation • Elton Mitchell Diabo, Councillor • Mike Morris, Community Coordinator • Chief, councillors and community members attending workshops • Operations and Maintenance staff Ontario First Nations Technical Services Corporation (OFNTSC) • Elmer Lickers, Senior O&M Advisor	Subject Matter Experts - Support Team • Guy Félio, Senior Advisor (Stantec) • Wayne Penno, Senior Engineer (Stantec) • Zoe Morrison, Planner (Stantec) • Heather Auld, Climatologist (RSI)

2.0 PROJECT DEFINITION

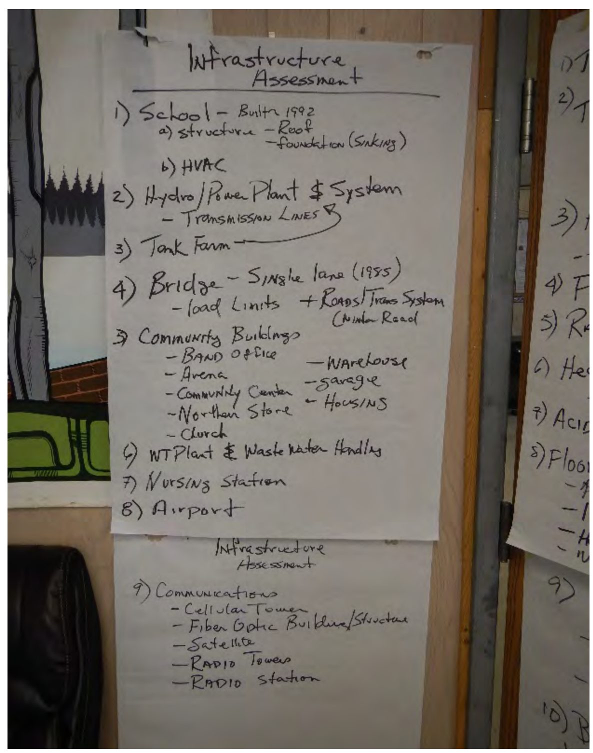
Workshop No. 1, presented on November 15, 2018, introduced the First Nations Infrastructure Resiliency Toolkit (FN-IRT) and the vulnerability assessment process, and provided a summary of the objectives of the project. Outcomes of Workshop 1 included the following. A copy of Workshop 1 presentation is included in **Appendix A** for reference.

> This first step of the Climate Risks Assessment (CRA) using the FN-IRT 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).

- Established a list of Kasabonika Lake infrastructure to be assessed, and any infrastructure performance concerns related to current climate.
- Created a list of past climate events that may have impacted the Kasabonika Lake infrastructure.
- Introduce the concept of Climate Severity Scale and how the scale is used in developing the FN-IRT Risk Matrix.

The Project Team decided to assess the climate (current and future) risks for a variety of Kasabonika Lake infrastructure assets. Details of the infrastructure assets to be assessed is found in Section 3.1.

- Community Buildings – Band office, arena, community center, northern store, church, warehouse and garage
- School
- Water and Wastewater Treatment Systems
- Residential Housing
- Hydro/Power Plant and System (NORCI)
- Nursing Station
- Airport
- Communication Systems and Components



Workshop No. 2 was held on November 16, 2018 and started with a review of the outcomes from Workshop No. 1. The remainder of the workshop focused on the risk assessment process using the FN-IRT, including a more detailed discussion on past climate events and impacts on Kasabonika Lake community and infrastructure. Outcomes from the workshop included the following (a copy of Workshop 2 presentation is included in **Appendix B** for reference).

- Completion and review of the Kasabonika Lake severity of impacts scale.

- Review and agreement of proposed probability scale for climate events.
- Review/selection of climate data (past climate events and impacts on infrastructure) and introduction to climate thresholds.
- Introduction of infrastructure performance considerations (structural, operational, functional) as they relate to the impacts of current and future climate events.
- Introduction of the FN-IRT climate vulnerability assessment process and the Risk Matrix worksheet.

2.1 CLIMATE RELATED CONCERNS

Part of workshop No. 2 included discussions among the workshop participants on how the weather has been changing in Kasabonika Lake. More specifically, they were asked to provide examples of any climate / weather events that have in the past or are currently affecting Kasabonika Lake FN infrastructure by causing infrastructure and/or operations disruptions and failures. Discussions were expanded to determine the threshold or intensity level of the climate events that would possibly cause damage or service disruptions should a component of the infrastructure be exposed to the event. The list of current climate events that have impacted the Kasabonika Lake community infrastructure are shown in **Figure 2.**

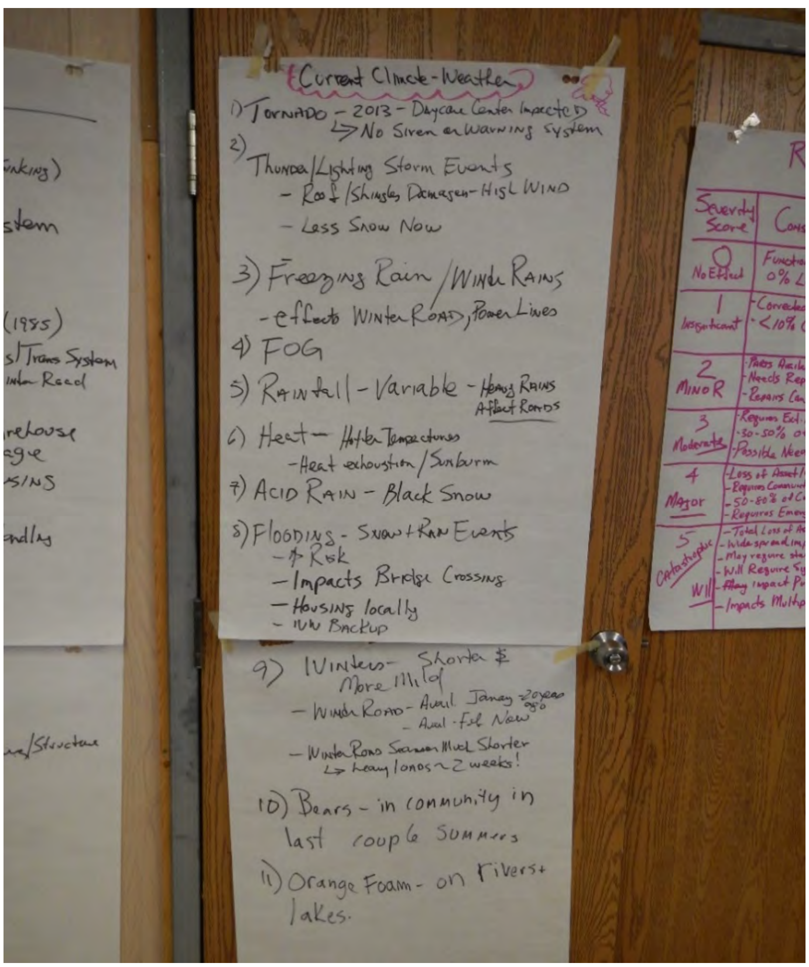


Figure 2: Kasabonika Lake - Current Climate Events (Source: CRA Workshop No. 2)

2.2 TIME HORIZON FOR THE STUDY

The time horizons selected for the study were as follows.

1. Current conditions (1950-2019) - used to establish baseline risks and trends.
2. 2020s - 2050s (2041-2070[2]) for future climate conditions.

Many of the Kasabonika Lake infrastructure assets were constructed in the 1990’s and early 2000’s. Given the current state of their infrastructure, a number of the Kasabonika Lake assets will be in an advanced stage of their service life and quite possibly exceeded their designed service life under the future climate time horizon selected for this assessment. It is important to continue to monitor the condition of all community assets to assess their vulnerability to climate events, since the risks of failure increase as the condition of the asset worsens with time and insufficient investments in Operations and Maintenance.

[2] 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 DATA COLLECTION

3.1 INVENTORY OF INFRASTRUCTURE COMPONENTS

Kasabonika Lake infrastructure assets selected for the climate risk assessment (CRA) were divided into three general categories for assessment.

1. Buildings - Nursing station and School
2. Support Infrastructure - Water and wastewater systems and Roads (includes winter road)
3. Third party services
    a. Electricity/Power Supply – Provided by HydroOne Remote Communities Inc (HORCI)
    b. Telecommunications – Provided by TBay Tel
    c. Airport – Maintained by Ministry of Transportation (MTO)
    d. Bridge - Maintained by MTO

Many of the community infrastructure buildings were visually inspected during tours of the community while the project team was on site. Additional information on the condition, age, etc. of the community assets are primarily based on the Kasabonika Lake ACRS reports provided to Stantec for reference. The locations of the community's assets being assessed are show in **Figure 3**.

Indigenous Services Canada is investing up to $41.2 million for education infrastructure in Kasabonika Lake, which includes renovations and additions to the existing school to accommodate Grades K4-6 students, construction of a new 3,000 m^2 school to accommodate approximately 180 Grade 7-12 students, and improvements to teacher accommodations in the community. Work on the teacher accommodations is under way. Construction of the new school and renovations and additions to the existing school are expected to begin in spring of 2020. (Source: News Release, Indigenous Services Canada; https://www.canada.ca/en/indigenous-services-canada/news/2019/08/grand-opening-of-expanded-nursing-station-and-funding-support-for-education-facilities-in-kasabonika-lake-first-nation.html).

3.1.1 Community Buildings

EMILY ANDERSON MEMORIAL MENOYAWIN HEALTH CENTRE (NURSING STATION)

The original nursing station is a single-storey timber framed structure on a concrete basement. The building has prefinished metal soffits, fascia and eaves troughs. Information on the age and condition of the nursing station is not available as the asset is not listed in the 2017 ACRS report, therefore in not an ISC funded asset of the community.

At the time of the site visits, modifications (renovations/addition) to the nursing station were being completed. The existing nursing station is being repurposed into a nursing residence.(Source: Penno-Co Construction Website; https://www.penn-co.com/projects/kasabonika-health-center).

The new nursing station has been increased in size to a total of 1898 m^2, which includes an addition to the existing health facility. The additional space allows for new residences, additional exam and emergency rooms and will also support an expanded range of health services and programs related to public health and dental care including children's oral health. The New Nursing station (shown in photograph to the right) was officially opened in the summer 2019.

The existing health facility is being renovated into a nurse’s residence. The building is constructed on strip footings and a concrete crawlspace wall. The super structure will be wood frame construction with shingles and Hardie board/siding finish.

CHIEF SIMEON MCKAY EDUCATION CENTER (SCHOOL)

The Chief Simeon McKay Education centre (school) was constructed in 1994. The building is a 2,460 m^2 timber frame construction with concrete foundation walls, hardboard lap siding and pre-finished metal roof and flashing. There is a partial finished basement. A large portion of the building is underlain by a crawl space with a dirt floor, which has reportedly flooded at times during spring melt. The building is in fair condition (4/10), with an estimated remaining service life of 15 years (Kasabonika Lake First Nation, 2017 ACRS Report, Neegan-Burnside, June 2017).

The school has14 classrooms for students from Kindergarten to Grade 12 including a gymnasium, library and industrial arts, science, and a multi-purpose room which are being used as high school classrooms. Interior finishing’s include vinyl sheet and carpeted flooring, and painted drywall ceiling and walls. The building is equipped with safety equipment such as smoke detectors, fire alarms, sprinkler system, fire extinguishers, emergency exit signs, emergency lighting, door panic hardware, and handicap access. The building HVAC system includes four oil fired furnaces and water heaters located in the crawlspace/basement. The school is on community water and sewer services. A new play area equipped with outdoor equipment donated by the Dream Catcher Charity was recently constructed in 2019.

Data Collection
March 2, 2020

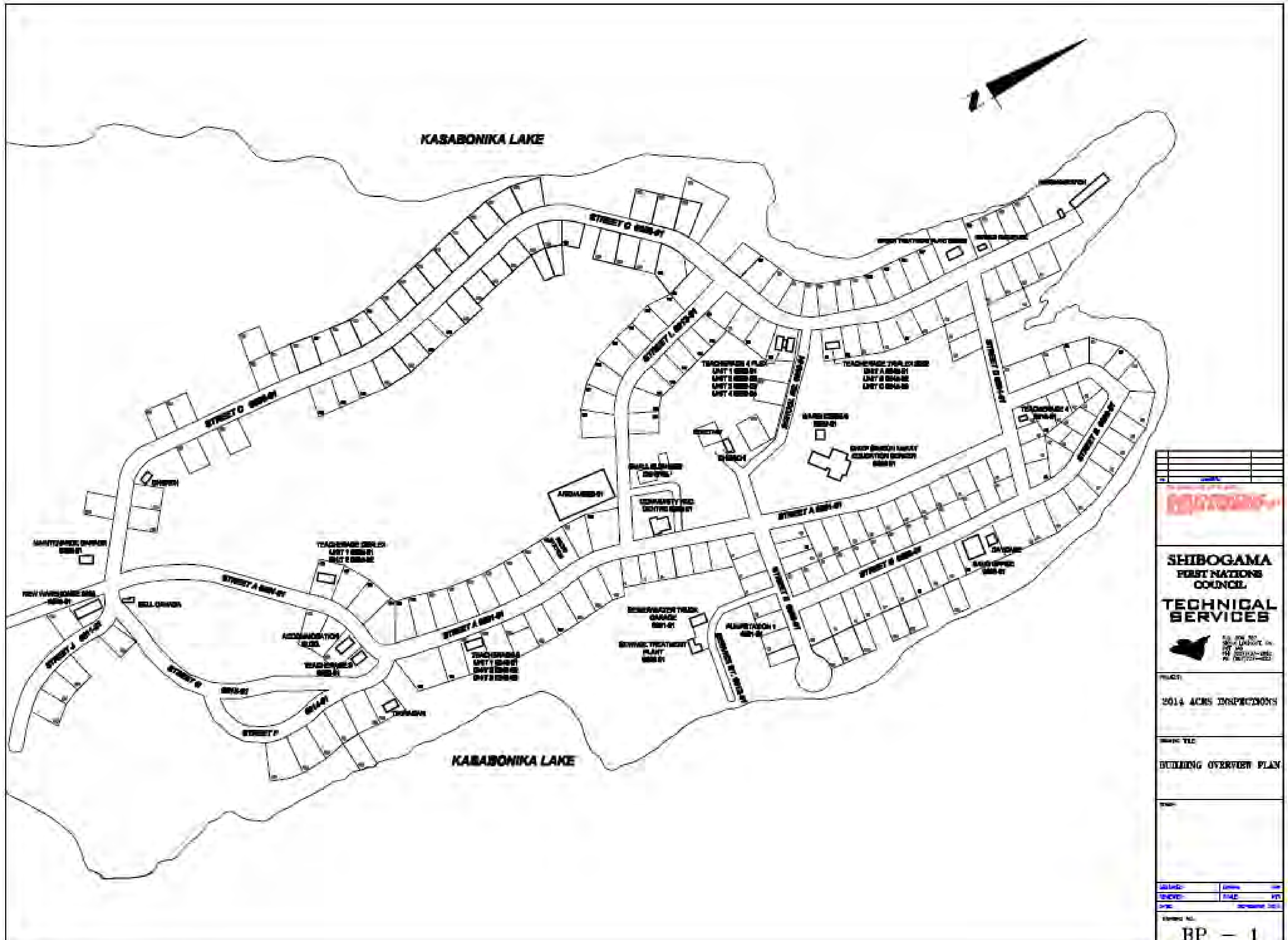


Figure 3: Kasabonika Lake First Nation – Building Overview Plan (Source: Kasabonika Lake First Nation 2014-15 REPORT, Asset Condition Reporting System (ACRS Report), Shibougama Technical Services, 2015)

3.1.2 Water and Wastewater Treatment Systems

3.1.2.1 Water Treatment System Components

WATER TREATMENT PLANT (WTP) BUILDING

The water treatment plant is located on the north shore in the northeast part of the island. The building is a steel frame construction with metal siding and prefinished metal roofing, soffits, fascia and eaves troughs. The building is heated by two forced air oil furnaces (Source: 2017 ACRS Report). The original building which was constructed in 1992 and expanded and upgraded in 2006. The Upgrade involved a 292 m² building addition constructed to house the process, control room/office, chemical feed room, chemical storage room, and incorporate the existing wet well. The raw water and treated water systems, HVAC and electrical systems were also upgraded (Source: Project Approval Request, Kasabonika Lake First Nation Sewage Lagoon and Associated Works Project, 2014; Project ARB9B, Prepared by Aboriginal Affairs and Northern Development Canada).

The WTP building houses three packaged water treatment units, electrical and process control panels, high lift distribution pumps, piping, and valves and a back-up generator. Treated water is stored in a wet well located below the concrete floor. The building is equipped with an office, lab facility and washroom. The water treatment system is monitored and controlled through a SCADA system.

The water treatment plant has a general condition rating of fair (5/10), and an estimated remaining life of 15 years (Source: 2017 ACRS Report).

POTABLE WATER DISTRIBUTION SYSTEM

Potable water from the water treatment plant is distributed to the community by a network of 200 mm and 150 mm underground pipes (See **Figure 4**). The water distribution systems consist of 1,855 m of 150 mm pipes, 2,469 m of 200 mm pipe and 28 fire hydrants. (Source: Project Approval Request, Kasabonika Lake First Nation Sewage Lagoon and Associated Works Project, 2014; Project ARB9B, Prepared by Aboriginal Affairs and Northern Development Canada).

All water piping is rated as being in fair condition (5/10) with a remaining life of 20 years (Source: 2017 ACRS Report).

3.1.2.2 Wastewater Treatment System Components

WASTEWATER COLLECTION SYSTEM

Raw sewage from the houses and community buildings is transferred to four pumping/lift stations by a network of underground sanitary mains (See **Figure 4**). The wastewater collection system consists of 1,855 m of 150 mm pipes and 4,240 m of 200 mm pipe. There are 37 manholes installed to provide access to the sanitary system.

Lift stations 1, 2 and 3 transfer sewage waste to pump Station 1. Sewage is pumped from Pump station 1 through a 150 mm sanitary force main/outfall pipe that leaves the island south of the old RBC treatment building and flows through a submerged pipe in the lake to the mainland, then by buried pipe to a three-cell lagoon. (Source: Project Approval Request, Kasabonika Lake First Nation Sewage Lagoon and Associated Works Project, 2014; Project ARB9B, Prepared by Aboriginal Affairs and Northern Development Canada).

The majority of the sanitary mains were installed in 1992 and 1995. They have a condition rating of fair (6/10) and an estimated service life of 15-20 years. Sanitary pipes vary in age from 1960 to 2005. Most of the sanitary pipes are rated in fair condition (5/10) with an expected remaining service life of 10-15 years. The pump and lift stations have general condition ratings from 4/10 to 6/10, with an expected remaining service life from 10 to 15 years (Source: 2017 ACRS Report).

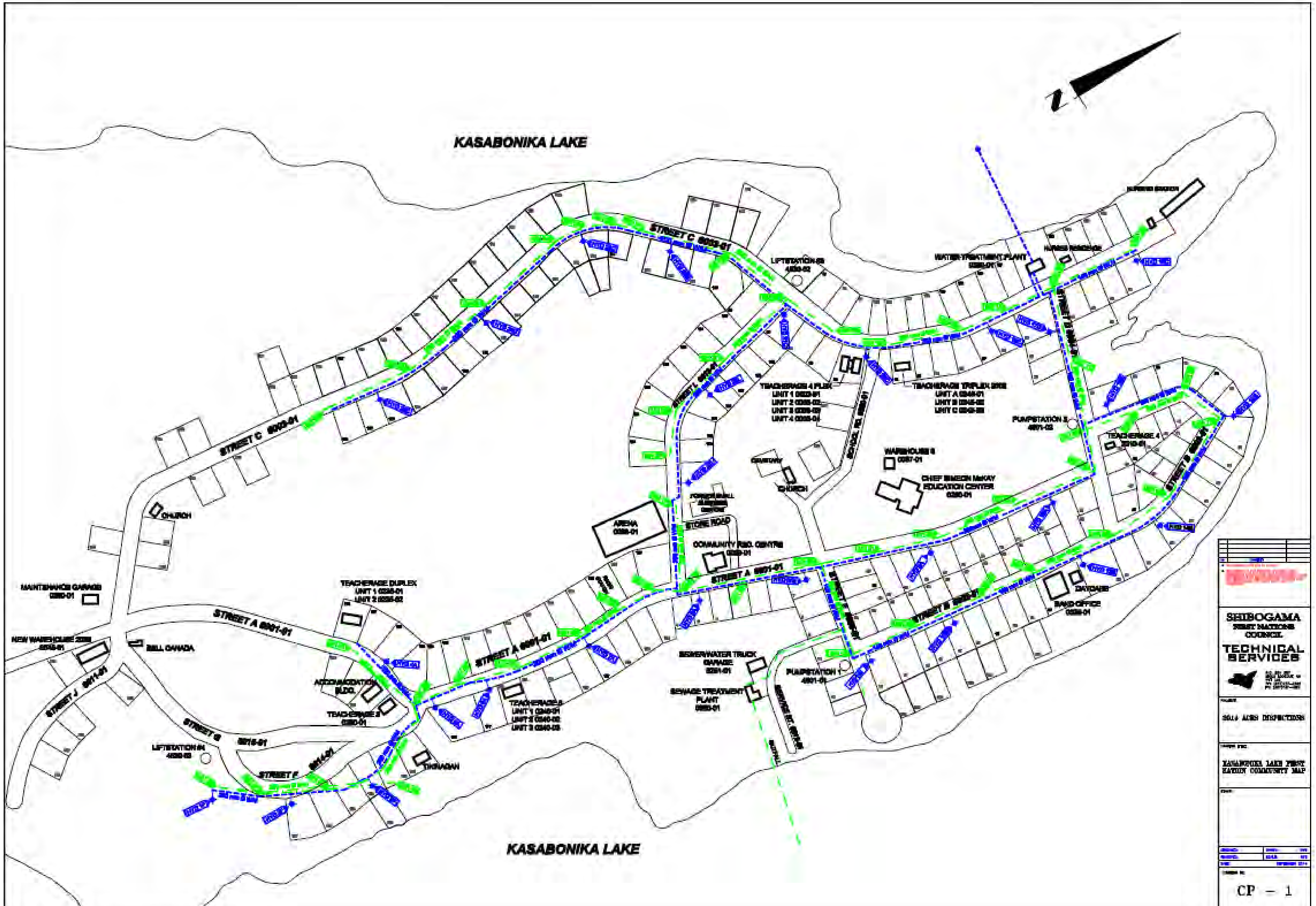


Figure 4: Kasabonika Lake First Nation – community services map (Source: Kasabonika Lake First Nation, Asset Condition Reporting System (ACRS Report), Shibogama Technical Services, 2017)

Data Collection
March 2, 2020

LAGOON

The old lagoon was constructed in 1992 and had a condition rating of 3/10 and a remaining service life of two years (2017 ACRS Report). Sewage was originally treated by a rotating biological contactor (RBC) before being transferred to the lagoon. The RBC which had an original design capacity of 170,000 L/day no longer met the treatment requirements of the community and was decommissioned in 2017.

A new three-cell facultative lagoon was constructed on the mainland south of the community (See **Figure 5**). The lagoon is comprised of two deep treatment cells and one deep storage cell. The new lagoon has been sized as a seasonal (12 month) retention lagoon, with a spring discharge one month after “ice off”. The lagoon will discharge seasonally 100% of the storage cell and 50% of each treatment cell to a tributary of Kasabonika Lake approximately 2 km upstream from the community (Source: Project Approval Request, Kasabonika Lake First Nation Sewage Lagoon and Associated Works Project, 2014; Project ARB9B, Prepared by Aboriginal Affairs and Northern Development Canada).

Figure 5: Kasabonika Lake lagoon and associated work, overall site plan, (Source: Project Approval Request, Kasabonika Lake First Nation Sewage Lagoon and Associated Works Project, 2014; Project ARB9B, Prepared by Aboriginal Affairs and Northern Development Canada)

3.1.3 Third Party Services

3.1.3.1 Power/Electricity (HORCI)

Power is provided to the community by HydroOne Remote Communities Inc (HORCI) who operate a diesel power generation station adjacent to the airport. Power is provided by three generators, with the size selected to meet the electrical demands of the community while minimizing operation costs. Power is transmitted from the generation plant to the community by overhead wires mounted on wooden poles.


3.1.3.2 Kasabonika Lake Airport

Kasabonika Lake is serviced by a 1,100 m gravel air strip operated and maintained by Ministry of Transportation Ontario (MTO). Wasaya Airlines provide regular scheduled passenger service between Kasabonika Lake, Sioux Lookout (Thunder Bay) and Winnipeg. The airport provides the only year-round access to the community.


3.1.3.3 Telecommunications

A Cellular Tower was installed in 2011 through a partnership between K-Net and Dryden Municipal Telephone System (DMTS). Kasabonika now owns the tower and delivers local cellular phone coverage as well as wireless Broadband Internet services.

Nishnawbe Aski Nation and Bell Canada have run a Fibre Optic cable from Wunnumin Lake First Nation to Kasabonika. Bell Canada own the trunk cable off reserve while Kasabonika Lake First Nation own the cable on reserve for future services via fibre (Source: Project Approval Request, Kasabonika Lake First Nation Sewage Lagoon and Associated Works Project, 2014; Project ARB9B, Prepared by Aboriginal Affairs and Northern Development Canada).

3.1.3.4 Bridge

The community of Kasabonika lake is located on an island. Access to the mainland is by a single lane bailey bridge operated by the Ministry of Transportation (MTO).

3.2 CONDITION OF INFRASTRUCTURE COMPONENTS

An automobile tour of the Kasabonika Lake community infrastructure was completed as part of community site visits. Detailed field inspections of the infrastructure to assess the condition/performance rating of the assets were not completed by the Project Team. The condition ratings referenced in this CRA study are based exclusively on the asset condition and performance information in the 2017 ACRS Reports and other information provided.

3.3 KASABONIKA LAKE CLIMATE CONSIDERATIONS

3.3.1 Climate Profile

The main source of current climate data for the Kasabonika Lake First Nation climate risk assessment was the NRCANmet dataset. NRCANmet was produced by Natural Resources Canada (NRCan) and provides daily maximum and minimum temperature and total precipitation data at 300 arc second spatial resolution (~10 km) over Canada for the 1950-2017 time period (Hopkinson et al., 2011; McKenney et al., 2011).

Future climate projections are based on the Intergovernmental Panel on Climate Change (IPCC) RCP[3] 8.5 scenario,

> 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.

[3] 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.

which is considered the global “business as usual” greenhouse gas emissions track (IPCC, 2018). The figures below provide examples of data used for the study.

3.3.1.1 Temperature

Between 1948 and 2016, Ontario has experienced an average annual mean temperature change of 1.3°C and seasonal mean changes ranging from 1.0°C in the autumn to 2.0°C in the winter (Bush and Lemmen, 2019). Temperature changes reflected across the province are more pronounced in the North, with up to 4.3°C of warming in winter months. Regional projections under RCP 8.5 anticipate a further increase in annual mean temperature of 2.3°C and 6.3°C for 2031-2050 and 2081-2100 respectively for Ontario (Bush and Lemmen, 2019). It is noted that climate changes in the region are expected to be more pronounced during the winter months than through the summer (Bush and Lemmen, 2019). These climate changes are reflected in the projection information presented in the following figures and tables, which are more specific to the Kasabonika Lake area.

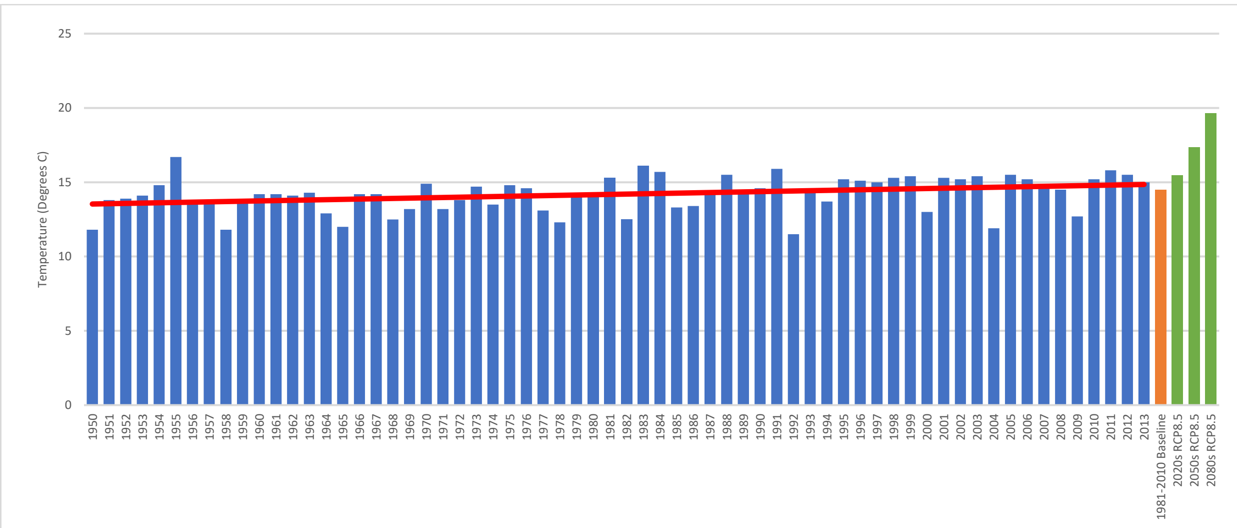


Figure 6: Mean Daily Temperature for Summer - Historical Trend and Future Climate Projection (NRCANmet data, RCP 8.5, 63-year period)

Table 2: Occurrence of Maximum Temperatures, NRCANmet (Location: -88.65, 53.58)

Maximum Temperature Threshold	Annual Occurrence of Days above Max. Temp (Days/year)						
	Historical 1981-2010	RCP 8.5					
		2020s	Trend	2050s	Trend	2080s	Trend
30°C	1.6	3.7	↗	9.1	↗	21.2	↗
35°C	0.2	0.2	→	1.1	↗	5.4	↗

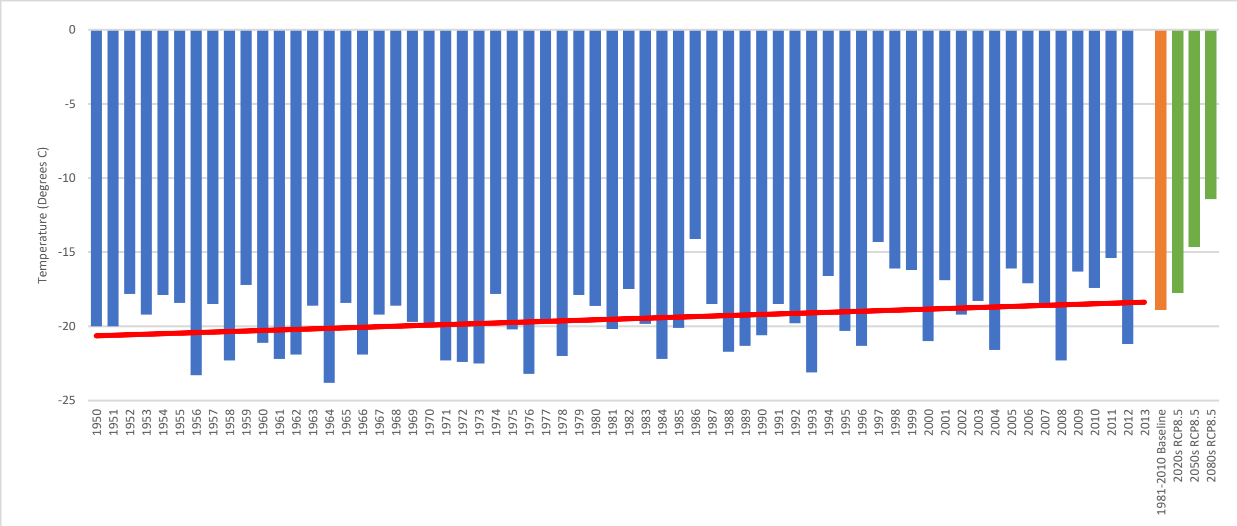


Figure 7: Mean Daily Temperature for Winter - Historical Trend and Future Climate Projection (NRCANmet data, RCP 8.5, 63-year period)

Table 3: Occurrence of Minimum Temperatures, NRCANmet (Location: -88.65, 53.58)

Minimum Temperature Threshold	Annual Occurrence of Days below Min. Temp (Days/year)						
	Historical 1981-2010	RCP 8.5					
		2020s	Trend	2050s	Trend	2080s	Trend
-30°C	32.5	21.8	↘	9.4	↘	2.2	↘

3.3.1.2 Temperature Trends in the Kasabonika Lake Area

Due to issues with missing data in the immediate vicinity of Kasabonika Lake First Nation, trends are analyzed using the NRCANmet gridded dataset. Historically, increasing temperatures are observed across all seasons, with the largest increases observed in the winter season (2.3 °C since 1950). Projections show that all seasons are likely to warm into the future, with a warming of average daily temperatures in all seasons between 3-5 °C.

The warming of the climate system has also led to important changes in extreme temperatures. Historical occurrences of extreme heat periods have increased since 1950 and are projected to increase nearly nine times the current frequency by the 2050s, with increases from 1-2 events per year to approximately 9 events per year. Winter months show opposing trends, with the number of extreme cold days projected to decrease from a little over a month of the year to just over a week on average by the 2050s. Nevertheless, extreme cold events continue to occur and are still likely to occur in a warming climate, primarily in association with stuck and persistent weather patterns (e.g. polar vortex events) such as those seen in recent winters (2012-13, 2013-14, 2017-18, and 2018-19). Even with warming winter temperatures, it is likely that cold air outbreaks (or cold snaps) will continue to occur.

3.3.1.3 Ice Road Impacts

Increasing temperatures in the cold season are already causing impacts on the reliability of winter road seasons, with shortened and less reliable winter road seasons showing up year to year. Projections show a decrease in the number of freezing days (as measured by the freezing index) from a historical average of approximately 150 days to a new average of 130 days by the 2050s. This represents nearly a month of lost freezing potential for winter road access.

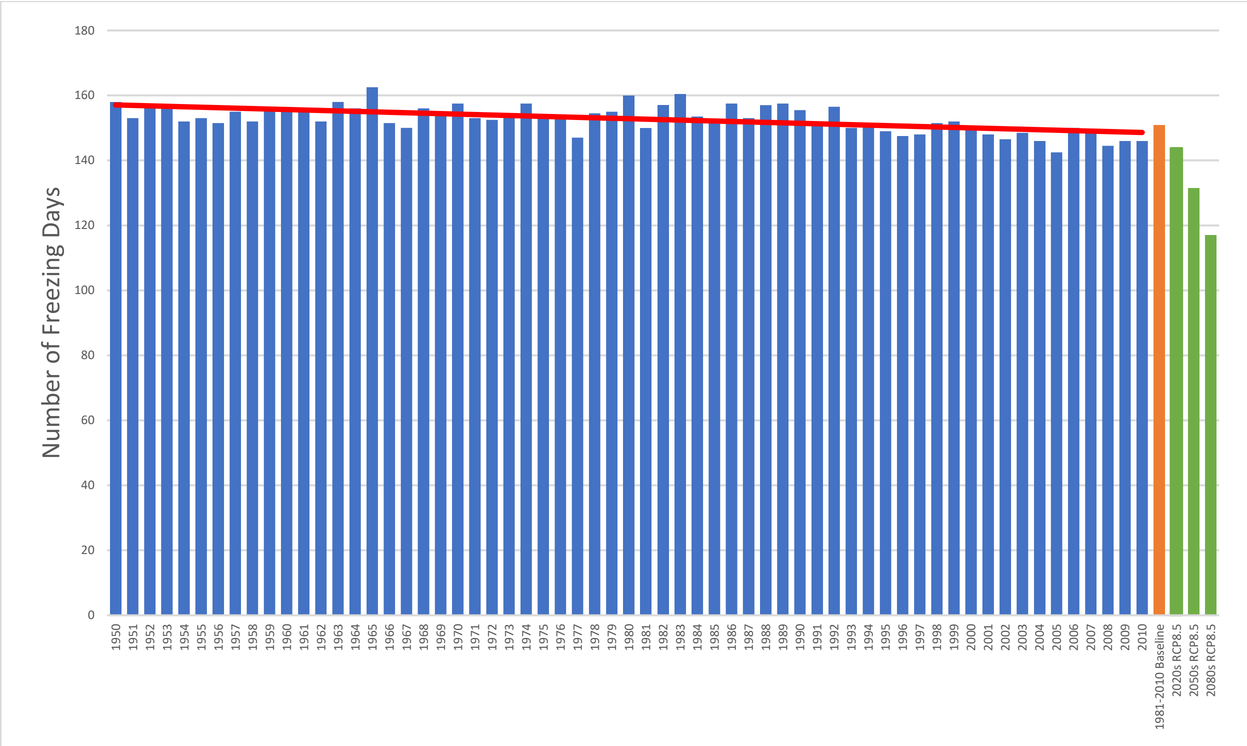


Figure 8: Frequency of Freezing Days (measured as days with mean temperature below 0 C) for Kasabonika Lake. NRCANmet data, RCP 8.5, 60-year period

3.3.1.4 Precipitation – Annual Totals

Based on available literature, total annual accumulated precipitation in the region has been found to increase over the past several decades. In Ontario, the average annual precipitation has increased by 9.7% between 1948 and 2012 (Bush and Lemmen, 2019, Vincent et al., 2015). The amount of precipitation during these periods is noted to vary seasonally, ranging from an increase of 5.2% in the winter months to 17.8% in the autumn months (Bush and Lemmen, 2019, Johnson et al., 2005, Vincent et al., 2015).

Unlike patterns of temperature change, patterns of precipitation are highly variable in time and space. Precipitation patterns are reflected in the historical data presented in the following figures and tables. Some of the uncertainty comes from the spatial density of observation stations across Canada, which has been historically decreasing since the late-20th century. The uncertainty in the historical precipitation data in the area does not affect the projected future trends, which rely on global climate model results relative to the climate normal values for the station.

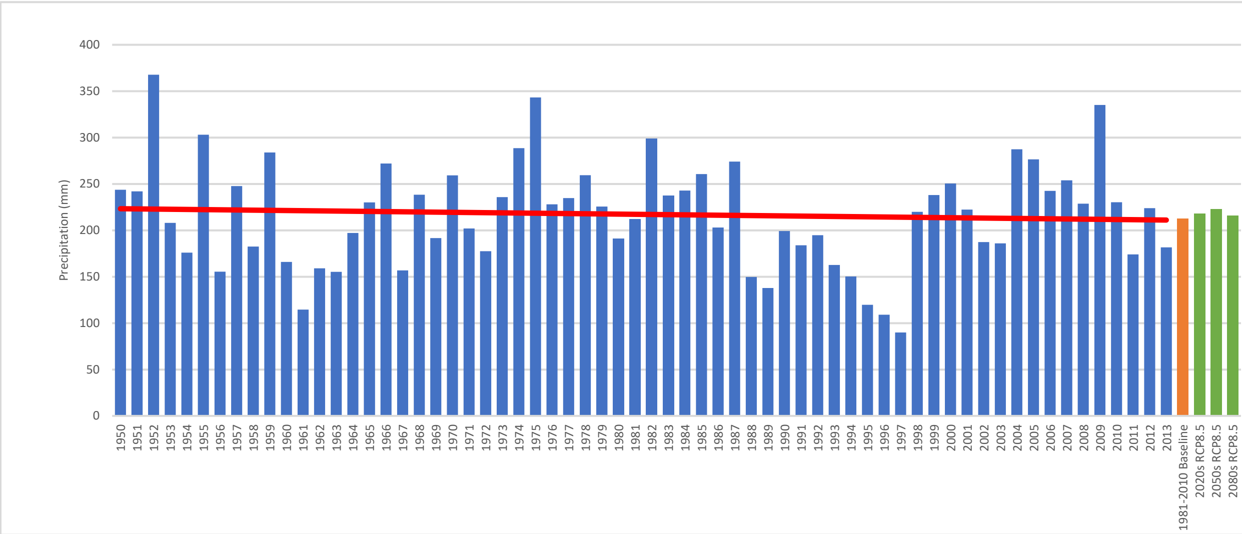


Figure 9: Total Precipitation during Summer Months - Historical Trend and Future Climate Projection (NRCANmet data, RCP 8.5, 63-year period)

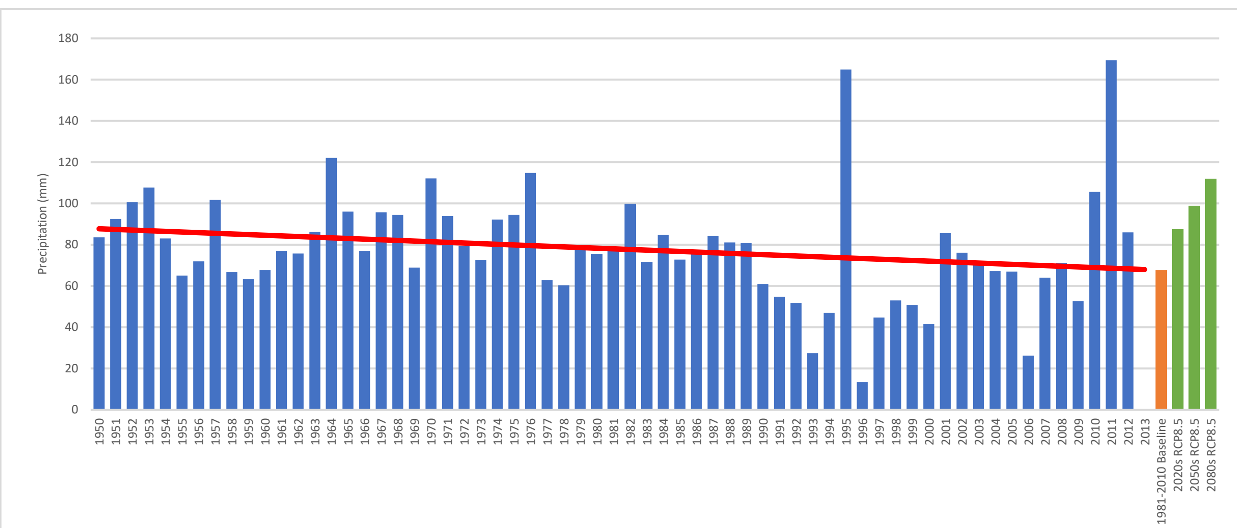


Figure 10: Total Precipitation during Winter Months - Historical Trend and Future Climate Projection (NRCANmet data, RCP 8.5, 63-year period)

3.3.1.5 Precipitation Trends in the Kasabonika Lake Area

Precipitation trends in the Kasabonika Lake area are likely changing, though due to distance to nearby stations (> 50 km) and overall data availability issues are harder to detect than temperature trends. Historical trends from NRCANmet have been relatively steady over the 63-year time series. There is potential for increasing precipitation (both rain and snow) annually and in nearly all seasons under a warming climate by the 2050s. Summer precipitation is likely steady historically, with projected changes indicating mid-century increases followed by end-of-century decreases. This pattern is similar to patterns observed and projected in the Prairies, where the variability of summer precipitation has increased. Winter and spring precipitation show little change historically, though missing data is likely a large factor in any trends reflected in the historical data.

Table 4: Average Percent Change in Total Annual and Seasonal Precipitation from 1981-2010 Baseline, NRCANmet (Location: -88.65, 53.58)

Season	Historical 1981-2010 (mm)	Average Percent Change in Total Precipitation from 1981-2010 Baseline (%)					
		RCP 8.5					
		2020s	Trend	2050s	Trend	2080s	Trend
Annual	542.4	7	↗	14	↗	18	↗
Winter	67.6	7	↗	20	↗	36	↗
Spring	89.9	11	↗	20	↗	32	↗
Summer	212.8	2	→	5	↗	2	→
Autumn	164.4	7	↗	13	↗	18	↗

3.3.1.6 Drought and Wildfire

In the Kasabonika Lake region, there is an increasing likelihood of forest fires due to increases in overall summer precipitation variability (e.g. prolonged dry periods). This effect, coupled with increasing summer temperatures, increases the amount of evaporation in the area and increases the probability of drought conditions. This has led to increases in the length of the fire season, stemming from increases in lightning, stuck and persistent weather patterns, and smoke intrusions into the region from distant fires.

Historically, five wildfire evacuations have occurred for Kasabonika Lake and the surrounding region since 1989. This is likely to increase into the future, as climate projections show that the likelihood of forest fire occurrence will increase by up to 300%. This stems in part from the relationship that every 1 °C of warming results in an increase of lightning strikes by up to 12%.

3.3.1.7 Wind

Due to the lack of data in the immediate vicinity of Kasabonika Lake First Nation, the closest weather monitoring station with published wind data is the Big Trout Lake weather monitoring station, located approximately 85 km away from the community. Extreme winds observed at Big Trout Lake may not be completely reflective of the winds for Kasabonika Lake, but climate data indicates that similar patterns of general weather have occurred in the region.

Estimates from Big Trout Lake indicate that wind gusts exceeding 100 km/hr occur approximately once every ten years (1:10 return period) while gusts of 90 km/hr or greater occur once every three to four years (1:3 to 1:4). Extreme wind events are often filtered out of historical databases by automated quality control techniques, so the historical frequency of events may be underestimated for the most extreme events. One Ontario study (Zhang, 2014) suggests the number of events with wind speeds of over 90 km/hr has the potential to increase by up to 50% by the mid-21st century.

3.3.2 Climate Elements Selected For Risk Assessment

Table 5 is a list of climate parameters and associated thresholds selected for the Kasabonika Lake climate risk assessment. The climate events were determined though discussions with community and Project Team members at the various workshops. Where possible, traditional knowledge about current and past climate events was obtained through discussions with community Elders (See **Figure 11**). The climate events were evaluated on their impacts of infrastructure-weather interactions and selected on the potential to cause structural \ functional \ operational failures, or service disruptions on the community infrastructure being assessed.

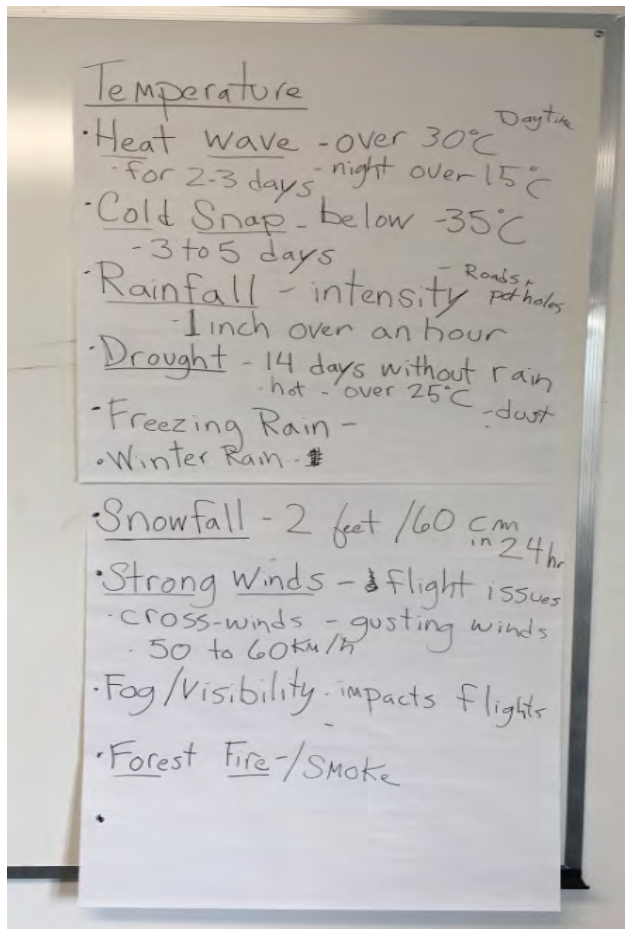


Table 5: Climate Elements and Thresholds Selected for the Kasabonika Lake FN Climate Risk Assessment

Climate Element	Climate Event	Description/Comment/Threshold
Temperature	Extreme Cold/Cold Snap	Cold temperatures of ≤-35°C for three or more consecutive days
	Heat Wave	Three of more consecutive days when the daytime high is >30º C and the overnight temperature remains >15º C
Precipitation	Heavy Snow Accumulation	>200cm of snow/year
	High Intensity Rainfall	>25mm of rain in one hour
	Freezing Rain	10mm of ice accumulation
	Drought	Temperatures >20º C during the day, and no accumulation of rain for > 14 days
	Fog	Decreased visibility impacts aircraft ability to land in community
Wind	High Winds	Wind gusts > 100 km/hour – creates issues with planes landing
Forest Fires		Smoke associated with fires is a health concern

Figure 11: Workshop 3- Meeting with Kasabonika Lake Community Elders

4.0 FN-IRT CLIMATE RISK ASSESSMENT PROCESS

The First Nation IRT risk assessment process is illustrated in the flow chart shown in **Figure 12**.

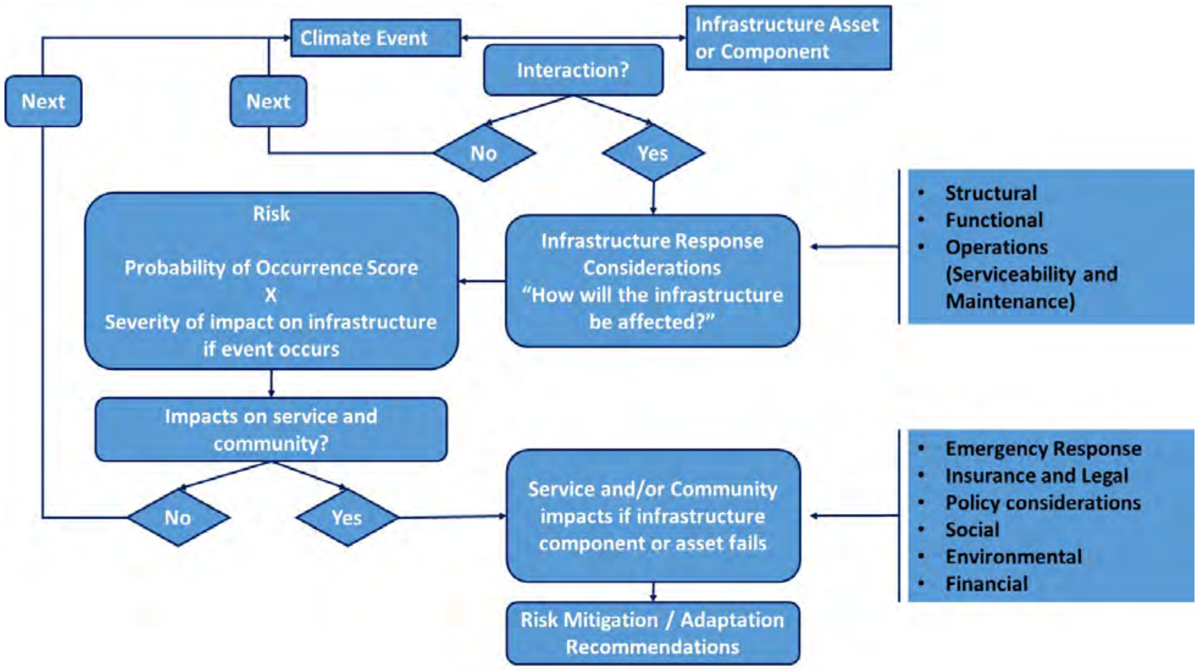


Figure 12: FN-IRT Risk Assessment Process Flowchart

The first step in completing the risk matrix worksheet (See **Figure 12** and **Appendix E)** is to decide if there is an interaction between an infrastructure component and a climate event (Question: If the selected climate event was to occur, would it interact with the infrastructure component?). Only those infrastructure asset components that are determined by the Project Team to be exposed or interact with a selected climate event are assessed for risks. If the infrastructure component is determined to interact with the climate event, then the Project Team evaluates the type of performance response (structural, functional, operations) the climate event will have on the component and assigns a severity score (1 to 5) using the Kasabonika Lake Severity Scale (See Section 4.3 **Table 9**) for each type of performance response. The performance response considerations used for this CRA are:

Structural Integrity – The climate event results in physical damage or deterioration to the infrastructure component. Examples include fracture or failure, material fatigue or weakening, cracking, deflection or permanent deformation of the component. Shingles being blown off by high winds is an example of a structural failure of a roof component.

Functional Response (Functionality) – The climate event results in a reduction in the capacity of the infrastructure component to perform its design function at its original/current condition. Examples include a partially blocked culvert has a reduced ability to allow water to flow through; and an aging HVAC unit will not be able to provide heating/cooling at the same level as when it was in new condition.

Operational Response – The effect the climate event will have on the ability of staff to perform repairs, O&M requirements and additional inspections for external support, and the resulting impacts on O&M and capital budgets. For example, the climate event results in additional operations and maintenance time/costs, staff increases due to overtime, emergency response considerations and so forth.

For each infrastructure component that is deemed to interact with the climate event, the project team is asked to assign a severity score to the expected impact the event would have on the infrastructure component from a structural, functional and operational perspective. Once the severity of the impact of the climate event is determined for each performance response, the risk to the infrastructure component is determined by multiplying the severity score by the probability of the climate event occurring.

RISK = SEVERITY OF IMPACT (Caused by Climate Event) X PROBABILITY OF CLIMATE EVENT OCCURING

Risks are tabulated for structural, functional and operational responses for the affected infrastructure components, and calculated for both current and future climate scenarios. The final step in the climate risk assessment is developing risk adaption and mitigation strategies for the highest risk identified. This is completed in Workshop No. 4.

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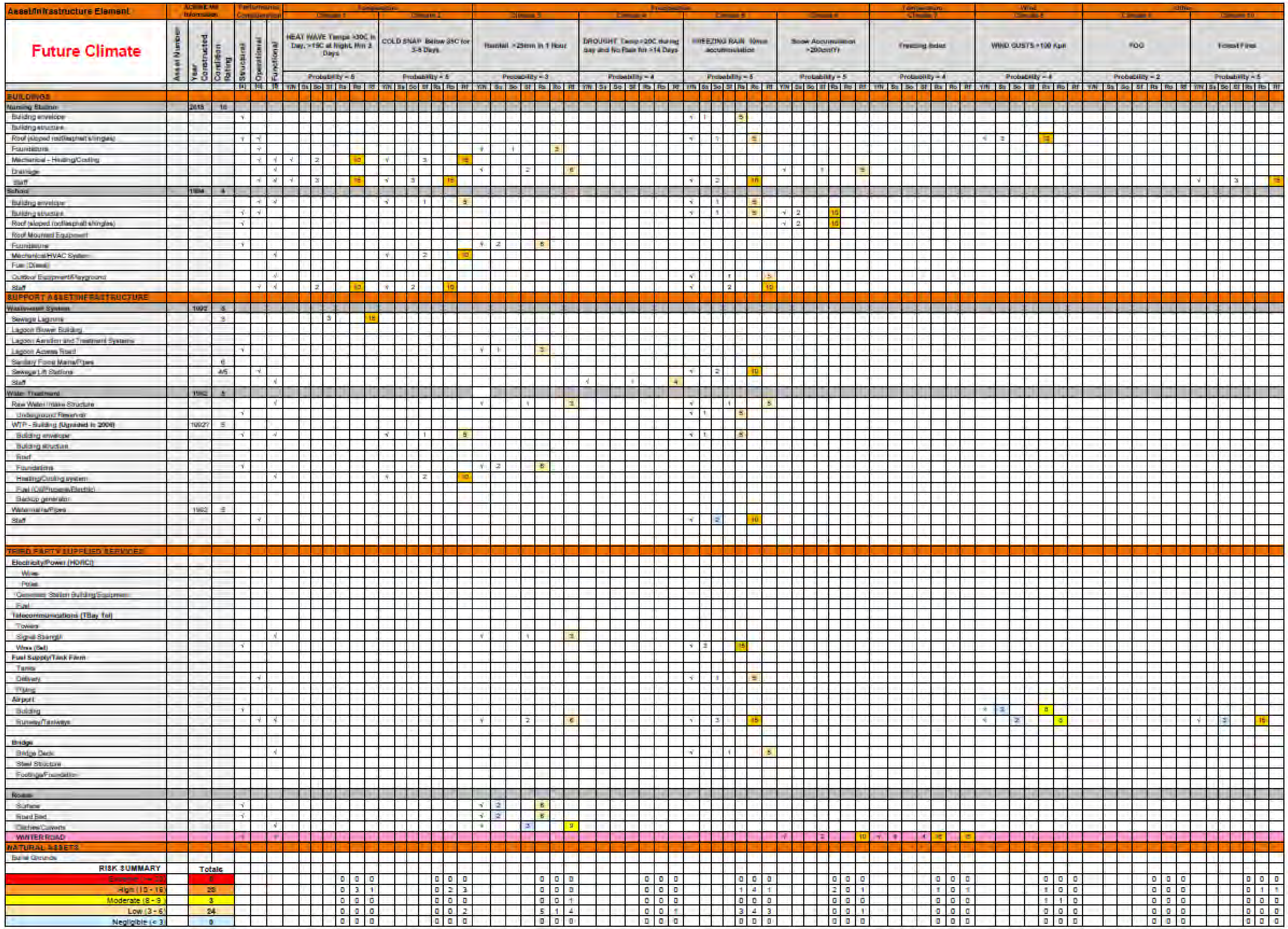
FN-IRT Climate Risk Assessment Process
March 2, 2020



Future Climate

Climate parameters: Temperature – Climate 1: HEAT WAVE Temps >30C in Day, >19C at Night, Min 3 Days (Probability = 5); Climate 2: COLD SNAP Below 35C for 3-5 Days (Probability = 5). Precipitation – Climate 3: Rainfall >25mm in 1 Hour (Probability = 3); Climate 4: DROUGHT Temp >20C during day and No Rain for >14 Days (Probability = 4); Climate 5: FREEZING RAIN 10mm accumulation (Probability = 5); Climate 6: Snow Accumulation >200cm/Yr (Probability = 5). Temperature – Climate 7: Freezing Index (Probability = 4). Wind – Climate 8: WIND GUSTS >100 Kph (Probability = 4). Other – Climate 9: FOG (Probability = 2); Climate 10: Forest Fires (Probability = 5).

Asset/Infrastructure Element	Asset Number	Year Constructed	Condition Rating	Structural	Operational	Functional
BUILDINGS						
Nursing Station		2015	16			
Building envelope				√		
Building structure						
Roof (sloped roof/asphalt shingles)				√	√	
Foundations					√	
Mechanical – Heating/Cooling					√	√
Drainage						√
Staff					√	√
School		1994	4			
Building envelope					√	√
Building structure				√	√	
Roof (sloped roof/asphalt shingles)				√		
Roof Mounted Equipment						
Foundations				√		
Mechanical/HVAC System						√
Fuel (Diesel)						
Outdoor Equipment/Playground						√
Staff					√	√
SUPPORT ASSET/INFRASTRUCTURE						
Wastewater System		1992	5			
Sewage Lagoons			3			
Lagoon Blower Building						
Lagoon Aeration and Treatment Systems						
Lagoon Access Road				√		
Sanitary Force Mains/Pipes			6			
Sewage Lift Stations			4/5		√	
Staff						√
Water Treatment		1992	5			
Raw Water Intake Structure						√
Underground Reservoir				√		
WTP - Building (Upgraded in 2006)		1992/?	5			
Building envelope				√		√
Building structure						
Roof						
Foundations				√		
Heating/Cooling system						√
Fuel (Oil/Propane/Electric)						
Backup generator						
Watermains/Pipes		1992	5			
Staff					√	
THIRD PARTY SUPPLIED SERVICES						
Electricity/Power (HORCI)						
Wires						
Poles						
Generator Station Building/Equipment						
Fuel						
Telecommunications (TBay Tel)						
Towers						
Signal Strength						√
Wires (Bell)				√		
Fuel Supply/Tank Farm						
Tanks						
Delivery					√	
Piping						
Airport						
Building				√		
Runway/Taxiways					√	√
Bridge						
Bridge Deck						√
Steel Structure						
Footings/Foundation						
Roads						
Surface				√		
Road Bed				√		
Ditches/Culverts						√
WINTER ROAD				√		√
NATURAL ASSETS						
Burial Grounds						

RISK SUMMARY	Totals
Extreme (over 20)	0
High (10 - 16)	28
Moderate (8 - 9)	3
Low (3 - 6)	24
Negligible (< 3)	0

Figure 13: Sample of Kasabonika Lake Risk Matrix Worksheet

4.1 RISK THRESHOLDS

Risk is defined as the combination of the likelihood or probability of an event occurring and the resulting impact or consequences should the event occur. In the FN-IRT, the ***risk is defined as the probability of a climate event occurring and the impact or severity of damage to the infrastructure component should the climate event occur***. The probability/likelihood and impact/severity scores are each ranked on a 1 to 5 scale as shown in Figure 14.

Impact/Consequence on Infrastructure if Climate Event Occurs						
	Catastrophic 5	Special				EXTREME
	4				HIGH	
	3			MODERATE		
	2		LOW			
	Insignificant 1	NEGLIGIBLE				Special
		1 Highly unlikely	2	3	4	5 Likely / Frequent
		Probability/Likelyhood of Climate Event Occuring				

Figure 14: FN-IRT Risk Matrix

For the Kasabonika Lake climate risk assessment, the risk scores or threshold have been further divided and colour coded as shown in Table 6.

Table 6: Risk Scores and Adaptation Responses

	RISK SCORE	ADAPTATION RESPONSE
Extreme:	> 20	Immediate control required
High:	10 - 16	High priority control measures required
Moderate:	8 - 9	Some control measures required to reduce risks to lower levels
Low:	3 - 6	Control likely not required
Negligible:	< 3	Risk events do not require further consideration
Special Case:		Further analysis may be required; monitor
• P=1 & S=5	Special Case	Very low probability but high Severity
• P=5 & S=1	Special Case	High probability of occurring but insignificant impact or severity

4.2 CLIMATE PROBABILITY SCORING

Once the Project Team has selected the climate events for the CRA, the probability of each selected event needs to be estimated for current and future climate scenarios. The Project Team led by the project climatologist establish the probability of the climate events occurring (current and future climate) using the following table as a guide.

Table 7: Climate Risk Assessment Probability Scoring

Rating	Occurrence	Qualitative Descriptor	Quantitative Descriptor
1	**>1:50 year**	Highly Unlikely	• Not likely to occur in assessment period; or • Not likely to increase in intensity and/or duration during the assessment period
2	**1:10-50 year**	Remotely Possible	• Likely to occur once between 10-50 years; or • Likely to increase in intensity and/or duration over a 10 to 50-year period
3	**1:1-10 year**	Occasional	• Likely to occur at least once a decade; or • Likely to increase in intensity and/or duration over a decade
4	**10/year to 1:1**	Normal	• Likely to occur between 1-10 times annually; or • Likely to increase in intensity and/or duration on an annual basis
5	**>10/year**	Frequent	• Likely to occur more than 10 times annually

Table 8 presents the FN-IRT probability scores used in the Kasabonika Lake Climate Risk Assessment based on the results of the climate analysis (current trends and future projections) for the Kasabonika Lake area, and discussions with the Project Team.

Table 8: Probability Scores for Selected Kasabonika Lake Climate Events

Note: Where climate data was not available, the professional judgement of the Project Team based on local experience and knowledge was used.

Type of Climate Element	Description	Comment	Probability	
			Current Climate	Future Climate
Temperature	Heat Wave	Temperature >30C in day and >15C at Night. Min 3 consecutive days. Heat stress on operators, workers, elders.	4	5
	Cold Snap	Temperatures below -35C for 3-5 Consecutive days	4	5
	Declining Freezing Index	How much cold weather to make ice and frost in the ground.	2	4
Precipitation	Rainfall - High Intensity	>25mm in 1 Hour	2	3
	Drought	Temperature >20C during day and No measurable rain for >14 Days	2	4
	Freezing Rain	Ice accretion of 10mm.Makes roads/runway slippery; may break branches on trees.	3	5
	Snowfall	Annual accumulation >200cm/Yr	2	5
Wind	High Winds	Gusts >100 km/hr	3	4
Other Events	Fog	Affects visibily at airport. Restricts access.	1	2
	Forest Fires	Evacuation threat, smoke issues, impacts on power infrastructure	3	5

4.3 INFRASTRUCTURE SEVERITY OF IMPACTS SCORING

Climate Risk is defined as the probability of a climate event occurring multiplied by the severity of the damage to the infrastructure assuming the infrastructure is exposed to the climate event. During workshops 1 and 2, the Kasabonika Lake Project Team members were asked to develop a severity rating scale that reflects the community's understanding of the impact on their infrastructure.

The severity scale uses a scale between zero (0) and five (5), with 0 being defined as having no effect on the infrastructure, and 5 being catastrophic (i.e., having the greatest impact on the infrastructure). To further determine the type of impact the climate event will have on the infrastructure component, each severity scale unit was divided into three categories of performance criteria — structural integrity, functionality and operations.

The Project Team was asked to describe the type of impact the climate event would have on an infrastructure element for each severity ranking from 0 to 5, and for each type of exposure category. The severity rating scale developed by Kasabonika Lake Project Team is shown in Table 9.

Table 9: Kasabonika Lake First Nation – FN-IRT Assessment – Severity Rating Scale

Kasabonika Lake - Severity Scale

Score and Description	Consequence or Effect [Structural, Functional, Operational]
0 No effect	• Asset functions normally • No loss of service (LOS)
1 Insignificant	• Can be corrected through normal maintenance • <10% of customers affected by some LOS
2 Minor	• Parts required for repairs are available in the community • Repair crew required to correct issue • Repairs can be completed in the community (no outside services required) • 10-30% of customers affected by some LOS
3 Moderate	• Assistance from outside resources required to correct • Parts and services not available in the community • May require additional funding • 30-50% of customers affected/possible LOS
4 Major	• Loss of asset/component or several critical components • Requires community-based response/action plan • Requires emergency/additional funding • Requires alternate service delivery • 50-80% of customers affected by some LOS
5 Catastrophic	• Total loss of asset/equipment/service • May require declaration of State of Emergency/BCR • Will require significant additional funding (ISC/other) • Will impact public health and safety • Impacts multiple assets and asset components • Widespread impact on community (>80% of community impacted)

5.0 CLIMATE RISK ASSESSMENT

5.1 INFRASTRUCTURE RISK SCORING

During Workshop No. 3, the project team first selected the infrastructure components that would be impacted or affected by each climate event, and then assigned an applicable structural, functional, and operational severity score for the expected damage that could be caused to the infrastructure by the climate event. Using the assigned probability for each climate event, structural, functional and operational risks scores are calculated for each affected infrastructure component, for both current and future climate. The risk matrices for the Kasabonika Lake are included in **Appendix E** for reference.

5.2 SUMMARY OF RISK RESULTS

Table 10 presents a summary of the risk counts (moderate, high, and extreme) under current and future climate expectations. Key highlights from the risk assessment include:

- There were no extreme risks under current climate or under future climate projections.
- High risks increased by more that 500% under future climate.
- The highest risks were associated with the winter road, with concerns about how future climate will impact the freezing index.
- Tornadoes were found to have a broad impact on all infrastructure studied. While the occurrence of a tornado under current climate was low (probability score of 2), the Project Team felt the occurrence of a tornado under future climate was much higher (probability score of 4). The resulting changes largely explains the 400% increase in moderate risks under future climate considerations.
- Winds (Gusts over 100 km/h) and winds associated with summer storms (microbursts/straight-line winds) were found to result in moderate structural, functional and operational risks, mostly related to building roof structures and the grounds around buildings.
- Winds were a significant risk to third party services (power/electrical supply and telecommunications). This substantiates previous known impacts on the community associated with prolonged power outages.
- Heavy rains (i.e. High intensity/short duration, 25-50 mm in two hours) were a high risk under future climate, due to the increased possibility of local flooding. House foundations and cisterns for houses not on municipal services were the primary infrastructure at risk.

Table 10: Risk Summary - Moderate, High and Extreme Risks

Category	Risk Score Counts: Current Climate Count	Risk Score Counts: Future (2050s) Climate	Climate Events	Principal Infrastructure/Components Affected
EXTREME	0	0		
HIGH	4	26	• SNOWFALL – Total Accumulation of snow >200cm	• School – Structural risk (Rs=10) to the building structure and roof
			• FREEZING RAIN – Accretion of 10mm of ice	• Staff – Operational risk (Ro=10/15) to staff servicing the Nursing Station, water and wastewater treatment systems. • Airport – Operational impact (Ro=15) on the airport Runway/Taxiway. • Telecommunication – Structural Risks (Rs=15) to Bell wires.
			• HEAT WAVE – Temperatures >30C during the day and >15C during the night for minimum of 3 consecutive nights	• Nursing Station and School - Operational risk (Ro=10/15) for school and nursing station staff. • Nursing Station - Operational risk (Ro=10) to HVAC system. • Sewage Lagoon – Functional risk (Rf=15) to the lagoon (bacteria affected by high temperatures?)
			• COLD SNAP – Temperatures <-35C for 3-5 consecutive days	• Staff - Operational risk (Ro=10/15) for school and nursing station staff. • Nursing Station, School, WTP – Functional risk (Rf=10/15) with HVAC systems in each building (Rf=15 for nursing station).
			• RAINFALL (HIGH INTENSITY) - >25mm in 1 Hour	• Roads – Functional Risk (Rf=9) to ditches and culverts.
			• HIGH WINDS Winds-Gusts > 100 km/h	• Nursing Station – Structural risk (Rs=12) to roof (Shingles damaged).
			• FOREST FIRES – Fire and smoke concerns	• Staff – Operational risk (Ro=10/15) to staff servicing the Nursing Station, school, water and wastewater treatment systems. • Airport – Operational risk (Ro=15) on the airport Runway/Taxiway (smoke reducing visibility)
			• FREEZING INDEX –	

Risk Score Counts			Climate Events	Principal Infrastructure/Components Affected
Category	**Current Climate Count**	**Future (2050s) Climate**		
				• Winter Road – Structural risk (Rs=16) and Functional risk (Rf=16) to winter road.
MODERATE	**15**	**3**	See Current and Future Risk Matrices in **Appendix E.**	See Current and Future Risk Matrices in **Appendix E.**

5.2.1 Influence of the Infrastructure Condition on Risk Scores

The condition of the infrastructure is a key element to establishing climate-related risks. While the current condition ratings of the Kasabonika Lake infrastructure are available from the 2017 ACRS Report, estimating the future condition of the infrastructure is a complex process. It requires forecasting annual expenditures on operations, maintenance, and capital investments in the infrastructure to:

- Maintain the infrastructure in a state of good repair over its expected service life and,
- Replacing the infrastructure when it has reached the end of its service life.

As the long-term O&M and capital investment plans for the Kasabonika Lake infrastructure are not known, the worst-case scenario (Condition 2) is that none will be replaced during the study time horizon and current maintenance procedures cannot be sustained due to funding pressures. This results in a higher vulnerability to the climate hazards identified.

Table 11 presents the comparison between the risks to the infrastructure replaced at the end of its design life and maintained in a state of good repair, and the risks with deteriorated infrastructure. The 31% increase in moderate risks are mostly associated with the effects of climate events on structural functions of infrastructure components related to the school (ACRS Condition rating of 4/10) and nursing station buildings systems (i.e. HVAC) and components (roof (shingles), building structure). Of interest is the occurrence of four extreme risks, with half of the high risks identified relating to structural and functional risks to the winter road under a declining freezing index. The other extreme risks associated with functional risks to the HVAC system in the nursing station under a cold snap, and functional risk to the lagoons under a heat wave.

Table 11: Forecast Increased Risks for Kasabonika Lake Infrastructure – Impacts of Asset Condition over Infrastructure Service Life

Future Climate Risk Score Counts - Kasabonika Lake Infrastructure			
Risk Rating	**Infrastructure replaced at end of design life and well maintained** **Condition 1**	**Infrastructure deteriorated (not replaced or poorly maintained)** **Condition 2**	**Asset Condition Impact on Risk**
High	26	34	**+ 31%**
Extreme	0	4	**+ 400%**

5.3 INFRASTRUCTURE RISKS AND COMMUNITY IMPACTS

Resilient infrastructure is necessary to provide resilient services that, in turn, contribute to the resilience of the community. The loss of performance or function of infrastructure can have an impact on the whole community in a variety of ways as described below.

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.

3. **Policy considerations** relate to the processes, procedures and guidelines developed by Chief and Council that affect the performance and availability of community infrastructure to provide the required levels of service for the community members. Operating and maintaining infrastructure in a state of good repair and re-capitalizing the assets in a timely manner needs to be part of long-term community risk adaptation and resiliency strategy.

4. **Social and cultural** impacts often result from the loss of services provided by a community's infrastructure. It is important to develop adaptation, mitigation and resiliency strategies that involve all community members, from the young to the Elders, to work together to find solutions that align with the community's social and cultural beliefs and their traditional ways.

5. **Environmental impacts** may result in short or long-term impacts to the community. Contamination of the community's raw water source will have an immediate impact on the community in terms of providing potable water, but the effects on the community may be much worse in the long term if the community needs to relocate to find a new water source.

6. **Financial impacts** may redirect resources from other planned investments or priority areas in the community. With limited sources of funding available, the Community may have to take extraordinary measures to address its financial situation. This could result in the lowering or removal of certain levels of services in the community.

6.0 CLIMATE ADAPTATION AND CREATING RESILIENT INFRASTRUCTURE

Climate change and the associated climate risks are being realized as a significant tangible threat to First Nation community infrastructure. Community infrastructure that is kept in a state of good repair through proper operations and maintenance practices, will often be able to withstand additional loading associated with most current climate events. However, the increasing frequency and intensity of future climate events will require communities to take actions to create more resilient infrastructure and develop adaptation strategies to reduce climate related risks to their infrastructure now and into the future.

Climate mitigation measures are actions taken to reduce and curb greenhouse gas (GHG) emissions, which are the single most important cause of climate change. Mitigation measures like reducing GHG emissions need to be addressed on a global scale to have any hope of reversing the current trend in global warming. On the other hand, climate adaptation acknowledges that even if GHG emissions were to be substantially reduced or stopped today, the current atmospheric concentration of carbon dioxide and other greenhouse gases would remain well above normal levels for years and potentially several decades to come. Mitigation therefore looks at addressing the causes of climate change, while adaptation is about building resilience of community infrastructure by reducing the vulnerability and addressing the impacts of climate change on community infrastructure.

Workshops 1, 2 and 3 of the Kasabonika Lake First Nation FN-IRT climate risk assessment, examined selected community infrastructure and determined the risk scores for infrastructure components for both current and future climate scenarios. During Workshop 4, the Project Team and community members developed adaptation and resiliency strategies to mitigate the highest risk to community infrastructure from current and future climate. The results of the workshop adaptation and resilience discussions are listed in **Table 12**.

The climate adaptation and resilience strategies developed during the Kasabonika Lake FN-IRT climate risks assessment are a first step towards reducing climate-related risks to Kasabonika Lake infrastructure. With present building codes lacking design criteria to address current and future climate impacts, it is not possible to construct infrastructure to be fully resilient to climate change. However, communities like Kasabonika Lake can narrow the gap between the current resilience capacity of their infrastructure, and the resilience capacity needed to prepare for future climate change impacts by implementing adaptation measures that reduce exposure and vulnerability to climate events, creating more climate resilient communities.

Table 12: Kasabonika Lake Risk Mitigation and Adaptation Measures

CLIMATE EVENT	INFRASTRUCTURE CLIMATE RISK ADAPTATION MEASURES
HEAT WAVE (Temperature > 30C during Day and >15C Overnight)	**HVAC System (Nursing Station) – The nursing station is operated and maintained by ISC. KLFN /ISC need to develop a coordinated service agreement for maintenance/operation of the nursing station to mitigate the risks to the community associated impacts of service interruptions related to climate risks.** • Perform regular O&M plan to maintain HVAC system in optimal operation condition to provide cooling during periods of high demand. • Develop a community cooling center to relocate patients if required – publish location and times on multiple medias (radio/Facebook/television). Include in emergency response plan. • Install emergency generator. Size the generator to include HVAC system so that it can be operated during power interruptions. • **Staff (Operational Risk)** • Ensure O&M service vehicles are equipped with A/C. • Develop a workplan with safe operating practice to protect workers during extreme heat events. • Create a Health and Safety committee to develop policies related to heat waves, and a plan to protect workers subject to extreme climate events. Provide First Aid training to supervisors/staff to allow early recognition of heat related illness and treatment. **Lagoon (Functional Risk)** • Research the potential impacts of Heat Wave on the lagoon function effectiveness. • Develop a testing program to ensure the lagoon is operating as designed. • Have operators trained at appropriate certification level to recognize problems/provide treatment response to maintain optimal operation of the lagoon in accordance with environmental requirements.
COLD SNAP (Temperature <-35C for 3-5 consecutive days)	**HVAC Systems (Nursing Station, School, Water Treatment Plant)** • Perform regular O&M plan to maintain HVAC system in optimal operation condition to provide heating during periods of high demand. • Test efficiencies of heaters and upgrade/replace to ensure heaters in school can provide sufficient heating during cold snaps. • Develop an emergency response plan (ERP) if heating system fails – include a community communications plan in the ERP so everyone (parents, children, Chief and Council) is aware of what to do in case of an emergency. • Install emergency generator at school (Note: the school also serves as an assembly area for emergency response planning, so should have back-up power). Size to include HVAC system so that it can be operated during power interruptions. **Staff (Operational Risk)** • Ensure O&M service vehicles are well maintained so heating systems operate adequately. • Develop a workplan with safe operating practice to protect workers during extreme cold events. Create a Health and Safety committee to develop policies related to cold snaps, and a plan to protect workers subject to extreme climate events. Provide First Aid training to supervisors/staff to allow early recognition of heat related illness and treatment.

CLIMATE EVENT	INFRASTRUCTURE CLIMATE RISK ADAPTATION MEASURES
DECLINING FREEZING INDEX	**WINTER ROAD (Structural and Functional risks)** • Consider building a permanent road access to the community. Explore opportunities to get access from roads developed to support the Ring of Fire development. • Work with ISC to develop an emergency response fund to provide financial assistance to bring critical goods and services to the community during periods of reduced winter road access (Need to fly goods into the community). • Consider increasing stockpiles/reserves of long-term non-perishable items in the community – those items that are dependant on the winter road for transport to the community. • Look for possible alternate sources of power for the community, to reduce dependency on power generation by HORCI (reduce or eliminate need to transport diesel fuel for power generation).
RAINFAL – HIGH INTENSITY (25mm in 1 Hour)	**ROADS - DITCHES/CULVERTS (Functional Risk)** • Complete regular maintenance (cleaning/brush cutting) of ditches to promote proper flow of water off road surfaces and prevent ponding along roads. • Complete maintenance of culverts to ensure the design capacity of the culvert is not reduced (Culverts in the town were found to be severely restricted by gravel and materials).
FREEZING RAIN (10mm od ice accretion)	**STAFF (Operational Risk)** • Provide PPE for workers who need to work in freezing rain conditions (i.e. traction aids for boots). • Apply sand/traction aid in work areas to reduce risk of slips and falls. • Develop safe work/operating practices. Review as regular part of health and safety meetings **THIRD PARTY SERVICES -Telecommunications - Wires (Structural Risk)** • Clear trees and branches around wire pathways. • Plan for loss of communications service in community emergency response plan. • Develop a work plan to inspect wires after ice storms, to assess the infrastructure condition and damage. **THIRD PARTY SERVICES – Airport – Runways/Taxiway** • Include possible closure of airport in community emergency response plan. • Install weather station at the airport to provide real time weather reporting. • Explore the potential for all season road access to community to reduce dependency on air travel as only access to community.
HIGH WINDS **(Gusts >100 km/h)**	**NURSING STATION/SCHOOL/HOUSES (Structural Risk)** • Develop community building requirements for new construction requiring the use of hurricane clips on roof structures. • Visually inspect houses and infrastructure roofs for loose shingles and damage, to minimize additional damage due to high winds. • Consider changing community building requirements to use steel roofing.

CLIMATE EVENT	INFRASTRUCTURE CLIMATE RISK ADAPTATION MEASURES
FOREST FIRES	**STAFF (Operational Risk)** • Provide PPE for workers who need to work when smoke is present due to forest fires (i.e. face masks). • Develop health and safety guidelines for risks associated with smoke and fires. • Review/update emergency response plan to include actions plan for evacuation. Develop community communication plan to assist when community threatened by forest fires (See (www.firesmartcanada.ca). • Create a fire break around the community. • Develop community policy to regulate/stop burning when fire risks are high. **THIRD PARTY SERVICES – Airport – Runways/Taxiway** • Include possible closure of airport in community emergency response plan. • Install weather station at the airport to provide real time weather reporting. • Explore the potential for all season road access to community to reduce dependency on air travel as only access to community.

APPENDIX A

WORKSHOP 1 POWERPOINT PRESENTATION

Kasabonika Lake First Nations
FN PIEVC Infrastructure Vulnerability Assessment
Infrastructure Exposure – Workshop #1

Wayne Penno, MBA, P.Eng.
Project Manager, Stantec

Elmer Lickers
Senior O&M Advisor

Wednesday November 14, 2018

Safety Moment

STOP & TALK: WORKING IN COLD ENVIRONMENTS

Health, Safety, Security and Environment

Individuals who are exposed to extreme cold or work in cold environments may be a risk of cold stress. Extremely cold or wet weather is a dangerous situation that can cause cold stress injuries such as hypothermia, frostbite, trench foot, chilblains, and cold water immersion.

What are the risk factors that contribute to cold stress:

- Wetness/dampness
- Dressing improperly
- Personal health factors – hypertension, hypothyroidism and diabetes
- Poor physical condition
- Exhaustion

Protecting Yourself from Cold Stress

- Check the weather forecast before going outside
- If possible, schedule your work for the warmest time of the day
- Limit time outside, take frequent breaks to warm up
- Acclimate to conditions gradually
- Stay hydrated with warm liquids
- Wear appropriate clothing - layer for insulation, avoid tight clothing
- Protect the ears, face, hand, and feet appropriately
    - a hat significantly reduces body heat loss
    - boots should be waterproof and insulated
    - Gloves insulated and water resistant if possible
- Carry extra clothing in case they become wet
- Wear chemical or battery-powered heat packs
- Monitor your physical condition and that of your friends or co-workers

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KASABONIKA FIRST NATION

Workshop 1 Agenda

Time	Description	Sessional Lead
9:00am – 9:30am	Welcome and introductions	Kasabonika Lake First Nation and O F N T S C
9:30am – 10:30am	Description of the FN PIEVC Protocol	Stantec and OFNTSC
10:30am – 10:45am	Health break	
10:45am – 12:15pm	Visit and Inspection of Kasabonika Lake infrastructure	Kasabonika Lake First Nation/All participants
12:15pm – 1:00pm	Lunch	
1:00pm – 2:30pm	Facilitated Discussion: Selection of infrastructure for vulnerability assessment. Performance concerns related to current climate?	All participants
2:30pm – 3:00pm	Roles and responsibilities of the team members.	All participants
3:00pm – 3:30pm	Next steps	Stantec and OFNTSC
3:30pm	Adjourn	

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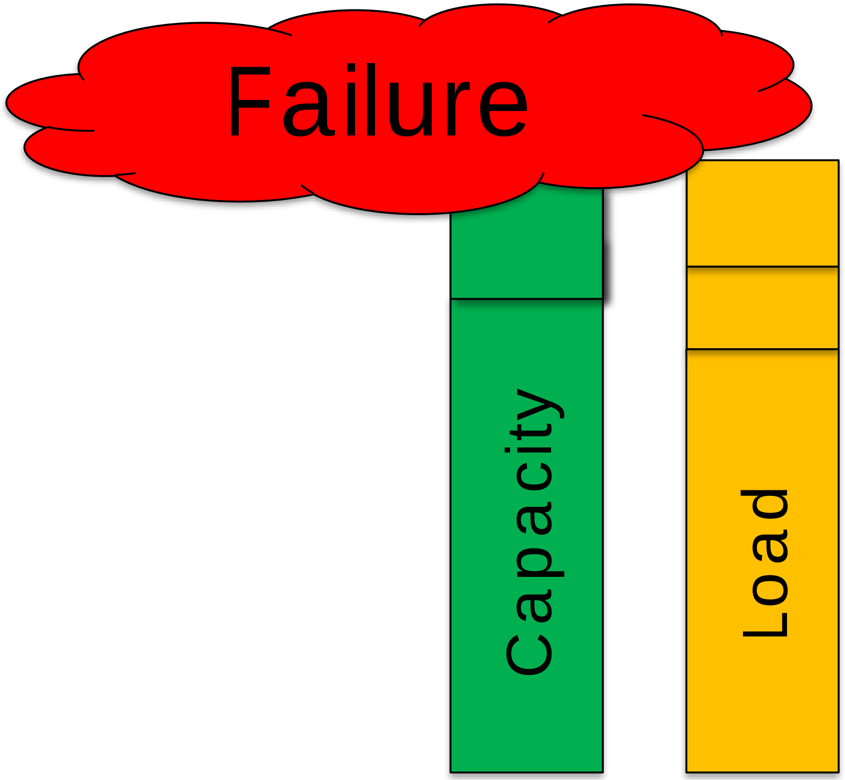
Workshop Objectives

- Overview of the PIEVC vulnerability assessment process
- Review/inspection/description of Kasabonika Lake infrastructure
- Discussion of past weather related performance issues and concerns
- Definition of the global project parameters and boundary conditions for the vulnerability assessment.
  - Which infrastructure is being assessed?
  - Uses of the infrastructure? Condition/age of infrastructure?
  - General climatic, geographic considerations.
- Team Members - Roles and responsibilities of the team members.
- Identify participants for the Special Project Advisory Committee
- Next steps?

Why Define Infrastructure Risks?

- Minimize service disruptions
- Protect people, property and the environment
- Optimize service
  - Manage lifecycle
  - Manage operations
  - Avoid surprises
  - Reduce/avoid costs
- To deal with the uncertainties of future climate
- First step in risk reduction planning to improve (climate) resilience

How do Small Changes Lead to Catastrophic Failure?



- Design Capacity
- Safety Factor
- Impact of age on structure
- Impact of unforeseen weathering

- Design Load
- Change of use over time
  - e.g. population growth
- Severe climate event

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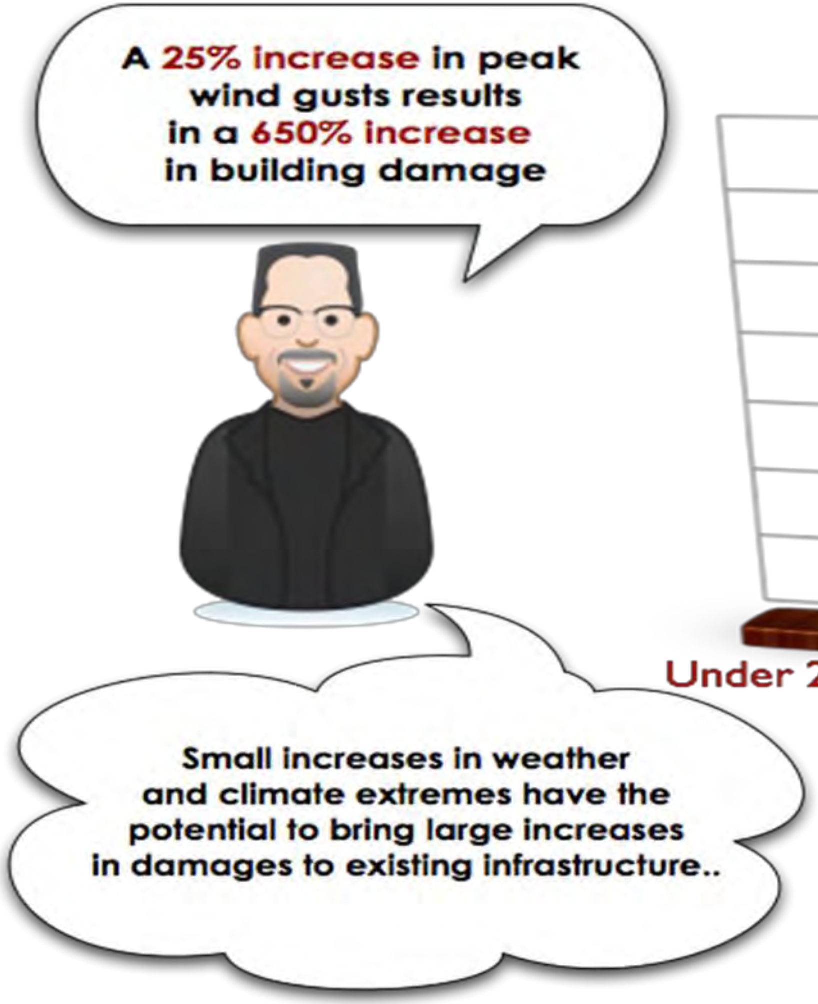
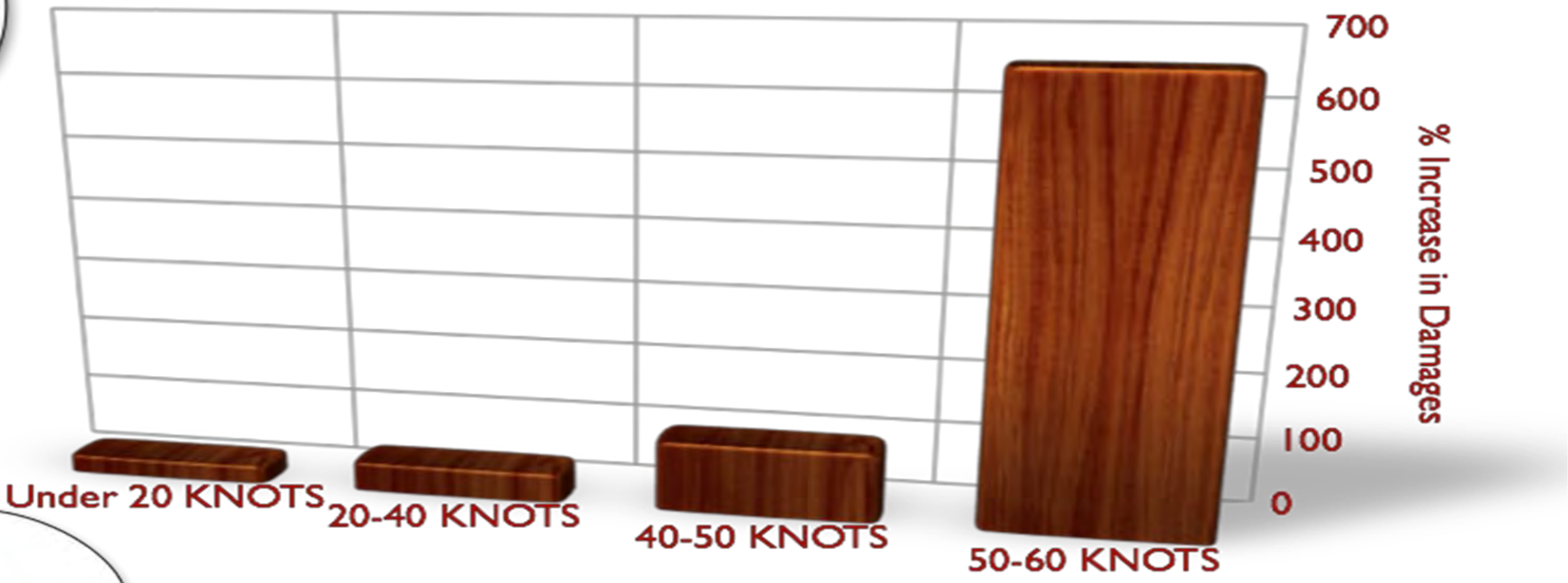
Small Increases Lead to Escalating Infrastructure Damage





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Community Resilience
To Achieve
Public Services Resilience
To Ensure
Infrastructure Resilience

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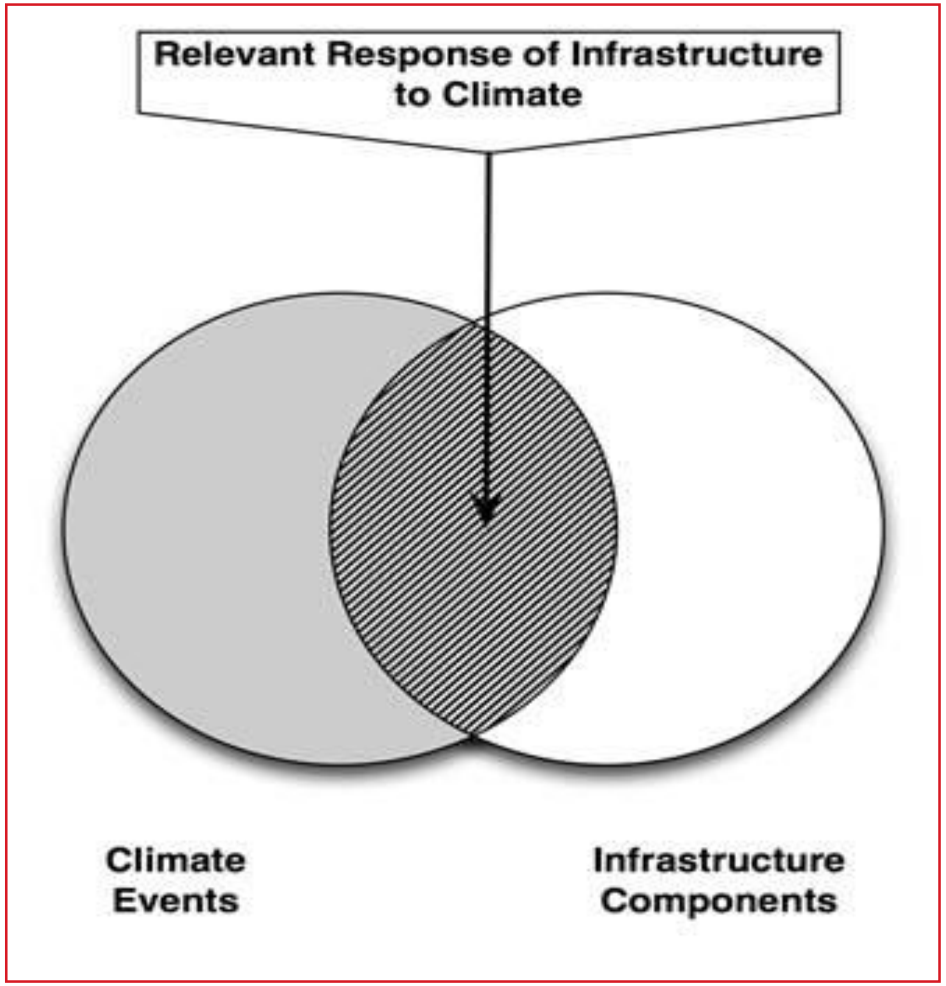
The PIEVC Protocol

- 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)

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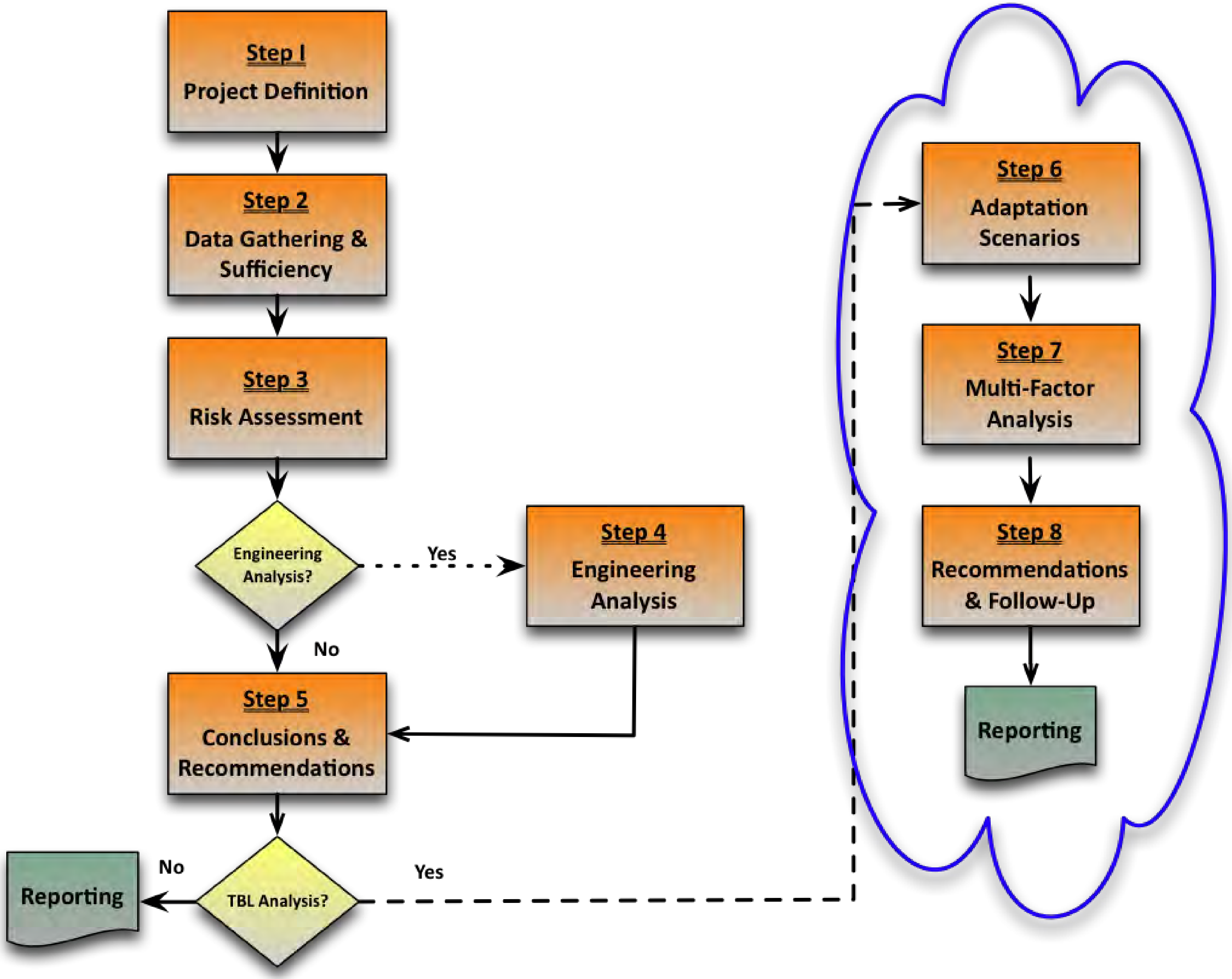
General description of the PIEVC process



TRIPLE BOTTOM LINE MODULE

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FN PIEVC/AM Toolkit

- 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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Kasabonika First Nation

FN PIEVC/AM Toolkit Framework

ACRS
ICMS
Inspection reports

BUILT ENVIRONMENT

Inventory
Condition
Service Life
Replacement value

CLIMATE RISKS ASSESSMENT (FN PIEVC Protocol)

Relevant Climate Parameters
Built Environment Exposure and Vulnerability
Risks
Mitigation and Adaptation Recommendations

ASSET MANAGEMENT PLAN

Demand (Current/Future)
Needs (O&M, Capital)
Life-Cycle Management Plans (additions/upgrades, replacement, O&M)
Risk Management
Prioritization and Investment Plans
Monitor, Report and Review

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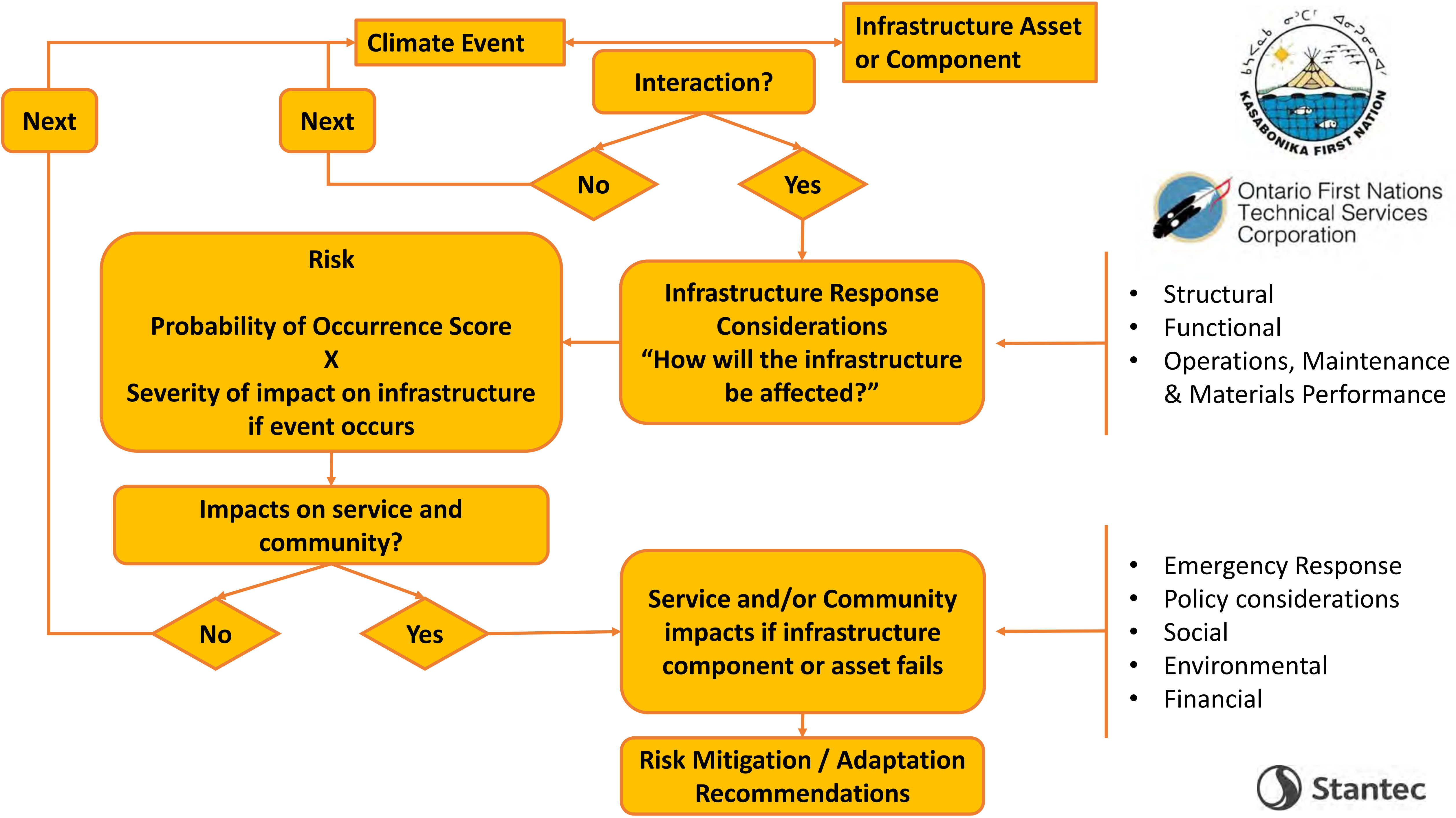

Climate Event
Infrastructure Asset or Component
Interaction?
Next
Next
No
Yes
Risk
Probability of Occurrence Score
X
Severity of impact on infrastructure if event occurs
Infrastructure Response Considerations
"How will the infrastructure be affected?"
• Structural
• Functional
• Operations, Maintenance & Materials Performance
Impacts on service and community?
No
Yes
Service and/or Community impacts if infrastructure component or asset fails
• Emergency Response
• Policy considerations
• Social
• Environmental
• Financial
Risk Mitigation / Adaptation Recommendations
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Based on Engineers Canada's PIEVC Protocol

FN PIEVC Climate Change Infrastructure Vulnerability Assessment Process

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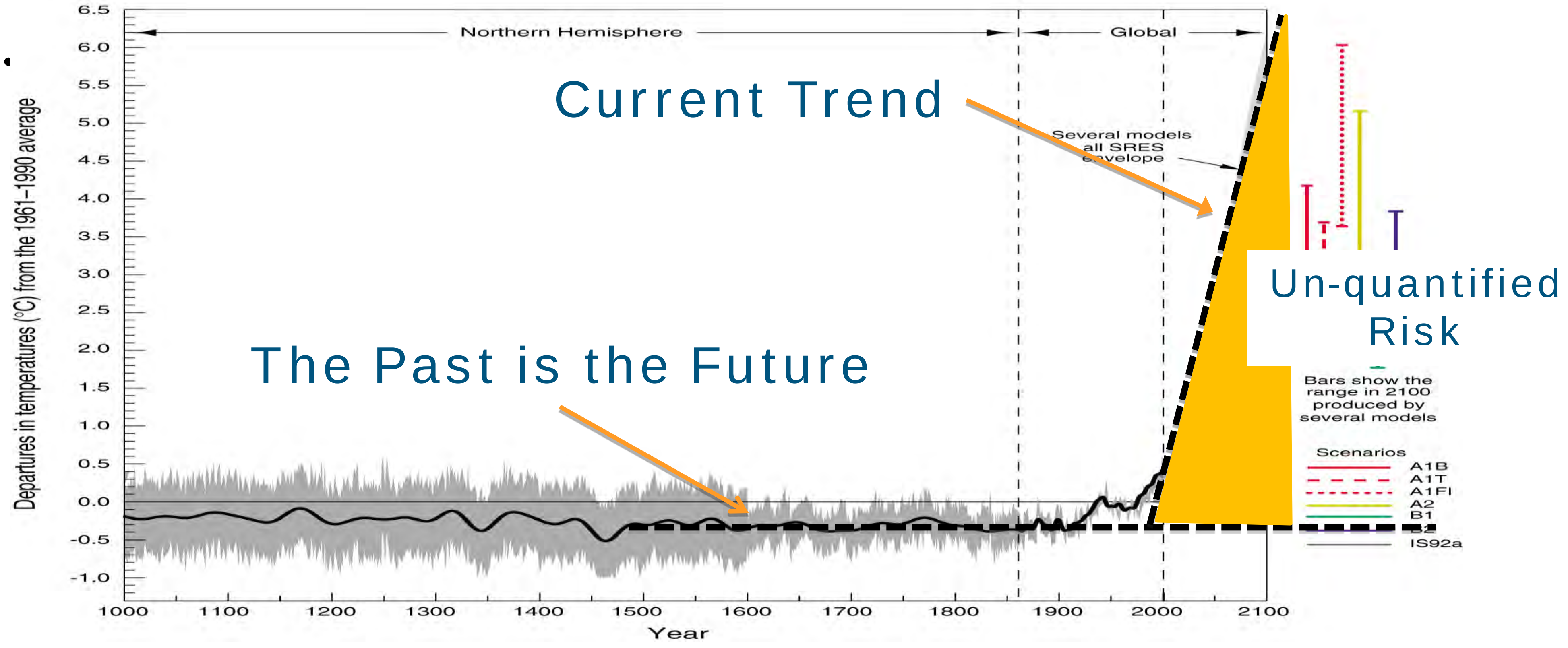
Infrastructure Vulnerability to CC

From planning, design, operations and maintenance ..



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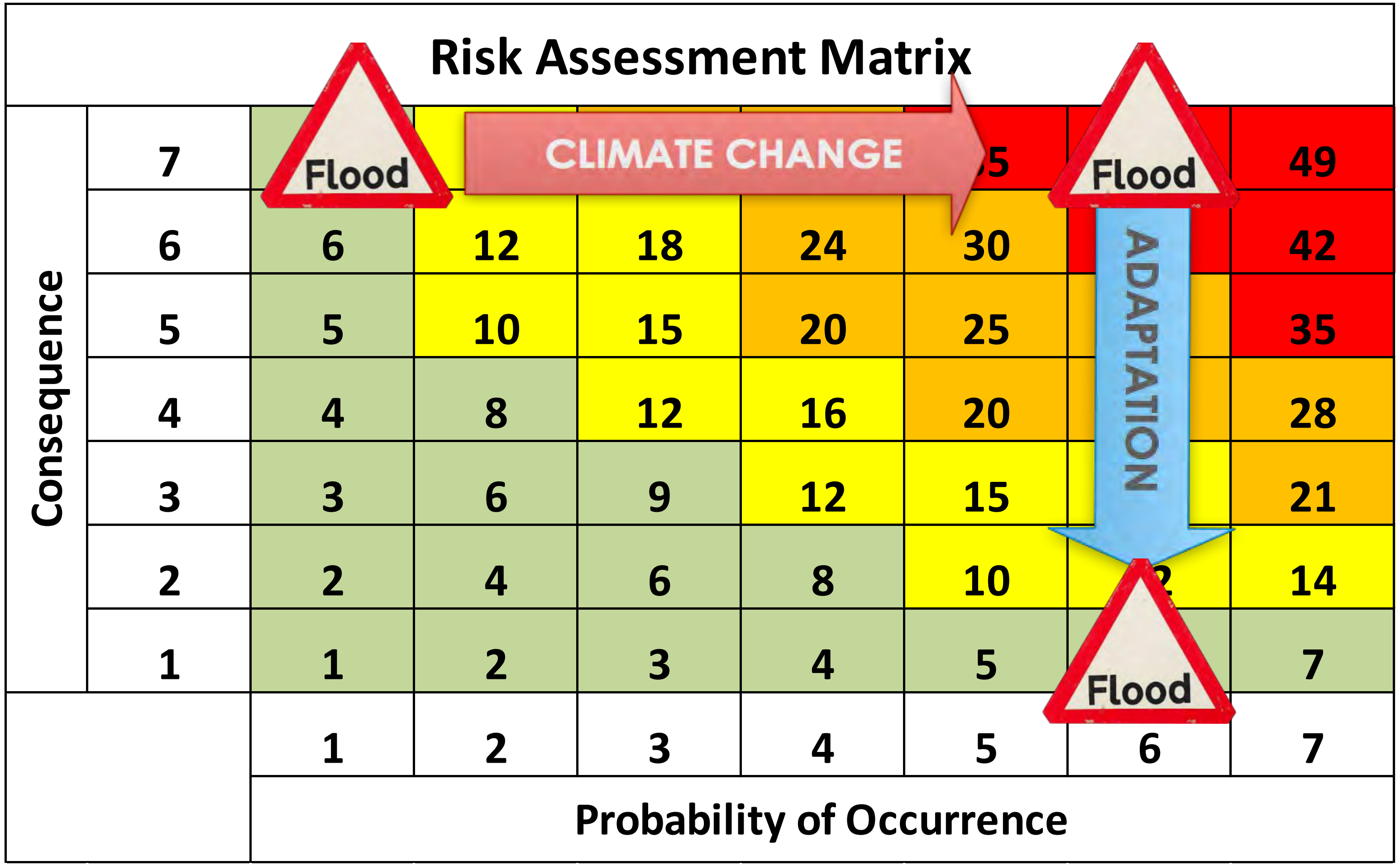

Risk Assessment Matrix

Consequence							
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	49
6	6	12	18	24	30	[illegible]	42
5	5	10	15	20	25	[illegible]	35
4	4	8	12	16	20	[illegible]	28
3	3	6	9	12	15	[illegible]	21
2	2	4	6	8	10	[illegible]	14
1	1	2	3	4	5	[illegible]	7
	1	2	3	4	5	6	7
	Probability of Occurrence						

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Risk Scores

Severity of Impact (S)							
	Catastrophic	5	5	10	15	20	25
	Major	4	4	8	12	16	20
	Moderate	3	3	6	9	12	15
	Minor	2	2	4	6	8	10
	Insignificant	1	1	2	3	4	5
			1	2	3	4	5
			Highly unlikely	Remotely possible	Occasional	Normal	Frequent
			Probability of Occurrence (P)				

Score	Description
< 5	**Low:** No action required
6 to 12	**Moderate:** Monitoring recommended. Action may be required if threat materialises; a more detailed analysis may be needed
>15	**High:** 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 may have accumulated impacts over time • Low probability, high impact events (e.g., tornado)

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KASABONIKA FIRST NATION

Assessing Infrastructure Vulnerability to Climate Change

Infrastructure Definition Process

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The FN PIEVC Risk Matrix

Infrastructure Components	nfrastructure Response Considerations						Max. Daily Temp.				Hotest Month (Aug.) Temp.				Low Precipitation (Aug.)				Combination - Aug. High Temp. with Low				Fog				Rain - 7 day period			
	Structural Design	Functionality	Serviceability	Watershed, Surface Water & Groundwater	Operations, Maintenance & Materials Performance	Environmental Effects	Days (per year) with Max Temps > 36°C				Very warm August Temps Mean >22.5°C (warmer than August 2012)				Days with August total precipitation ≤ ~50mm (equal to or less than August 2012)				Combination August Warm Temperatures & low rainfalls				Fog visibilities below ½ statute mile (for shipping)				> 120 mm rainfall in 7 days			
	Mark Relevant Responses with ✓						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
Cornwall Island								5				6				5				4				3				3		
Water Supply System																														
Water Treatment Plant																														
Building structure	✓	✓	✓		✓																									
Building envelope	✓	✓	✓		✓																									
Roof	✓	✓	✓		✓																									
Process equipment		✓	✓		✓												4	20			5	20								
HVAC system	✓	✓	✓		✓								3	18							3	12								
Foundations	✓																												1	3
Site services	✓	✓	✓		✓	✓																								
Storage and/or alternate use	✓	✓	✓		✓																								3	9
Access road	✓	✓	✓		✓																									
Environment (plants, trees, animals)						✓							3	18			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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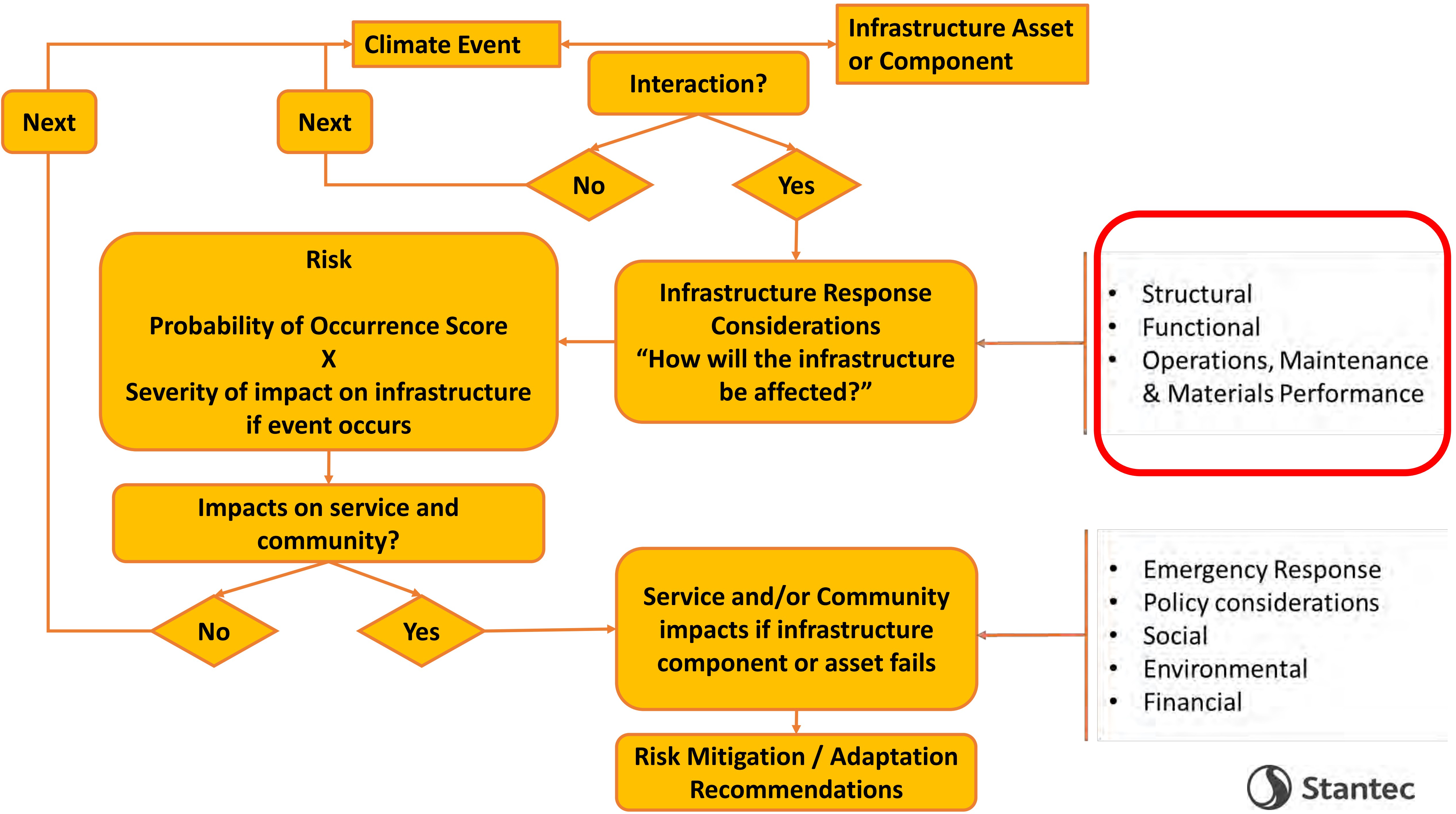
Infrastructure Definition

- Define the global project parameters and boundary conditions for the engineering vulnerability assessment:
  - Which infrastructure is being assessed?
  - Its location;
  - Climatic, geographic considerations;
  - Define performance criteria; and
  - Uses of the infrastructure.
- First step of narrowing the focus to allow efficient data acquisition and vulnerability assessment.

Infrastructure Performance Criteria


Climate Event
Infrastructure Asset or Component
Interaction?
Next
Next
No
Yes
Risk
Probability of Occurrence Score
X
Severity of impact on infrastructure if event occurs
Infrastructure Response Considerations
"How will the infrastructure be affected?"
• Structural
• Functional
• Operations, Maintenance & Materials Performance
Impacts on service and community?
No
Yes
Service and/or Community impacts if infrastructure component or asset fails
• Emergency Response
• Policy considerations
• Social
• Environmental
• Financial
Risk Mitigation / Adaptation Recommendations
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1. Structural Design/Capacity

Climate loading may affect the infrastructure or infrastructure component being assessed through:

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

2. Functionality

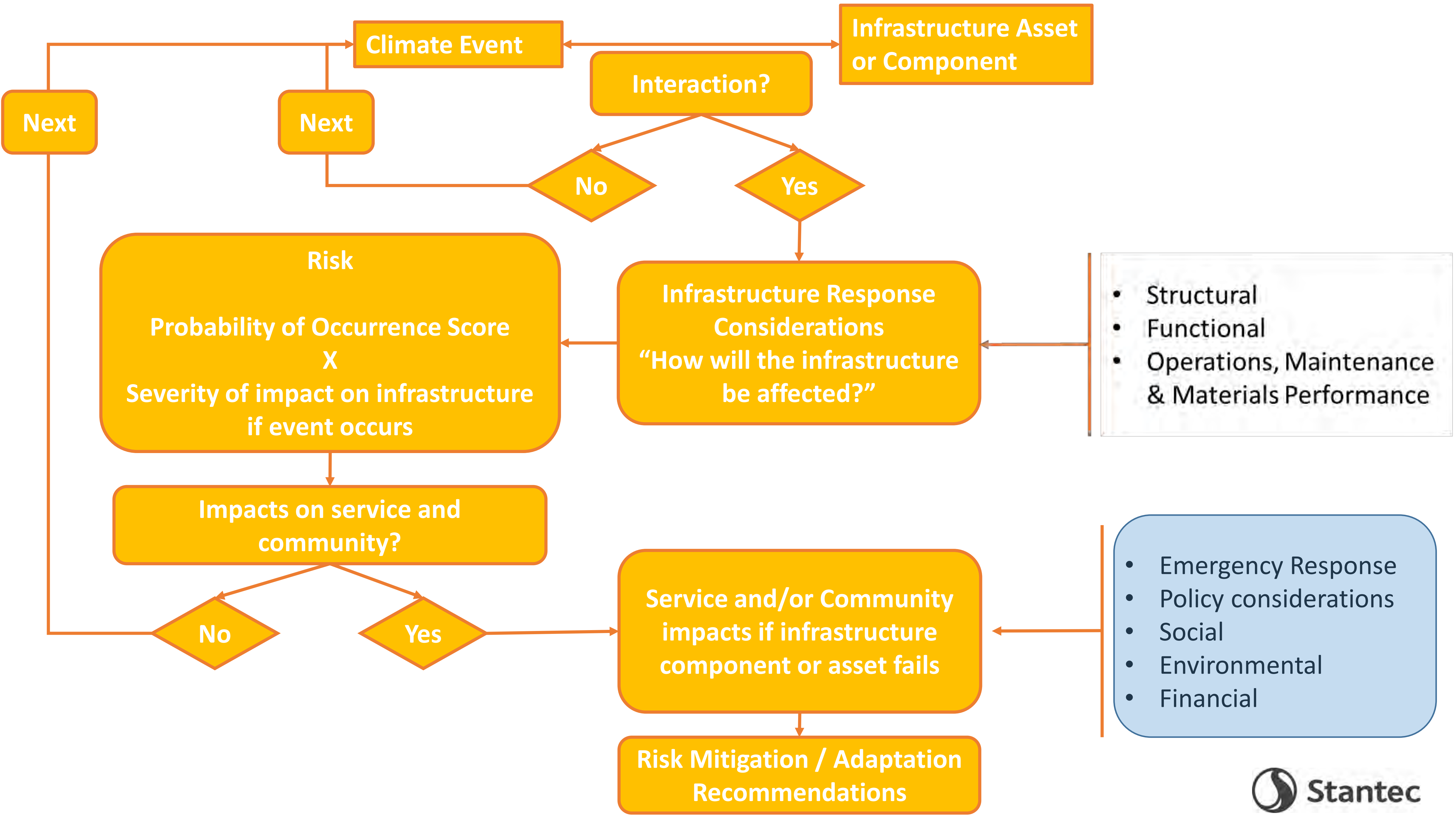
Climate loading may affect the infrastructure or infrastructure component being assessed through:

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

3. Operations, Maintenance, and Materials Performance

Climate loading may affect the infrastructure or infrastructure component being assessed through:

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


Climate Event
Infrastructure Asset or Component
Interaction?
Next
Next
No
Yes
Risk
Probability of Occurrence Score
X
Severity of impact on infrastructure if event occurs
Infrastructure Response Considerations
"How will the infrastructure be affected?"
Structural
Functional
Operations, Maintenance & Materials Performance
Impacts on service and community?
No
Yes
Service and/or Community impacts if infrastructure component or asset fails
Emergency Response
Policy considerations
Social
Environmental
Financial
Risk Mitigation / Adaptation Recommendations
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1. Emergency Response

Climate loading may affect the infrastructure or infrastructure components being assessed through:

- Procedures and systems to address climate related events:
    - Severe storm events
    - Flooding
    - Ice dams
    - Water damage
    - Forest Fires

2. Policy Considerations

Climate loading may affect the infrastructure or infrastructure components being assessed through:

- Codes
- Guidelines
- Standards
- Internal operations and maintenance policies and procedures
- Levels of Service policy
- Land use planning

3. Social Effects

Climate loading may affect the infrastructure or infrastructure components being assessed through:

- Accessibility to critical facilities such as hospitals, fire and police services
- Energy supply to a community
- Dislocation of affected populations
- Provision of basic services such as potable water distribution and wastewater collection
- Closure of schools and other public services
- Destruction or damage to heritage buildings, monuments, etc. or historically important resources

4. Environmental Effects

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

- Release of toxic, controlled or deleterious substances
- Degradation of water quality
- Damage to sensitive ecosystems
- Physical harm to birds and animals
- Contamination of potable water supplies
- Public perception and interaction

5. Financial Considerations

Climate loading may affect the infrastructure or infrastructure components being assessed through:

- Drain on current/future financial resources to deal with unplanned repairs, maintenance and/or replacements
- Shifting financial resources from other community priorities
- Impacts on services and/or levels of service
- Community economic impacts and/or hardships

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Wayne Penno, MBA, P.Eng
Project Manager

Elmer Lickers

Senior O & M Advisor

Thank You   Miigwech

APPENDIX B

WORKSHOP 2 POWERPOINT PRESENTATION

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Kasabonika Lake First Nations
FN PIEVC Infrastructure Vulnerability Assessment
Infrastructure Exposure and Climate Considerations - Workshop #2

Wayne Penno, MBA, P.Eng.
Project Manager, Stantec

Elmer Lickers
Senior O&M Advisor

Thursday November 15, 2018

Stantec

Ontario First Nations Technical Services Corporation

Workshop 2 Agenda

Time	Description	Lead Speaker
9:00am – 9:30am	Review of Workshop 1, Project Overview and Objectives	Stantec/OFNTSC
9:30am – 10:30am	FN PIEVC infrastructure vulnerability to climate change process	Stantec
10:30am – 10:45am	Health break	
10:45am – 11:45am	Infrastructure performance considerations	All participants
11:45am – 12:15pm	Description, identification and selection of performance criteria	All participants
12:15pm – 1:00pm	Lunch	
1:00pm – 2:30pm	FN PIEVC Risk Matrix – Risk=**Probability** of CC Event x **Severity** of CC Event	All participants
2:30pm – 3:00pm	Review/discussion of relevant climate events/climate projections.	All participants
3:00pm – 3:30pm	Next steps	Stantec
3:30pm	Adjourn	

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Assessment of the CC Vulnerability of Kasabonika Lake Infrastructure

Infrastructure Definition Process

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Kasabonika Lake

Identify the components of the infrastructure to be assessed in general terms

Infrastructure Definition

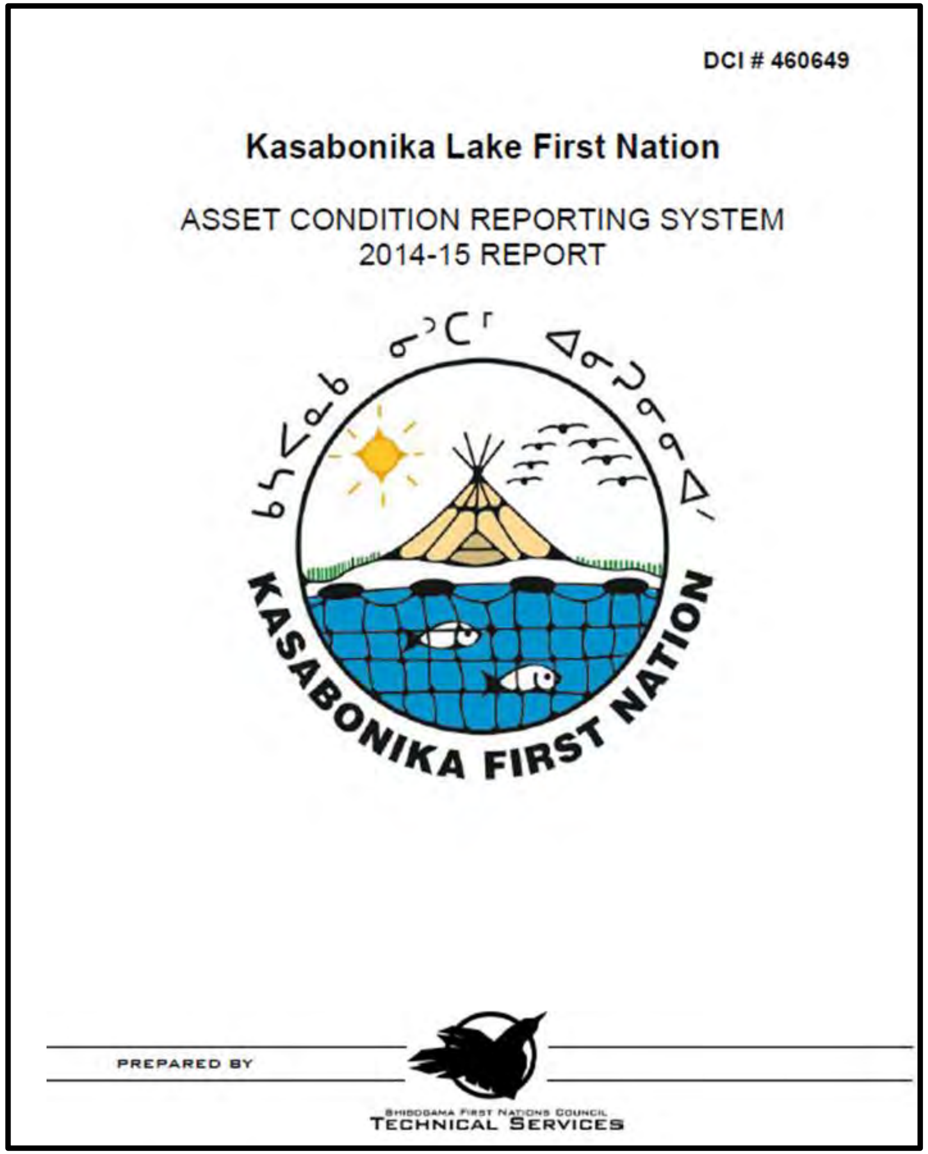
- Define the global project parameters and boundary conditions for the engineering vulnerability assessment.
  - Which infrastructure and infrastructure components are being assessed?
  - Its location?
  - Climatic, geographic considerations?
  - Define performance criteria, and
  - Uses of the infrastructure and related services provided.

☑ First step of narrowing the focus to allow efficient data acquisition and vulnerability assessment.

Confirm the Infrastructure List

Main components

- Potable Water
  - Intake and transmission to plant
  - WTP
  - Distribution and appurtenances
- Wastewater
  - Collection
  - Treatment
  - Receiving environment
- Administration and operations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Kasabonika Lake First Nation

ASSET CONDITION REPORTING SYSTEM
2014-15 REPORT

KASABONIKA FIRST NATION

PREPARED BY

SHIBOGAMA FIRST NATIONS COUNCIL
TECHNICAL SERVICES

Ontario First Nations Technical Services Corporation

Kasabonika First Nation

The FN PIEVC Risk Matrix

Infrastructure Components	Structural Design	Functionality	Serviceability	Watershed, Surface Water & Groundwater	Operations, Maintenance & Materials Performance	Environmental Effects
	nfrastructure Response Considerations					
	Mark Relevant Responses with ✓					
Cornwall Island						
Water Supply System						
Water Treatment Plant						
Building structure	✓	✓	✓		✓	
Building envelope	✓	✓	✓		✓	
Roof	✓	✓	✓		✓	
Process equipment		✓	✓		✓	
HVAC system	✓	✓	✓		✓	
Foundations	✓					
Site services	✓	✓	✓		✓	✓
Storage and/or alternate use	✓	✓	✓		✓	
Access road	✓	✓	✓		✓	
Environment (plants, trees, animals)						✓
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	Max. Daily Temp.				Hotest Month (Aug.) Temp.				Low Precipitation (Aug.)				Combination - Aug. High Temp. with Low				Fog				Rain - 7 day period			
	Days (per year) with Max Temps > 36°C				Very warm August Temps Mean >22.5°C (warmer than August 2012)				Days with August total precipitation ≤ ~50mm (equal to or less than August 2012)				Combination August Warm Temperatures & low rainfalls				Fog visibilities below ½ statute mile (for shipping)				> 120 mm rainfall in 7 days			
	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
Cornwall Island		5				6				5				4				3				3		
Water Supply System																								
Water Treatment Plant																								
Building structure																								
Building envelope																								
Roof																								
Process equipment											4	20			5	20								
HVAC system							3	18							3	12								
Foundations																							1	3
Site services																								
Storage and/or alternate use																							3	9
Access road																								
Environment (plants, trees, animals)							3	18			5	25			6	24								
Environment (soil conditions)											2	10			3	12							3	9
Backwater disposal																								
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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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Potable Water System Example

Sub-System Components Possibly Impacted by Climate

- Raw water intake
- Underground reservoir
- Above ground reservoir/tower
- Low lift pump station
  - Building
  - Equipment
- Water mains and piping
- Hydrants
- Others?

Potable Water System Example

Water Treatment Plant

- Building structure
- Building envelope
- Roof
- Foundations
- Process and treatment equipment
- HVAC
- Electrical systems
- SCADA/communications
- Storage
- Site services
- Site access/access road
- Power/Back-up generator

Wastewater Collection and Treatment System

System Components Possibly Impacted by Climate

- Sanitary Mains
- Sewage lift stations
  - Building
  - Equipment
- Lagoons
  - Cells
  - Blower building and equipment
- Storage building (old fire hall)?
- Others?

Administration and Operations

System Components Possibly Impacted by Climate

- Vehicles and fleet
- Personnel/travel
- Records
- Supplies/delivery
- Emergency procedures/personnel
- Power/Electricity
- Communication/cellular tower
- Island access
- General road network
- Others?

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KASABONIKA FIRST NATION

"If a climate event impacts the infrastructure, how will the condition and performance be affected?"

Establish the Infrastructure Performance Criteria

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Infrastructure Components	ACRS	Performance Considerations					Climate Elements																			
		Structural	Operational	Functionality			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																										

1. Structural Design/Capacity

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

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

2. Functionality

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

- Effective Capacity of the infrastructure to provide the intended service
  - Short term
  - Medium term
  - Long term
- Examples from Kasabonika Lake Infrastructure?

3. Serviceability

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

- Ability to conduct routine and/or planned maintenance and refurbishment activities
  - Short term
  - Medium term
  - Long term
- Equipment service life - component replacement frequencies

Impacts on service/service delivery in the community if the infrastructure fails?

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1. Emergency Response

With respect to the infrastructure or infrastructure components being assessed, a loss of performance or failure due to climate loading may affect:

- Procedures and systems to address:
  - Severe storm events
  - Flooding
  - Ice-related damage
  - Water damage
  - Wind damage

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2. Insurance and Legal Considerations

With respect to the infrastructure or infrastructure components being assessed, a loss of performance or failure due to climate loading may affect:

- Insurance rates
- The ability to acquire insurance
- Insurance policy limitations and exclusions
- Legal impacts and liability

3. Policy Considerations

With respect to the infrastructure or infrastructure components being assessed, a loss of performance or failure due to climate loading may affect:

- Codes
- Guidelines
- Standards
- Internal operations and maintenance policies and procedures
- Levels of Service policy
- Land use planning

4. Social/Community Effects

With respect to the infrastructure or infrastructure components being assessed, a loss of performance or failure due to climate loading may affect:

- Accessibility to critical facilities such as hospitals, fire and police services
- Energy supply to a community
- Dislocation of affected populations
- Provision of basic services such as potable water distribution and wastewater collection
- Closure of schools and other public services
- Destruction or damage to heritage buildings, monuments, etc. or historically important resources

5. Environmental Effects

With respect to the infrastructure or infrastructure components being assessed, a loss of performance or failure due to climate loading may cause:

- Release of toxic, controlled or deleterious substances
- Degradation of water quality
- Damage to sensitive ecosystems
- Physical harm to birds and animals
- Contamination of potable water supplies
- Public perception and interaction

6. Fiscal Impacts

With respect to the infrastructure or infrastructure components being assessed, a loss of performance or failure due to climate loading may cause:

- Drain on current/future financial resources to deal with unplanned repairs, maintenance and/or replacements
- Shifting financial resources from other community priorities
- Impacts on services and/or levels of service
- Community economic impacts and/or hardships

The FN PIEVC Risk Matrix

Infrastructure Components	nfrastructure Response Considerations						Max. Daily Temp.				Hotest Month (Aug.) Temp.				Low Precipitation (Aug.)				Combination - Aug. High Temp. with Low				Fog				Rain - 7 day period			
	Structural Design	Functionality	Serviceability	Watershed, Surface Water & Groundwater	Operations, Maintenance & Materials Performance	Environmental Effects	Days (per year) with Max Temps > 36°C				Very warm August Temps Mean >22.5°C (warmer than August 2012)				Days with August total precipitation ≤ ~50mm (equal to or less than August 2012)				Combination August Warm Temperatures & low rainfalls				Fog visibilities below ½ statute mile (for shipping)				> 120 mm rainfall in 7 days			
	Mark Relevant Responses with ✓						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
Cornwall Island								5				6				5				4				3				3		
Water Supply System																														
Water Treatment Plant																														
Building structure	✓	✓	✓		✓																									
Building envelope	✓	✓	✓		✓																									
Roof	✓	✓	✓		✓																									
Process equipment		✓	✓		✓												4	20			5	20								
HVAC system	✓	✓	✓		✓								3	18							3	12								
Foundations	✓																												1	3
Site services	✓	✓	✓		✓	✓																								
Storage and/or alternate use	✓	✓	✓		✓																								3	9
Access road	✓	✓	✓		✓																									
Environment (plants, trees, animals)						✓							3	18			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	✓	✓	✓		✓																									

The FN PIEVC Risk Matrix

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	Mark Relevant Responses with ✓						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
Cornwall Island								5				6				5				4				3				3		
Water Supply System																														
Water Treatment Plant																														
Building structure	✓	✓	✓		✓																									
Building envelope	✓	✓	✓		✓																									
Roof	✓	✓	✓		✓																									
Process equipment		✓	✓		✓												4	20			5	20								
HVAC system	✓	✓	✓		✓								3	18							3	12								
Foundations	✓																												1	3
Site services	✓	✓	✓		✓	✓																								
Storage and/or alternate use	✓	✓	✓		✓																								3	9
Access road	✓	✓	✓		✓																									
Environment (plants, trees, animals)						✓							3	18			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	✓	✓	✓		✓																									
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WTP - Intake	✓	✓	✓		✓																									
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The FN PIEVC Risk Matrix

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	Mark Relevant Responses with ✓						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
Cornwall Island								5				6				5				4				3				3		
Water Supply System																														
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Process equipment		✓	✓		✓												4	20			5	20								
HVAC system	✓	✓	✓		✓								3	18							3	12								
Foundations	✓																												1	3
Site services	✓	✓	✓		✓	✓																								
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Access road	✓	✓	✓		✓																									
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Backwater disposal	✓	✓	✓	✓	✓																									
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WTP - Reservoir		✓															5	25			5	20								
WTP - Intake	✓	✓	✓		✓																									
WTP - Low Lift Pump	✓	✓	✓		✓																									

The FN PIEVC Risk Matrix

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	Mark Relevant Responses with ✓						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
Cornwall Island								5				6				5				4				3				3		
Water Supply System																														
Water Treatment Plant																														
Building structure	✓	✓	✓		✓																									
Building envelope	✓	✓	✓		✓																									
Roof	✓	✓	✓		✓																									
Process equipment		✓	✓		✓												4	20			5	20								
HVAC system	✓	✓	✓		✓								3	18							3	12								
Foundations	✓																												1	3
Site services	✓	✓	✓		✓	✓																								
Storage and/or alternate use	✓	✓	✓		✓																								3	9
Access road	✓	✓	✓		✓																									
Environment (plants, trees, animals)						✓							3	18			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	✓	✓	✓		✓																									

Severity Scales Exercise

Ontario First Nations Technical Services Corporation

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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Consequences Example 1

Severity 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

Consequences Example 2

Score and Description	**Consequence (Structural, Functional, Operational)**	**Service impacts on the community** *Could also include estimated time to restore service?*
0 No effect	• No service interruption • No budget impacts • Fully operational – normal • No additional complaints about the service	0% loss of service
1 Insignificant	• Can be corrected through the regular maintenance cycle	Isolated loss of service <10% of service customers affected
2 Minor	• Require minor repairs but have the internal capacity and inventory of parts to do those repairs • No impact on O&M and capital budget – no additional budget required • *No replacement of major components or asset* • *May need further assessment*	Localized disruptions of service 10% to <25% of service customers affected
3 Moderate	• Have the capacity to do repairs but need to order parts • May need to have certified staff (e.g., electrician) do repairs • Need inspection with possibly external expertise	25% to <50% of community affected
4 Major	• Partial loss of equipment and/or components • Loss of function of asset, several assets, or critical components • Requires detailed assessment with external expertise • Requires major repairs and possibly complete replacement of components/equipment • Impacts on O&M and capital budget that may require additional funding • Requires implementing alternative service delivery	Reduced service to a large portion of the community 50% to <75% of service customers affected
5 Catastrophic	• Total loss of equipment and service that requires full replacement of asset, several assets and major components • Impacts on other elements of asset or other assets • May have impacts on the public health and safety • Significant impacts on capital budget requiring additional funding • Consider declaring state of emergency	Widespread impacts on service >75% of service customers affected

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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																										

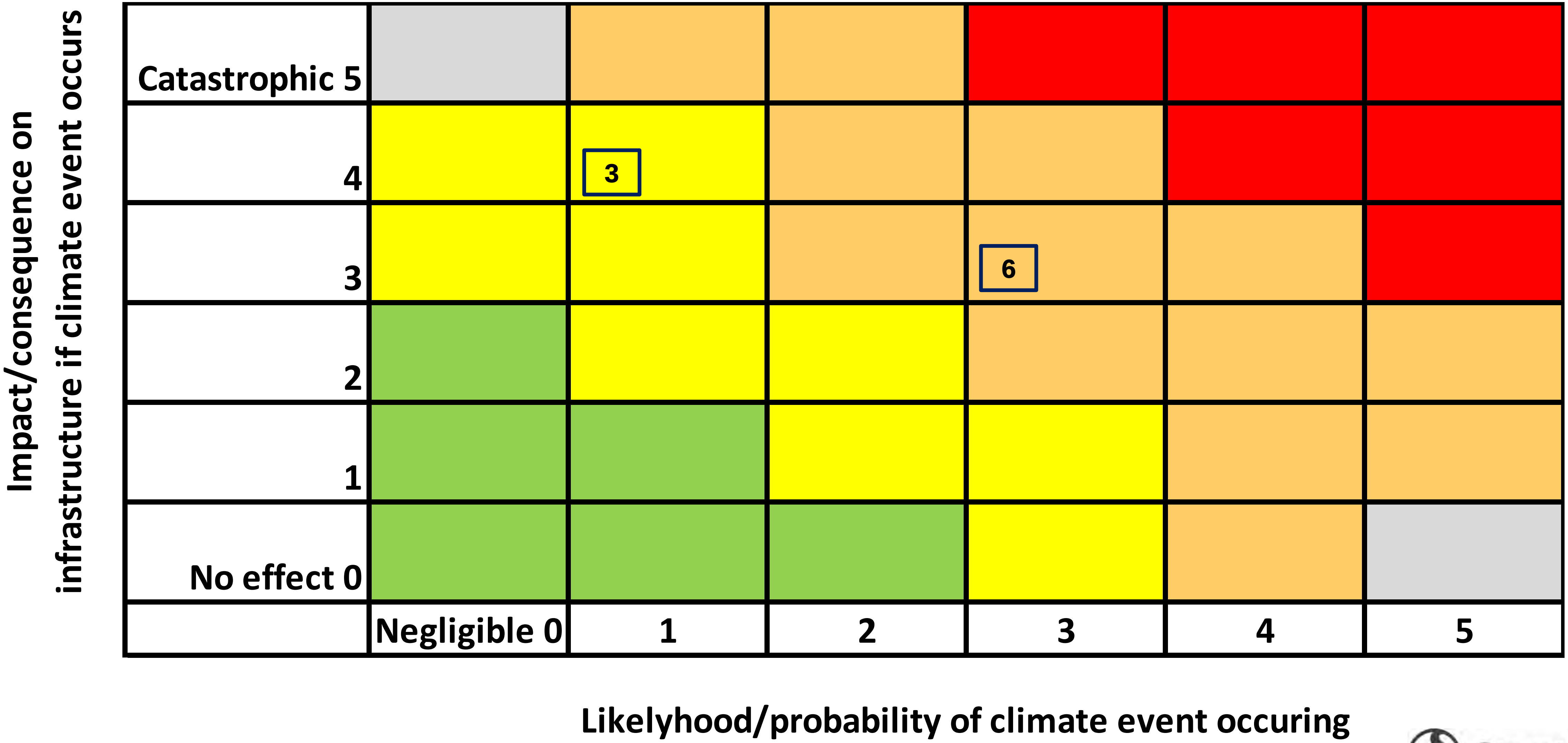
Infrastructure Components	ACRS	Performance Considerations: Structural	Operational	Functionality	Environment (Land)	Environment (Water)
Water Treatment Plant						
- Building structure						
- Building envelope						
- Roof						
- Foundations						
- Process equipment						
- HVAC system			✓	✓		
- SCADA						
- Communications						
- Electricity						
- Site services						
- Access road						
- Third party supplies						
Administration and Operations						

(Current) Climate Elements

Infrastructure Components	Temperature: 5 consecutive days with temp. > 30 deg.				Temperature: 10 consecutive days with temp. < -30 deg.			
	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
- SCADA								
- Communications								
- Electricity								
- Site services								
- Access road								
- Third party supplies								
Administration and Operations								

Infrastructure Components	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
Water Treatment Plant												
- Building structure												
- Building envelope												
- Roof												
- Foundations												
- Process equipment												
- HVAC system	**N**				**N**							
- SCADA												
- Communications												
- Electricity												
- Site services												
- Access road												
- Third party supplies												
Administration and Operations												

Current Climate



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																										
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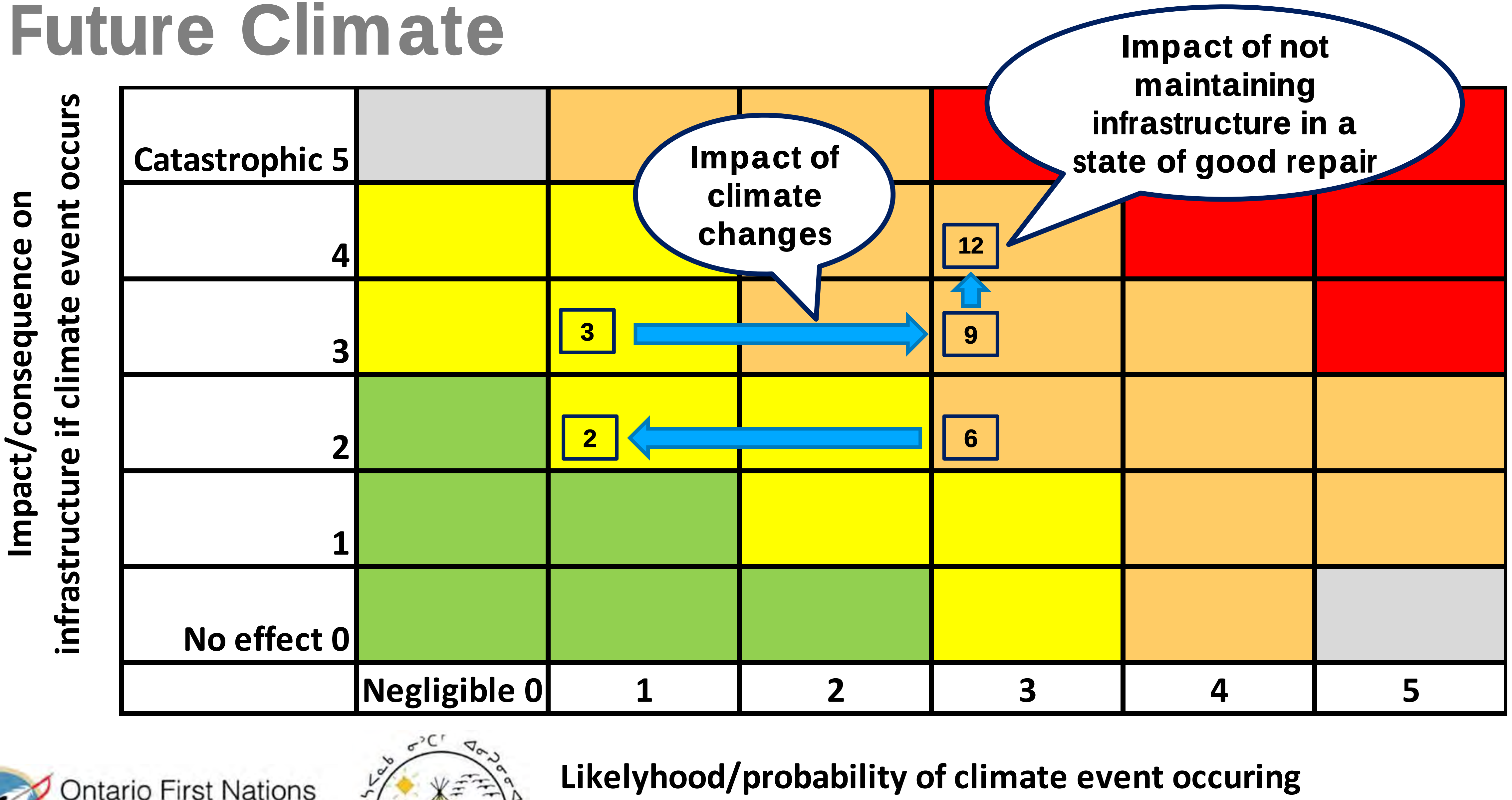
Future Climate



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KASABONIKA FIRST NATION

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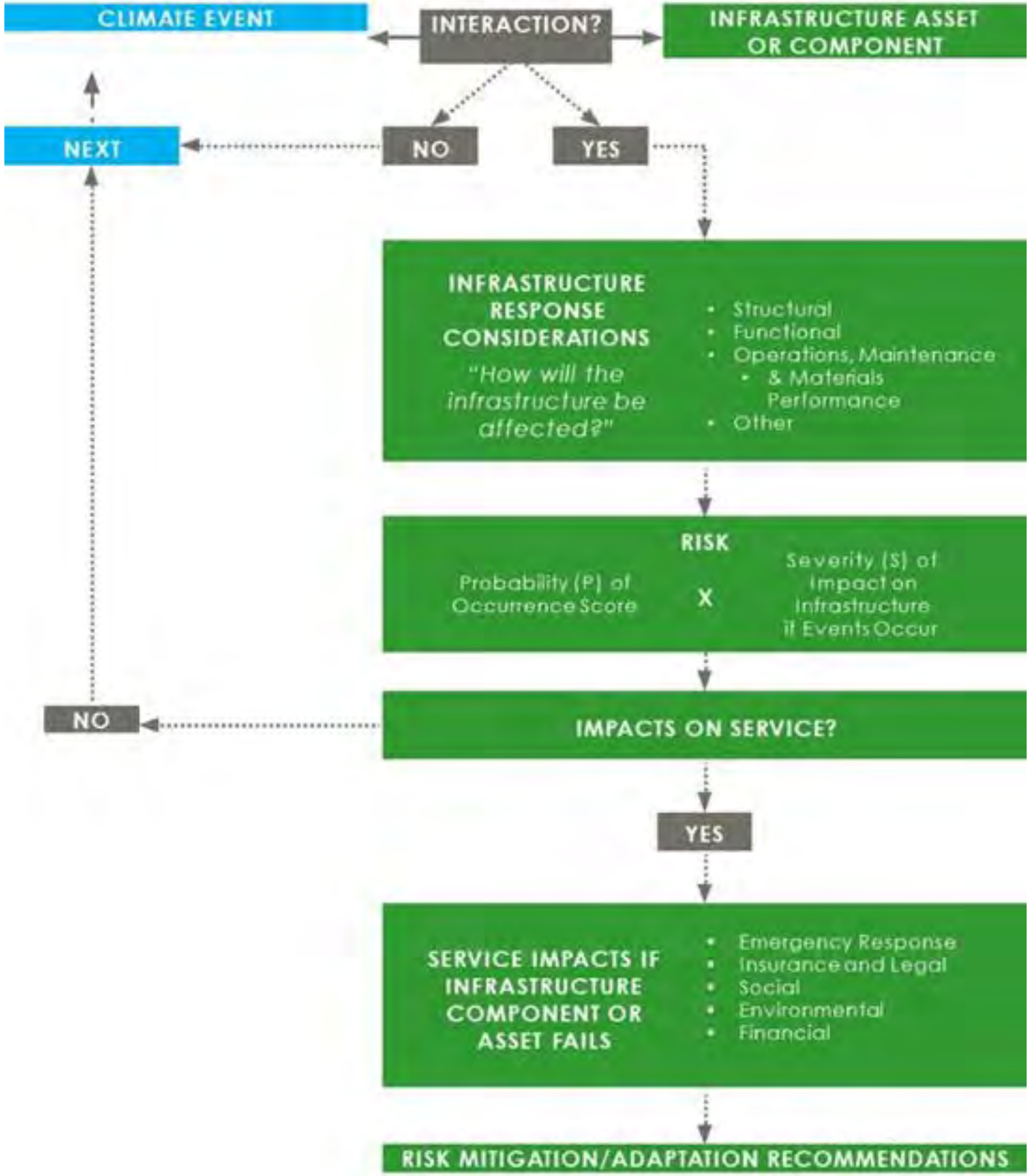
FN PIEVC Assessment Process



KASABONIKA FIRST NATION

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Kasabonika Lake
Climate Elements to Consider

General information on projections

Discussion on past events that have caused infrastructure disruptions and/or damage

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Discussion

How is the climate changing in Kasabonika Lake?

Kasabonika First Nation

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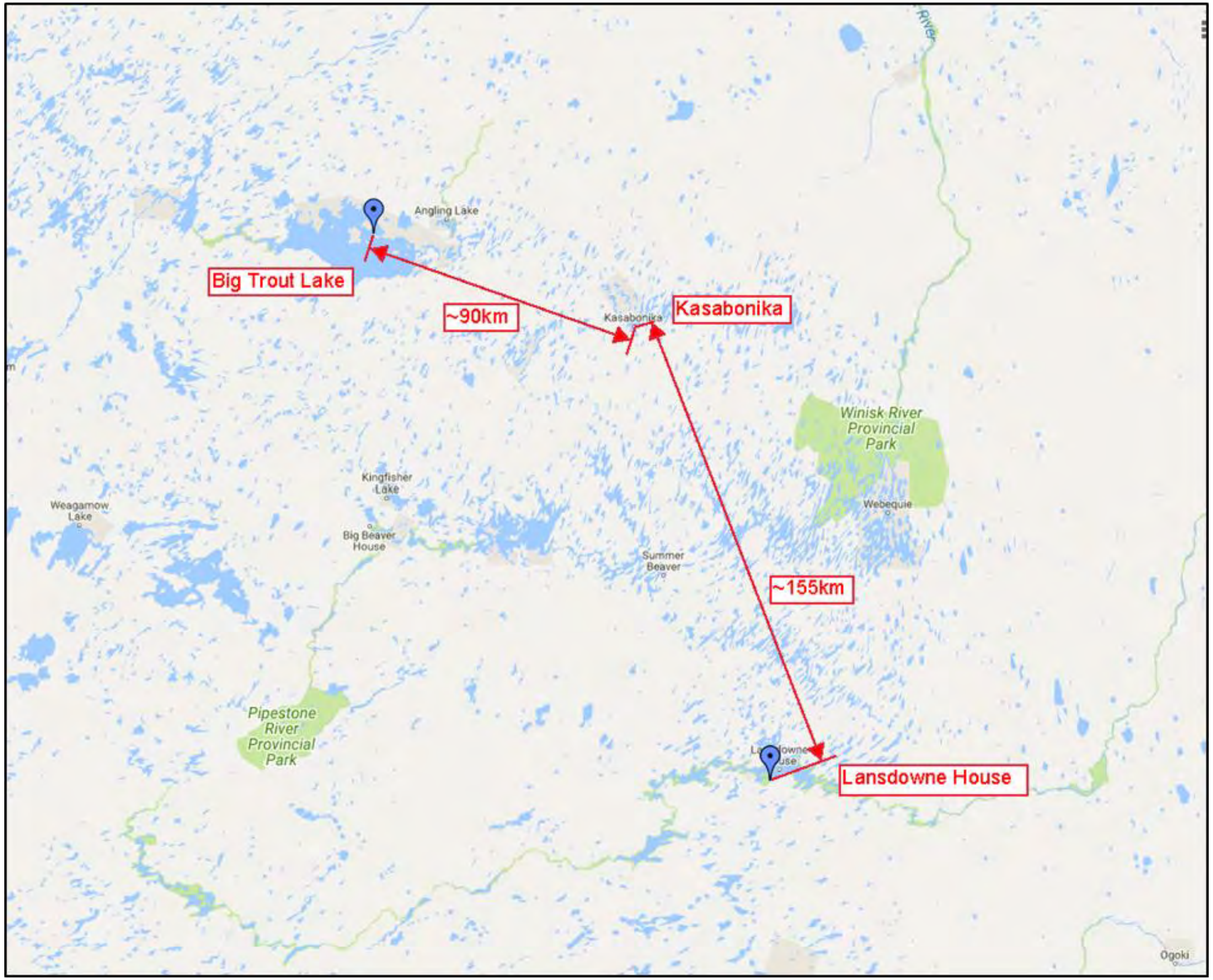
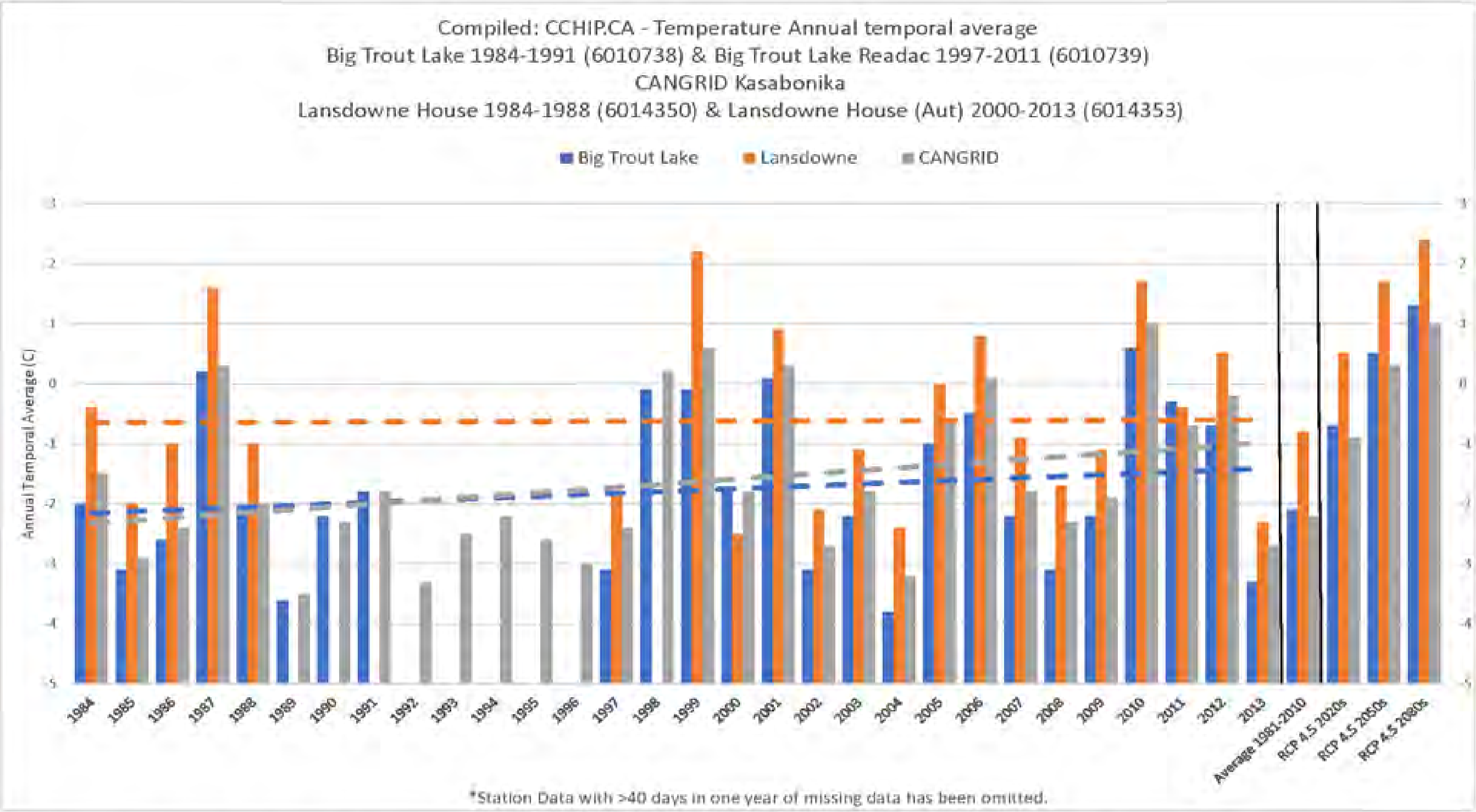
Climate Data Stations



Annual Temporal Average - Mean Mean Daily Temperature (RCP 8.5)



The CANGRID "historical" data suggests Kasabonika is 0.74°C cooler than the Lansdowne Station and 0.32°C warmer than the Big Trout Lake station.

Average's and RCP 4.5 projections for CANGRID (Kasabonika) align much more with Big Trout Lake than with Lansdowne

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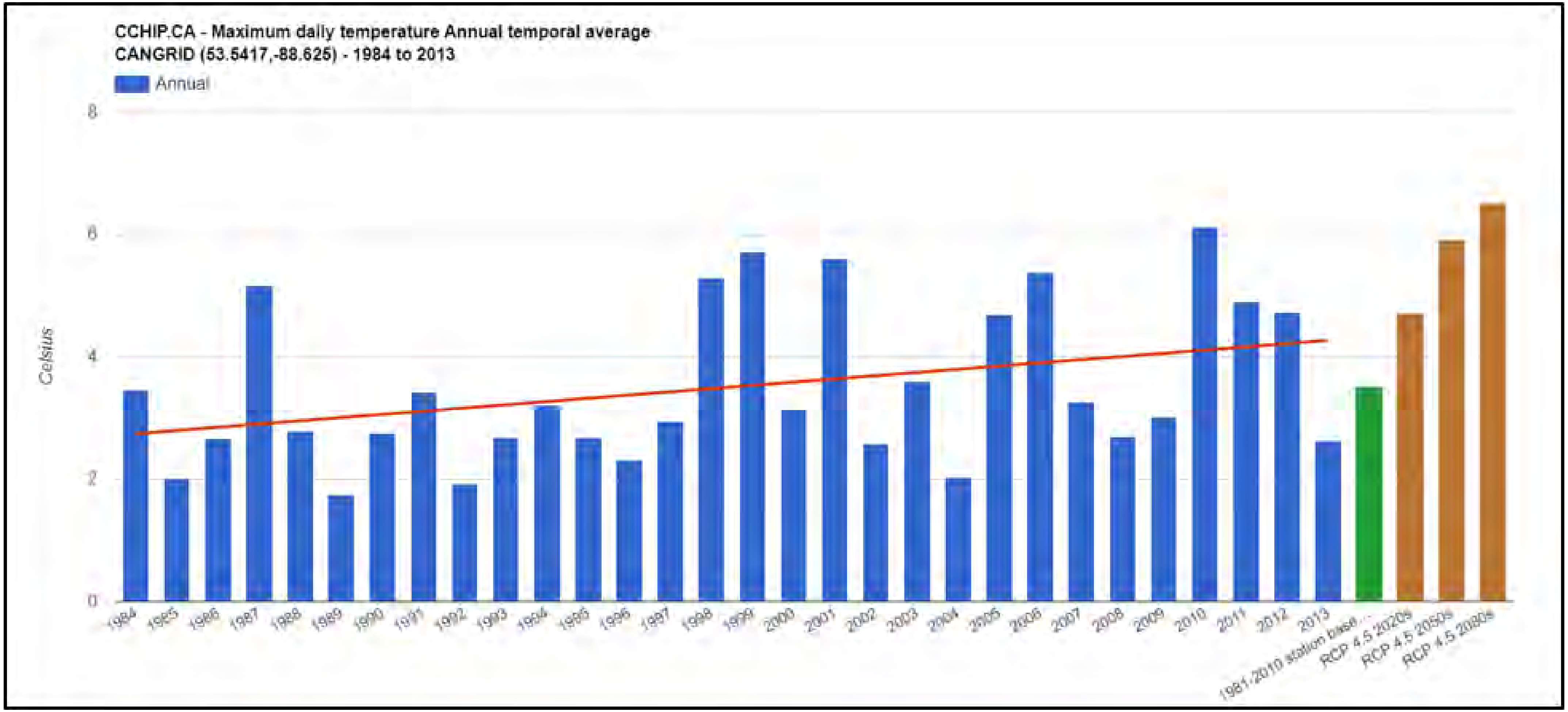
Max Daily Temporal Average - Mean Daily Temperature (RCP 8.5)



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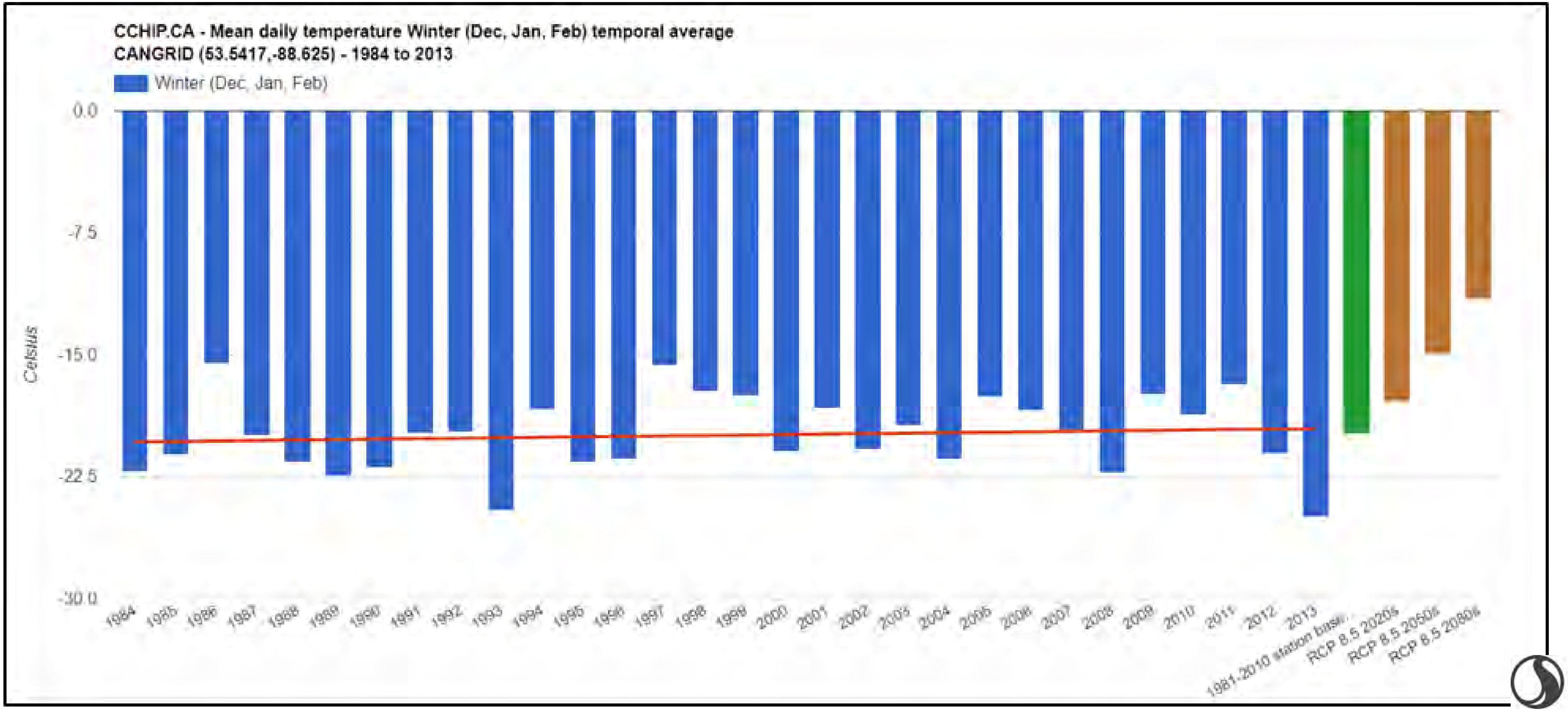
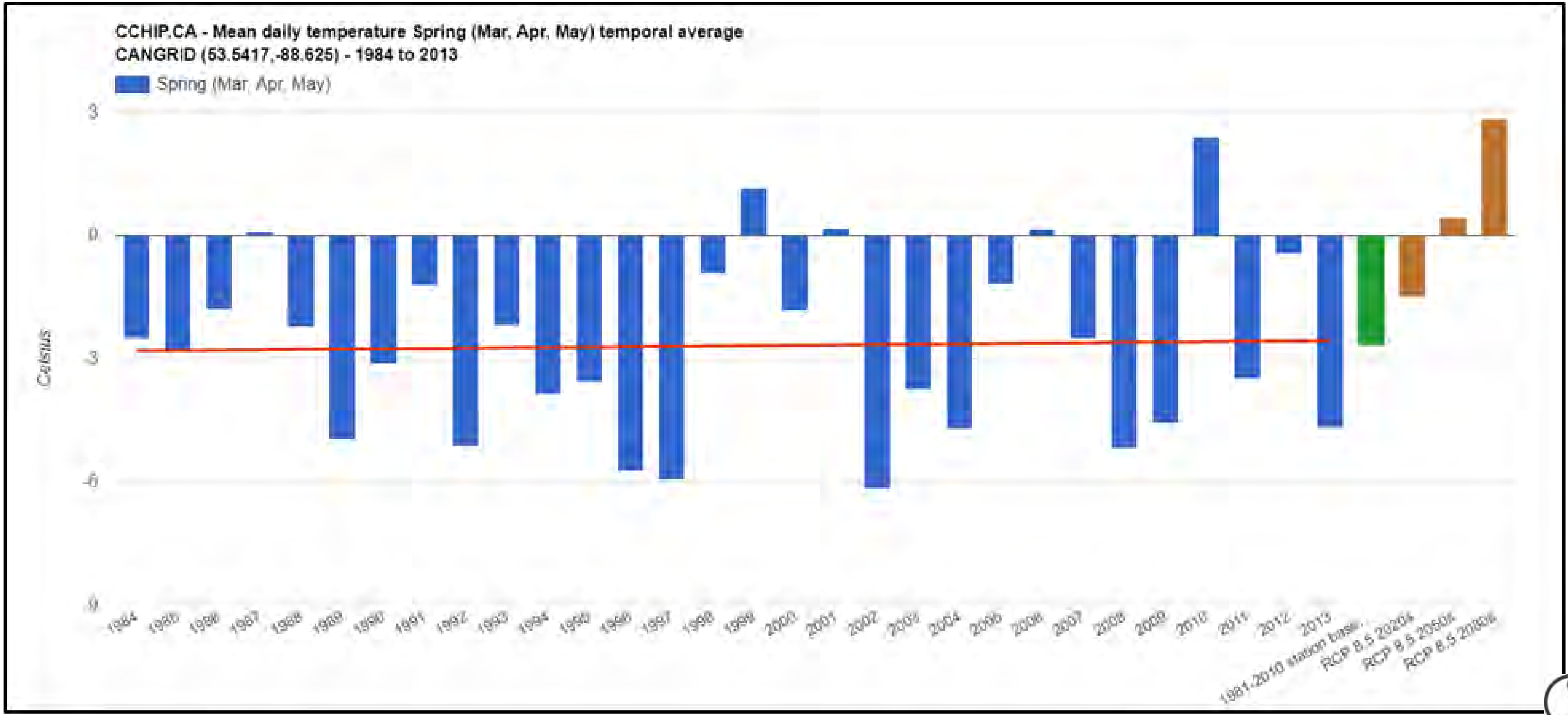
Winter Temporal Average - Mean Daily Temperature (RCP 8.5)



Spring Temporal Average - Mean Daily Temperature (RCP 8.5)



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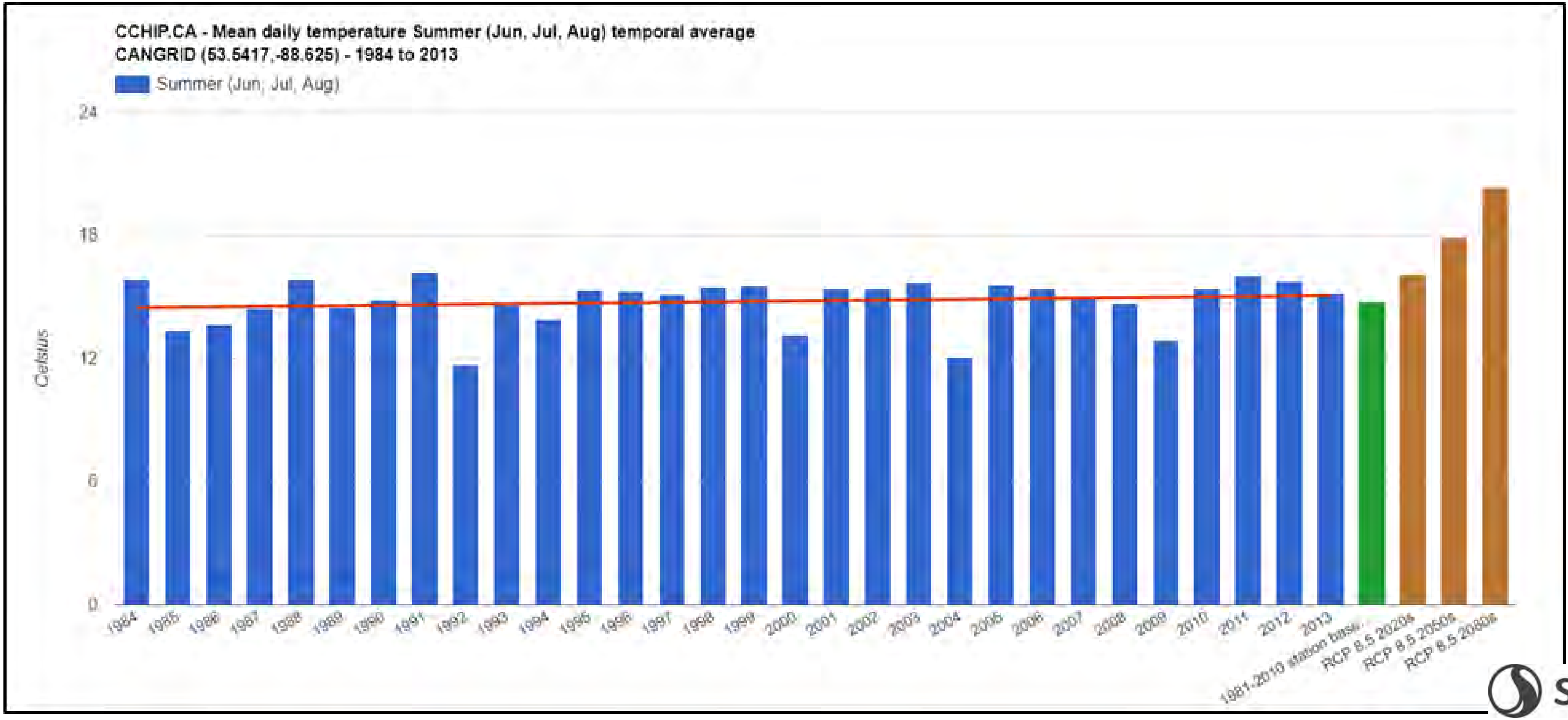
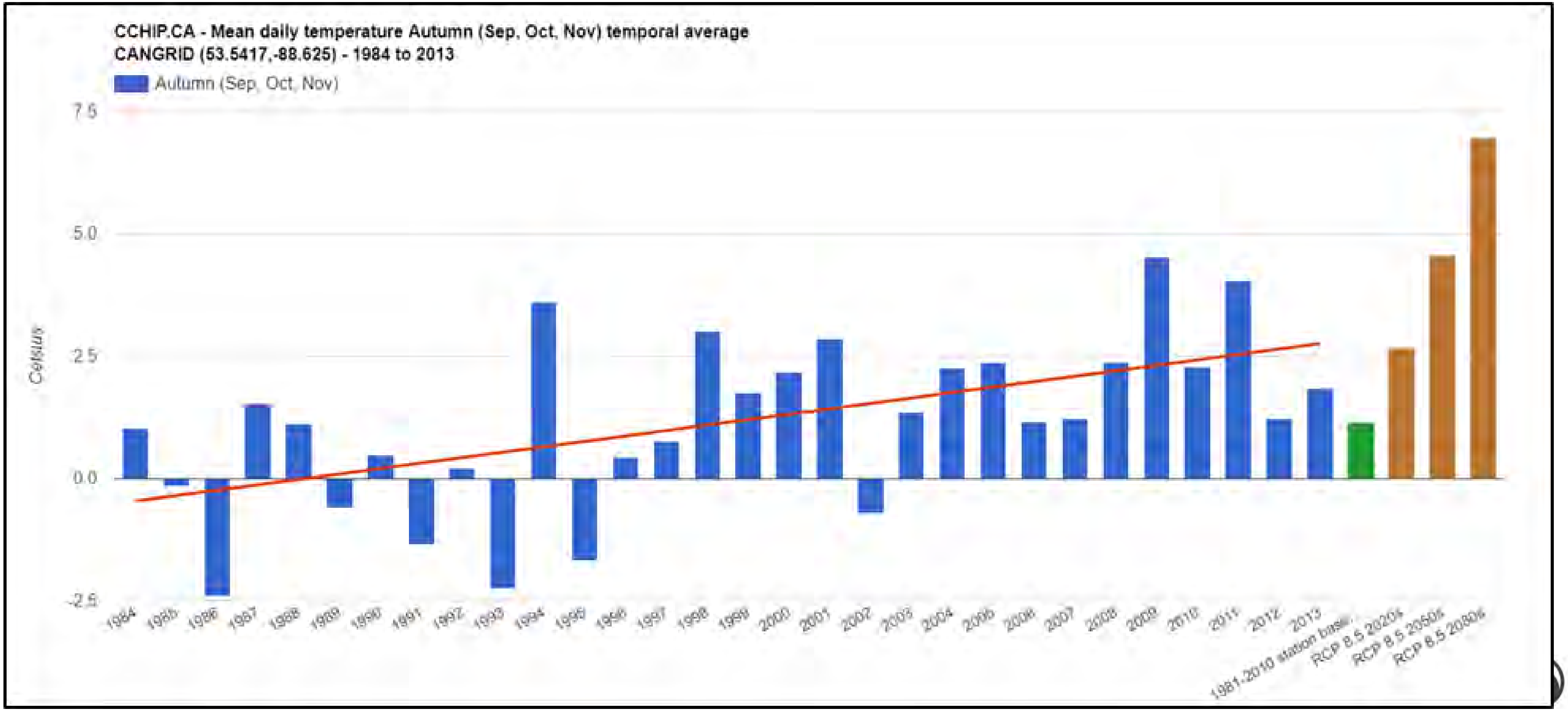
Summer Temporal Average Mean Daily Temperature (RCP 8.5)



Autumn Temporal Average Mean Daily Temperature (RCP 8.5)



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Daily Frost Profile (RCP 8.5)

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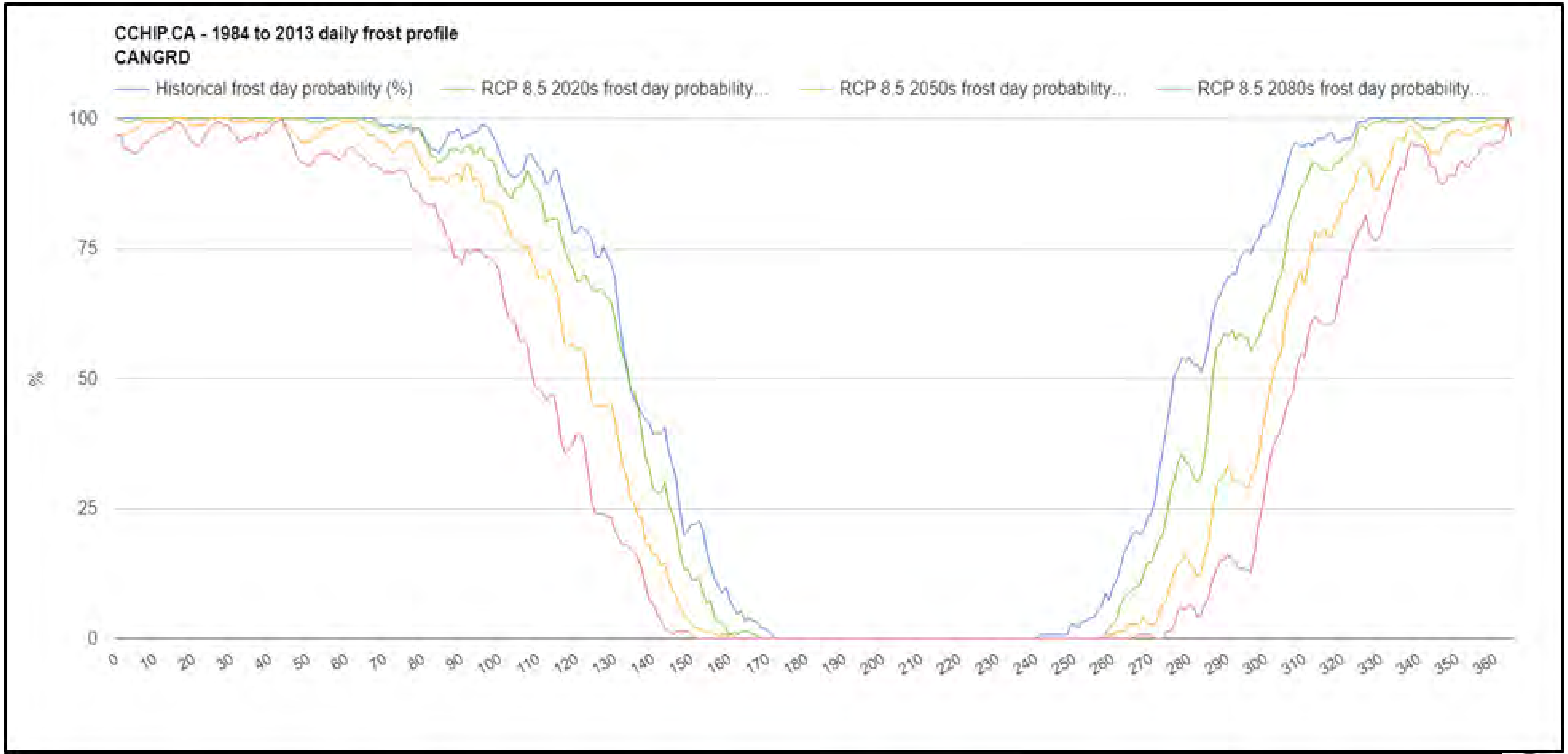
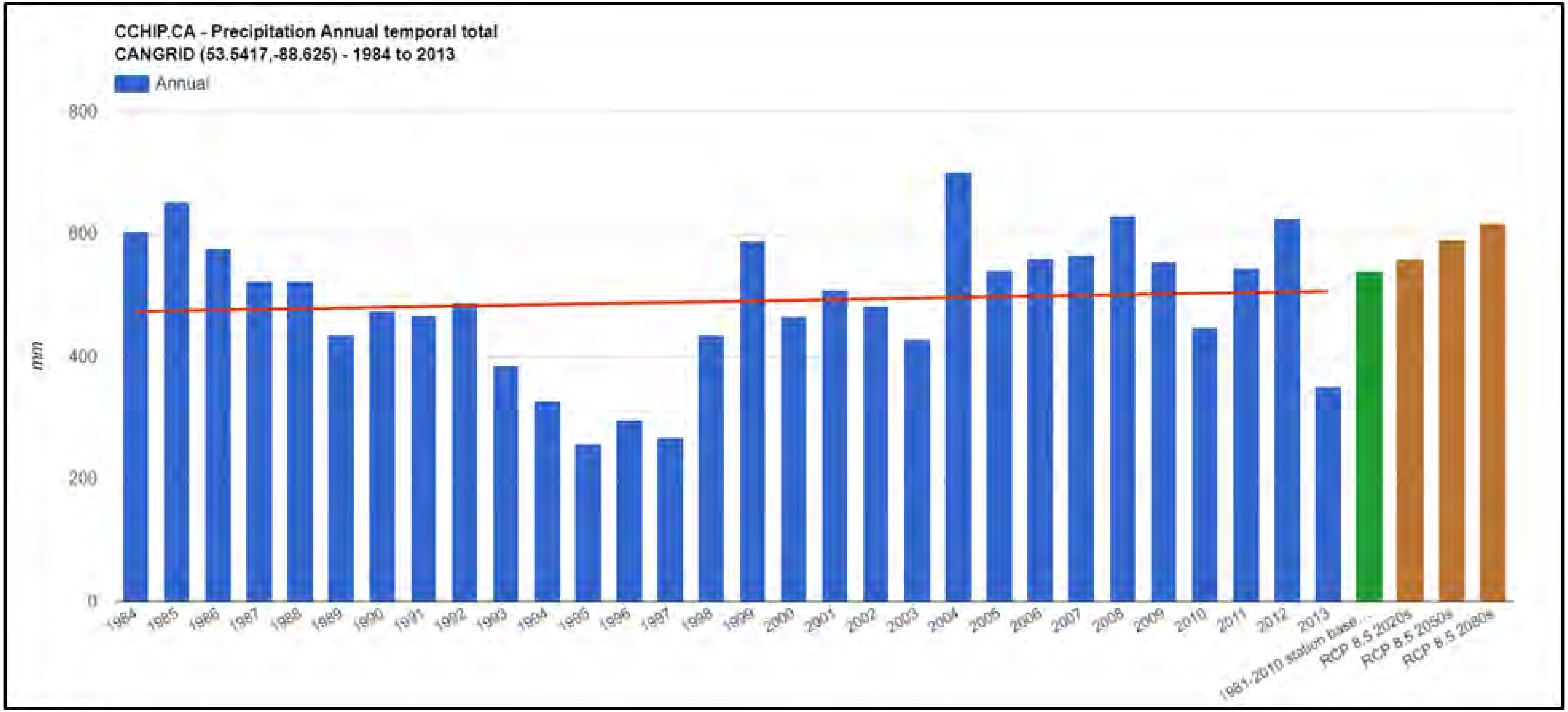


Annual Temporal Precipitation



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Precipitation (mm) Intensity-Duration-Frequency

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Historical (ungauged interpolation for Kasabonika)

T (years)	2	5	10	25	50	100
5 min	7.51	10.74	12.84	15.45	17.36	19.22
10 min	10.63	15.18	18.11	21.72	24.35	26.91
15 min	12.97	19.29	23.68	29.49	34.01	38.68
30 min	16.21	24.45	30.25	37.96	43.99	50.24
1 h	19.52	28.28	34.37	42.42	48.69	55.19
2 h	21.97	32.42	41.59	56.75	71.42	89.80
6 h	28.55	39.80	50.70	70.22	90.45	117.19
12 h	36.25	48.91	60.60	80.64	100.56	125.98
24 h	43.43	59.41	72.28	91.74	108.89	128.62

2025-2075 (RCP 8.5 projection for Kasabonika)

T (years)	2	5	10	25	50	100
5 min	8.91	13.09	15.95	20.04	22.59	26.59
10 min	12.61	18.50	22.48	28.17	31.68	37.22
15 min	15.39	23.50	29.40	38.25	44.26	53.50
30 min	19.22	29.80	37.55	49.23	57.24	69.49
1 h	23.15	34.47	42.66	55.01	63.36	76.34
2 h	26.06	39.51	51.64	73.59	92.94	124.22
6 h	33.86	48.51	62.94	91.06	117.70	162.10
12 h	43.00	59.61	75.23	104.57	130.86	174.26
24 h	51.52	72.39	89.74	118.97	141.70	177.91

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Thank You   Miigwech

Wayne Penno, Stantec Consulting Ltd.

Elmer Lickers, OFNTSC

APPENDIX C

WORKSHOP 3 POWERPOINT PRESENTATION

Kasabonika Lake First Nation
FN PIEVC Infrastructure Vulnerability Assessment
Risk Assessment
Workshop #3

Wayne Penno, MBA, P.Eng
Project Manager, Stantec

Tuesday-Wednesday, June 11, 2019

Agenda

Time	Description	
10:00am – 10:15am	Welcome and introductions	Kasabonika Lake and OFNTSC
10:15am – 11:00am	Review of Workshop # 2 findings and PIEVC Protocol steps and discussion	Consultants
11:00am – 12:00pm	Presentation of climate parameters and selection	Climate Scientist
12:00pm-1:00pm	Lunch/Health Break	
1:00pm - 2:15pm	Risk matrix: infrastructure vulnerability and climate interactions	All participants
2:15 – 3:00pm	Risk matrix development: climate events' probabilities, severity ratings and risk scores	All participants
3:00pm – 3:30pm	Review and next steps	Consultants
3:30pm	Adjourn	

Objectives

- Review of Workshop 1 and 2
- 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
- Next steps - Workshop 4

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KASABONIKA FIRST NATION

Kasabonika Lake

Identify the components of the infrastructure to be assessed in general terms

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Assessment of the CC Vulnerability of Kasabonika Lake FN Infrastructure

Infrastructure Definition Process

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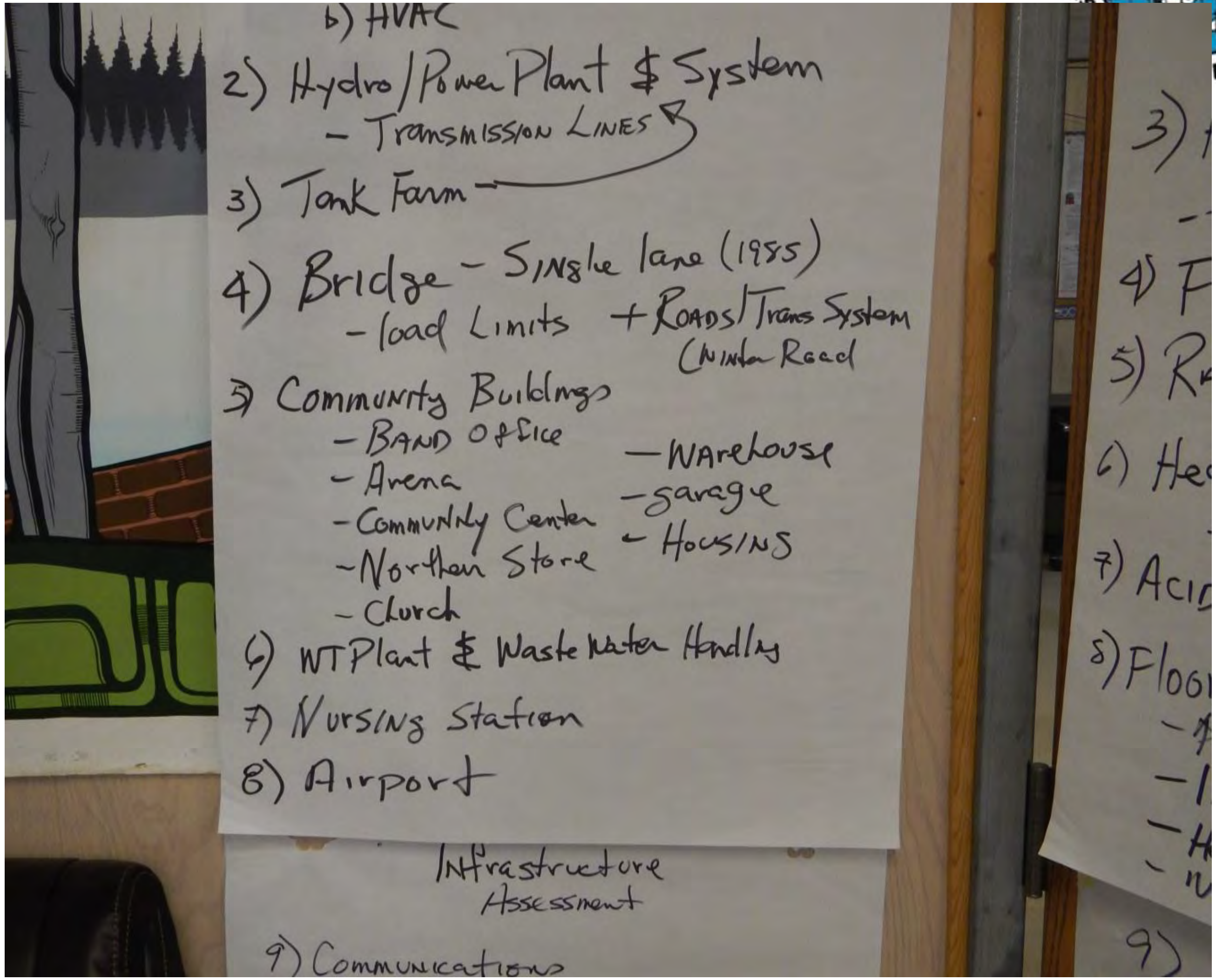
What KLFN Infrastructure will Be assessed?

Identify the components of the infrastructure to be assessed in general terms



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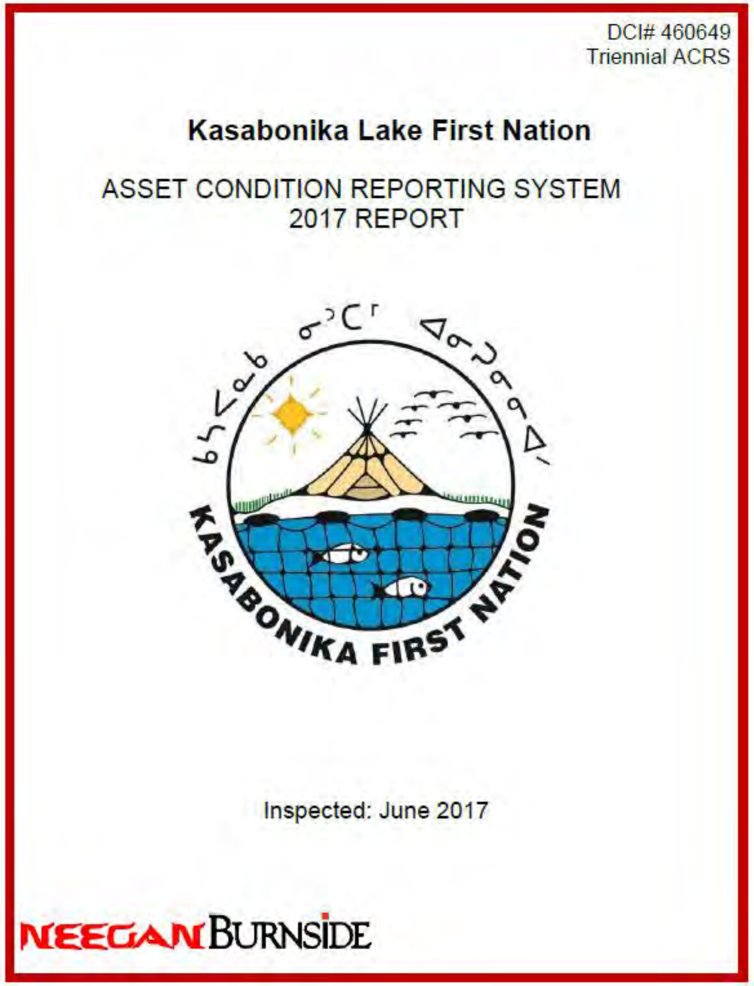
KLFN Infrastructure to be Assessed

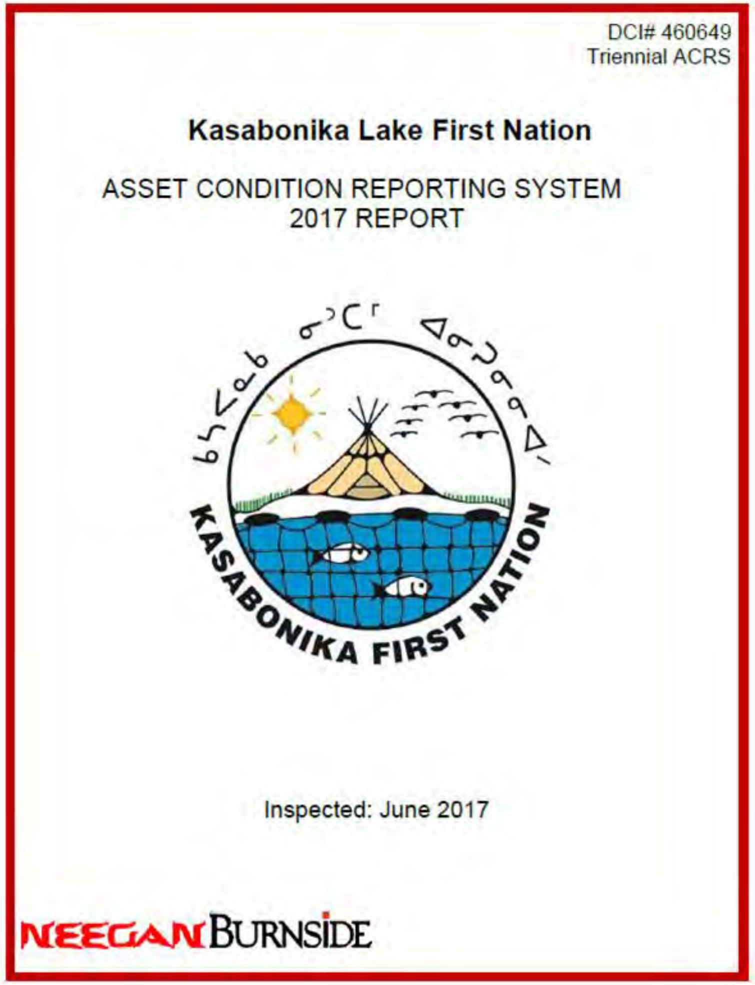
Main Components – Support Services

- Potable Water System
- Wastewater/Lagoons
- Administration and Operations Buildings
- Third party services
    - Telecommunications
    - Electricity (HORCI)
    - Fuel supply
    - Airport
- Nursing Station
- Bridge
- Arena



Administration and Operations

- Other buildings and yards
  - Public works garage and shed
- Vehicles and fleet
- Personnel/Staff
- Third party suppliers
- Island access
- General road network


DCI# 460649
Triennial ACRS

Kasabonika Lake First Nation

ASSET CONDITION REPORTING SYSTEM
2017 REPORT

KASABONIKA FIRST NATION

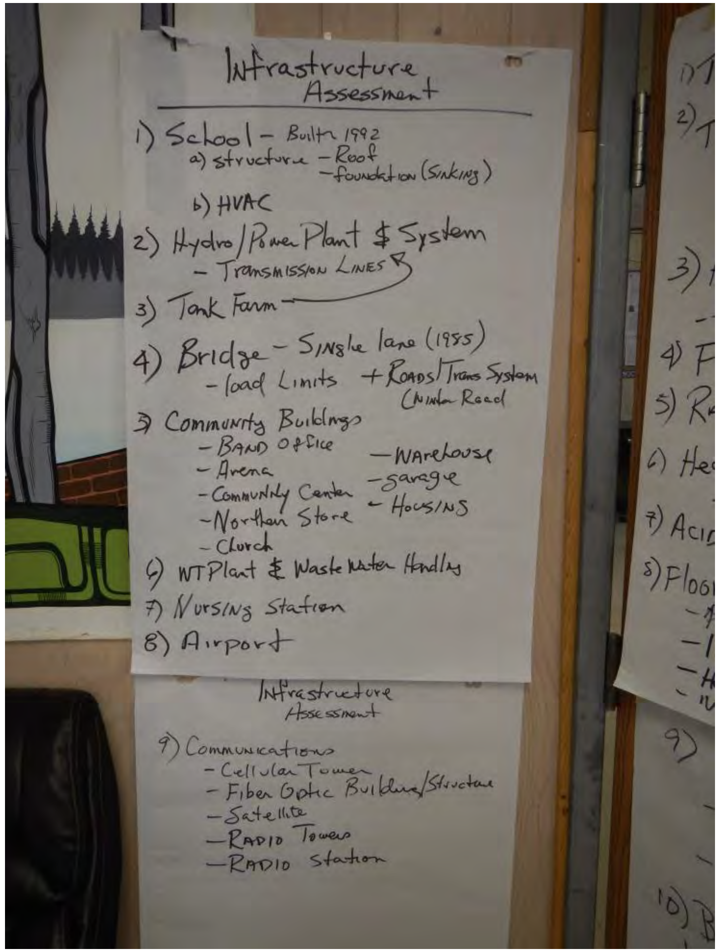
Inspected: June 2017

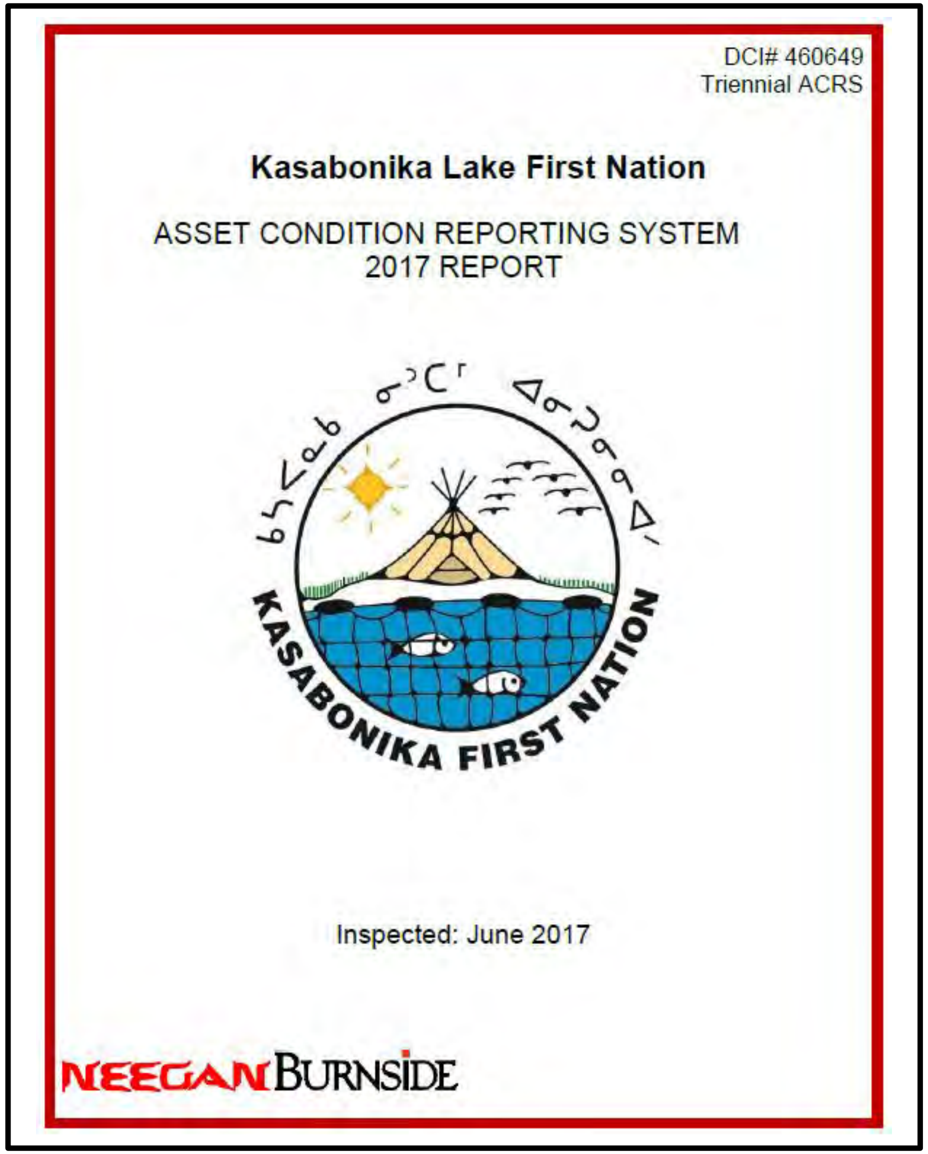
NEEGAN BURNSIDE

Buildings – general breakdown (not all apply)

- Building Structure
- Building Envelope
- Roof
- Foundations
- Process equipment
- HVAC
- Electrical systems
- SCADA/communications
- Storage
- Site services
- Access road
- Backup generator

Confirm the Infrastructure List




DCI# 460649
Triennial ACRS

Kasabonika Lake First Nation

ASSET CONDITION REPORTING SYSTEM
2017 REPORT

KASABONIKA FIRST NATION

Inspected: June 2017

NEEGAN BURNSIDE

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Kasabonika First Nation

Kasabonika Lake Climate Elements to Consider

General information on projections

Discussion on past events that have caused infrastructure disruptions and/or damage

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Discussion

How is the climate changing in Kasabonika Lake?

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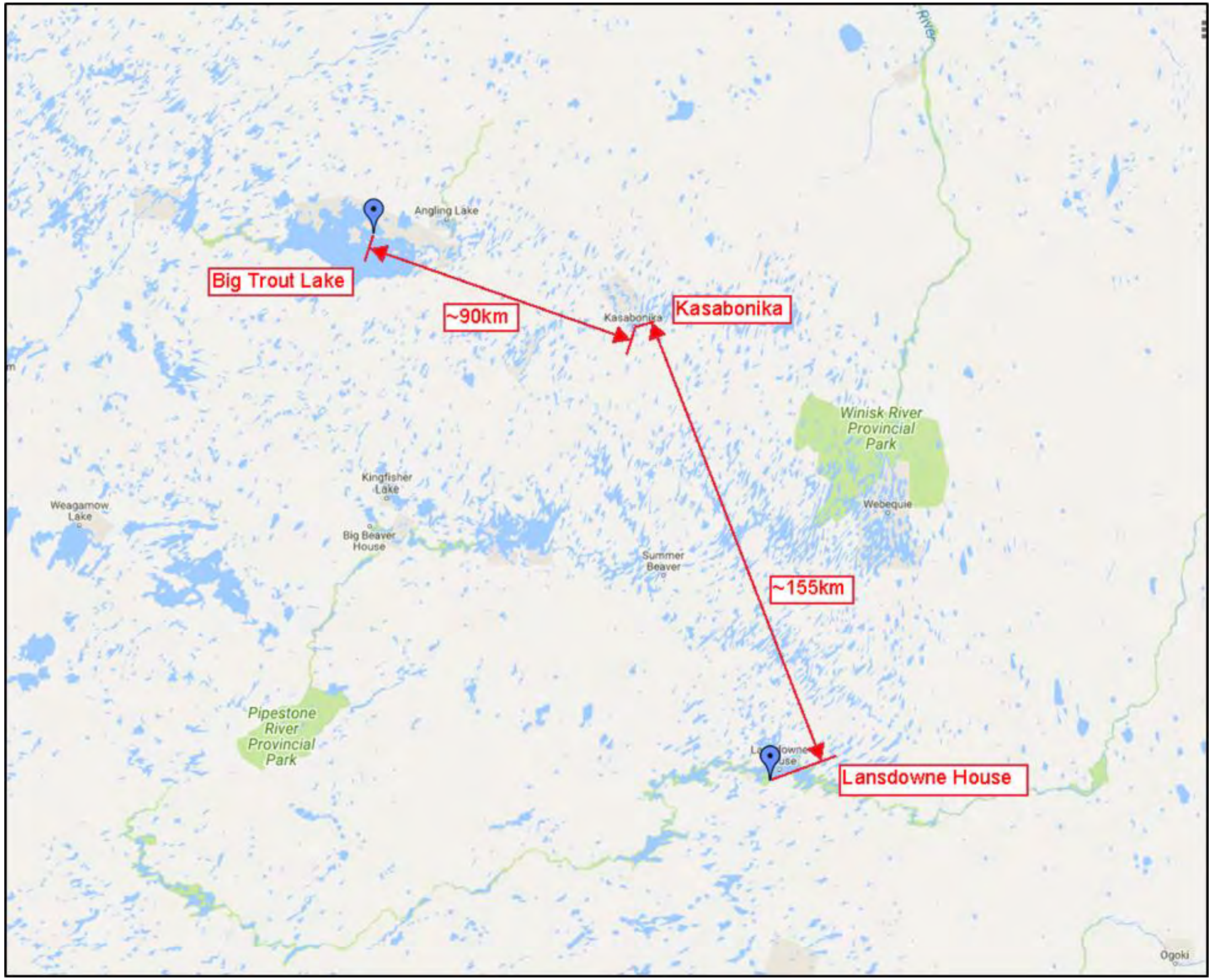
Climate Data Stations



Winter Temporal Average - Mean Daily Temperature (RCP 8.5)

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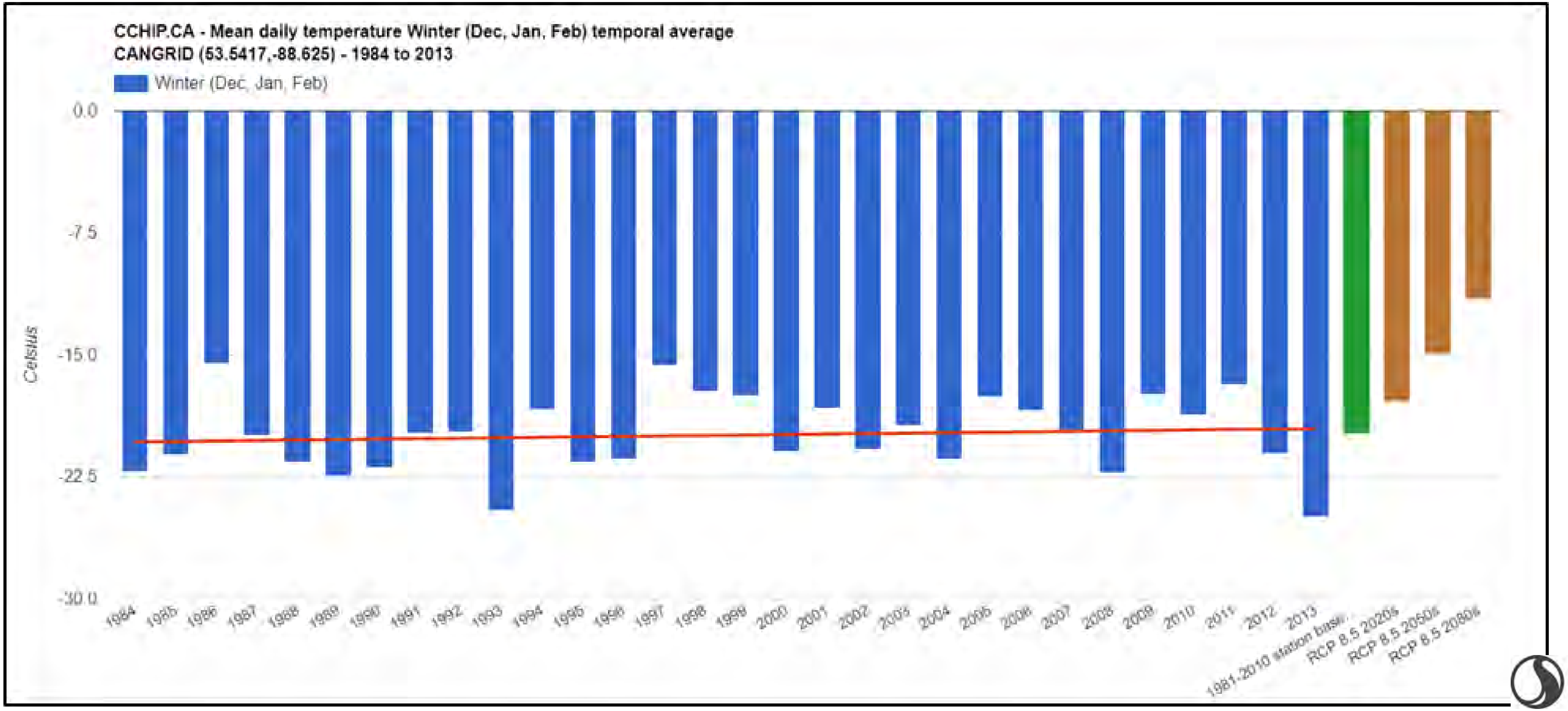
KASABONIKA FIRST NATION



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Daily Frost Profile (RCP 8.5)

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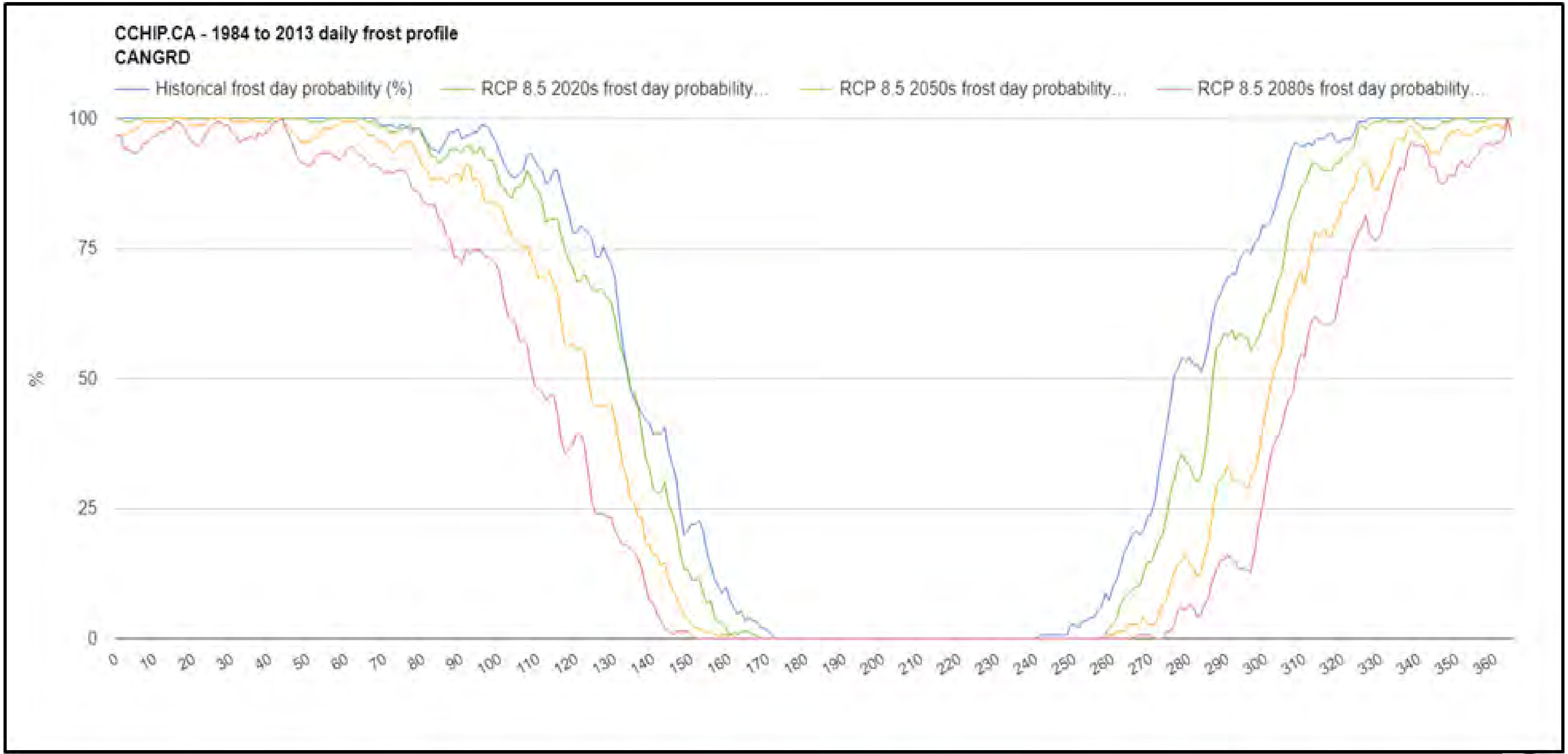

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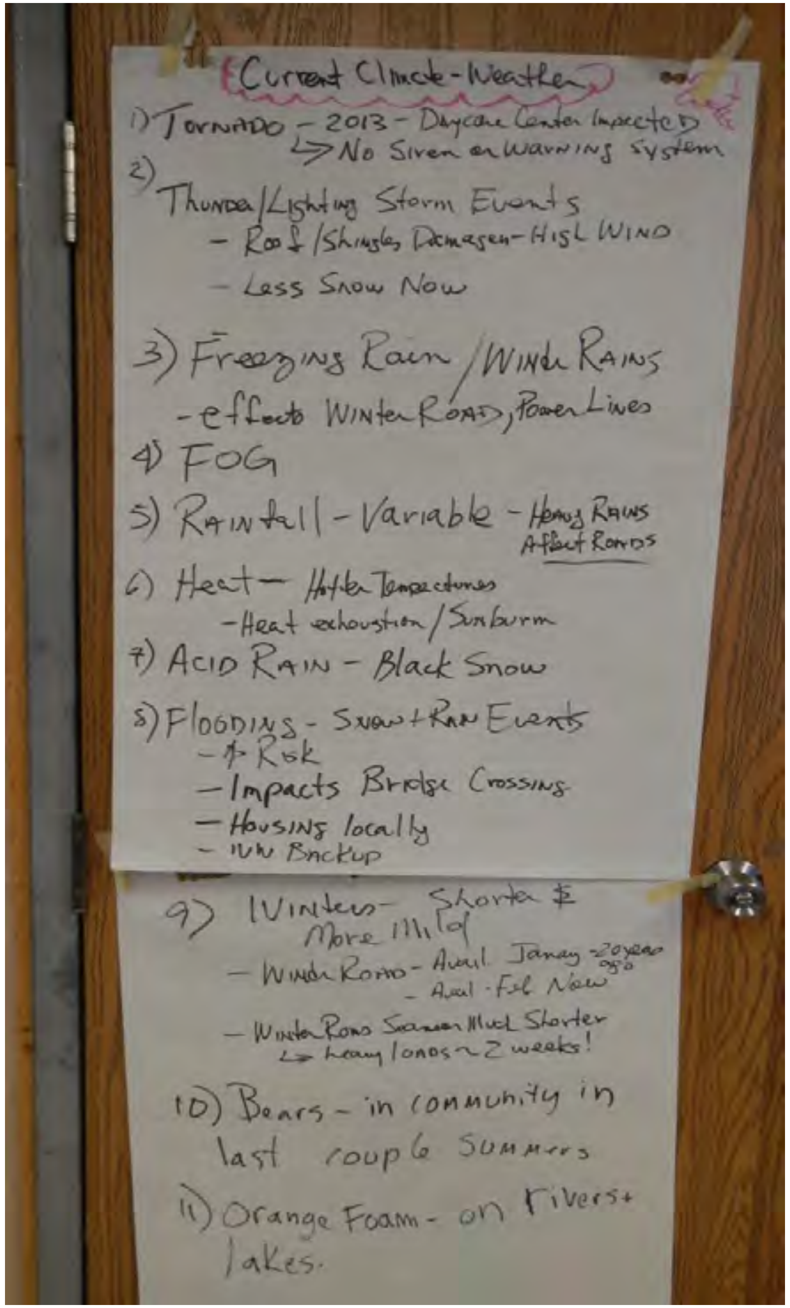
Precipitation Intensity

Historical (ungauged interpolation for Kasabonika)

T (years)	2	5	10	25	50	100
5 min	90.12	128.93	154.13	185.44	208.30	230.68
10 min	63.79	91.10	108.67	130.34	146.08	161.44
15 min	51.90	77.15	94.72	117.98	136.04	154.70
30 min	32.41	48.91	60.49	75.93	87.98	100.48
1 h	19.52	28.28	34.37	42.42	48.69	55.19
2 h	10.98	16.21	20.80	28.38	35.71	44.90
6 h	4.76	6.63	8.45	11.70	15.08	19.53
12 h	3.02	4.08	5.05	6.72	8.38	10.50
24 h	1.81	2.48	3.01	3.82	4.54	5.36

2025-2075 (RCP 8.5 projection for Kasabonika)

T (years)	2	5	10	25	50	100
5 min	106.90	157.11	191.34	240.48	271.05	319.09
10 min	75.66	111.01	134.90	169.03	190.08	223.30
15 min	61.56	94.01	117.59	152.99	177.02	213.99
30 min	38.44	59.60	75.10	98.46	114.48	138.98
1 h	23.15	34.47	42.66	55.01	63.36	76.34
2 h	13.03	19.76	25.82	36.80	46.47	62.11
6 h	5.64	8.08	10.49	15.18	19.62	27.02
12 h	3.58	4.97	6.27	8.71	10.90	14.52
24 h	2.15	3.02	3.74	4.96	5.90	7.41



Current Climate Events That Have an Effect of Infrastructure Performance

Climate Elements to Consider

General information on projections

Discussion on past events that have caused infrastructure disruptions and/or damage

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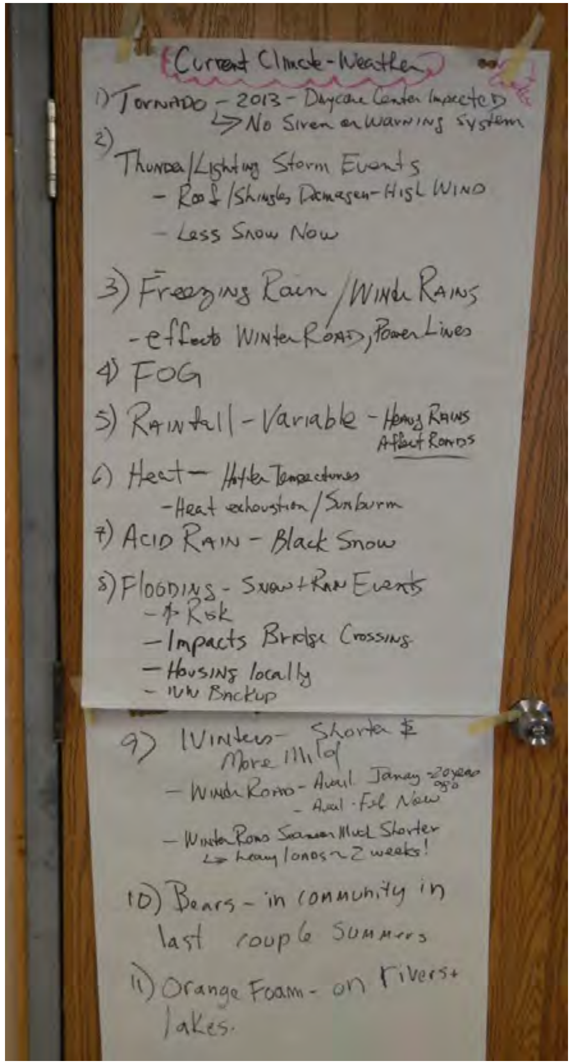
Kasabonika Lake First Nations

Climate Considerations

Weather Station Data and Projections

Heather Auld, Climate Scientist, RSI

Climate Elements Exercise



Climate Elements																			
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

What climate elements could impact the performance of Kasabonika Lake infrastructure components?

“If a climate event impacts the infrastructure, how will the condition and performance be affected?”

Establish the Infrastructure Performance Criteria

Infrastructure Components	ACRS	Performance Considerations					Climate Elements																			
		Structural	Operational	Functionality			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																										

1. Structural Design/Capacity

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

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

2. Functionality

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

- Effective Capacity of the infrastructure to provide the intended service
  - Short term
  - Medium term
  - Long term
- Examples from Kasabonika Lake Infrastructure?

3. Serviceability

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

- Ability to conduct routine and/or planned maintenance and refurbishment activities
  - Short term
  - Medium term
  - Long term
- Equipment service life - component replacement frequencies

Completing the risk matrix

To complete the risk matrix you need:

- ✓ Infrastructure definition
  - ✓ List and attributes (from ACRS)
  - ✓ Response (performance) considerations
  - ✓ Severity of impacts rating (if climate event occurs)
- ✓ Climate (current, future) and probability scale

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Severity Scales Exerci

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KASABONIKA FIRST NATION

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

Severity Scale — Kasabonika Lake

Score and Description	Consequence [Structural, Functional, Operations]
0 No effect	• Asset or component functions normally • 0% loss of Service
1 Insignificant	• Issues can be corrected through regularly scheduled maintenance • <10% of customers are affected • Only minor loss of services (LOS)
2 Minor	• Impacts can be corrected locally • A repair crew is required to correct the problem. • Parts (if required) are available in the community • 10-30% of customers/community are affected
3 Moderate	• Requires external assistance (parts and repair personnel) to correct the problem • 30-50% of customers/community are affected by some LOS • May require additional external funding to correct
4 Major	• Partial/significant loss of asset/component or loss of one or several critical assets having a significant impact on community services • 50-80% of customers/community are affected by some LOS • Require emergency assistance/additional funding to correct
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Establish the Infrastructure Performance Criteria

“If a climate event impacts the infrastructure, how will the condition and performance be affected?”

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Infrastructure Components	ACRS	Performance Considerations					(Current) Climate Elements																			
		Structural	Functional	Operational			Temperature Extreme high > 35 deg.				Temperature Cooling degree days Normal = 283				Rain Short duration / high intensity				Freezing Rain 15 – 25 mm in 12 hours				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
Building																										
Substructure																										
- **Foundations**																										
- **Basement**																										
Shell																										
- **Superstructure**																										
- **Exterior Enclosure**																										
- **Roofing**																										
Services																										
- **Conveyance (elevators)**																										
- **Plumbing**																										
- **HVAC**			✓				Y				Y				N				N							
- **Fire protection**																										
- **Electrical**																										
Grounds																										

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Infrastructure Components	ACRS	Performance Considerations					(Current) Climate Elements																			
							Temperature Extreme high > 35 deg.				Temperature Cooling degree days Normal = 283				Rain Short duration / high intensity				Freezing Rain 15 – 25 mm in 12 hours				Climate event 5			
		Structural	Functional	Operational			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
Building																										
Substructure																										
- **Foundations**																										
- **Basement**																										
Shell																										
- **Superstructure**																										
- **Exterior Enclosure**																										
- **Roofing**																										
Services																										
- **Conveyance (elevators)**																										
- **Plumbing**																										
- **HVAC**			✓				Y	4	3	12	Y	4	2	8	N				N							
- **Fire protection**																										
- **Electrical**																										
Grounds																										

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(Future) Climate Elements

Infrastructure Components	ACRS	Performance Considerations: Structural	Functional				Temperature – Extreme high > 35 deg.				Temperature – Cooling degree days Normal = 283				Rain – Short duration / high intensity				Freezing Rain – 15 – 25 mm in 12 hours				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
Building																										
Substructure																										
- **Foundations**																										
- **Basement**																										
Shell																										
- **Superstructure**																										
- **Exterior Enclosure**																										
- **Roofing**																										
Services																										
- **Conveyance (elevators)**																										
- **Plumbing**																										
- **HVAC**			✓				Y	5	4	20	Y	5	3	15	N				N							
- **Fire protection**																										
- **Electrical**																										
Grounds																										

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Impact of not maintaining infrastructure in a state of good repair

Consequences						
	Very High					
	High					20
	Moderate				12	15
	Low					
	Very Low					
		Very Low	Low	Moderate	High	Very High
	Likelihood					

Impact of climate changes

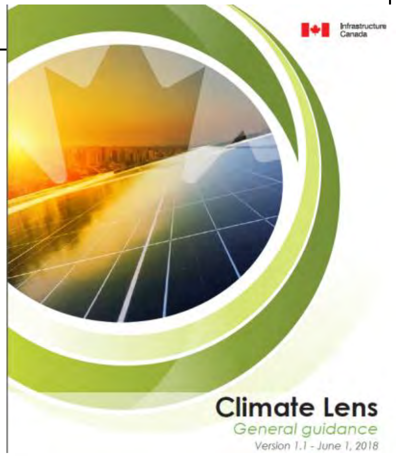
Extreme Risk: Immediate controls required

High Risk: High priority control measures required

Moderate Risk: Some controls required to reduce risks to lower levels

Low Risk: Controls likely not required

Negligible Risk: Risk events do not require further consideration



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The FN PIEVC Risk Matrix

Infrastructure Components	nfrastructure Response Considerations						Max. Daily Temp.				Hotest Month (Aug.) Temp.				Low Precipitation (Aug.)				Combination - Aug. High Temp. with Low				Fog				Rain - 7 day period			
	Structural Design	Functionality	Serviceability	Watershed, Surface Water & Groundwater	Operations, Maintenance & Materials Performance	Environmental Effects	Days (per year) with Max Temps > 36°C				Very warm August Temps Mean >22.5°C (warmer than August 2012)				Days with August total precipitation ≤ ~50mm (equal to or less than August 2012)				Combination August Warm Temperatures & low rainfalls				Fog visibilities below ½ statute mile (for shipping)				> 120 mm rainfall in 7 days			
	Mark Relevant Responses with ✓						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
Cornwall Island								5				6				5				4				3				3		
Water Supply System																														
Water Treatment Plant																														
Building structure	✓	✓	✓		✓																									
Building envelope	✓	✓	✓		✓																									
Roof	✓	✓	✓		✓																									
Process equipment		✓	✓		✓												4	20			5	20								
HVAC system	✓	✓	✓		✓								3	18							3	12								
Foundations	✓																												1	3
Site services	✓	✓	✓		✓	✓																								
Storage and/or alternate use	✓	✓	✓		✓																								3	9
Access road	✓	✓	✓		✓																									
Environment (plants, trees, animals)						✓							3	18			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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Infrastructure Components	ACRS	Performance Considerations					Climate Elements																			
		Structural	Operational	Functionality			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																										

KLFN Consequences Scale

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KASABONIKA FIRST NATION

Severity Scale – Kasabonika Lake

Score and Description	Consequence [Structural, Functional, Operations]
0 No effect	• Asset or component functions normally • 0% loss of Service
1 Insignificant	• Issues can be corrected through regularly scheduled maintenance • <10% of customers are affected • Only minor loss of services (LOS)
2 Minor	• Impacts can be corrected locally • A repair crew is required to correct the problem. • Parts (if required) are available in the community • 10-30% of customers/community are affected
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Work on the Risk Matrix

- Infrastructure list
- Performance considerations
- Climate parameters and probabilities
- Interactions: Y/N
- Severity if climate event occurs
- Risk

Asset/Infrastructure Elements	ACRS/ICMS Information					Performance Considerations					1 Max. Temp				2 Seasonal Temp variaions				3 Wind			
	Asset #	Quantity	Units	Year constructed	General condition	Structural	Operations	Functional	Environment (Land)	Environment (Water)	Days with Temp >XX deg. C				Heating and cooling degree days				Exceeding XX km.p.h			
											Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Wastewater System																						
Lagoons	453000			1987	4																	
Lagoon blower building	003200			1986	7																	
Lagoon Road	601500			1985	7																	
Sanitary mains South	450100			1987	7																	
Sanitary mains Central	450200			1991	7																	
Sanitary mains North	450300			1997	7																	
Sanitary mains West	450400			2001	7																	
Sewage lift stations (4)	452000			1987	7-8																	
Potable water system																						
Intake structure																						
Water treatment plant - Building	003500			1990	7																	
Building envelope																						

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KASABONIKA FIRST NATION

Wayne Penno, Stantec

Elmer Lickers, OFNTSC

Heather Auld, RSI

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APPENDIX D

WORKSHOP 4 POWERPOINT PRESENTATION

FN PIEVC Infrastructure Vulnerability Assessment
Kasabonika Lake First Nation
Mitigation of Risks and Adaptation Measures
Workshop #4

Wayne Penno, MBA, P.Eng
Project Manager, Stantec

Wednesday-Thursday, June 12-13, 2019

In Collaboration with:

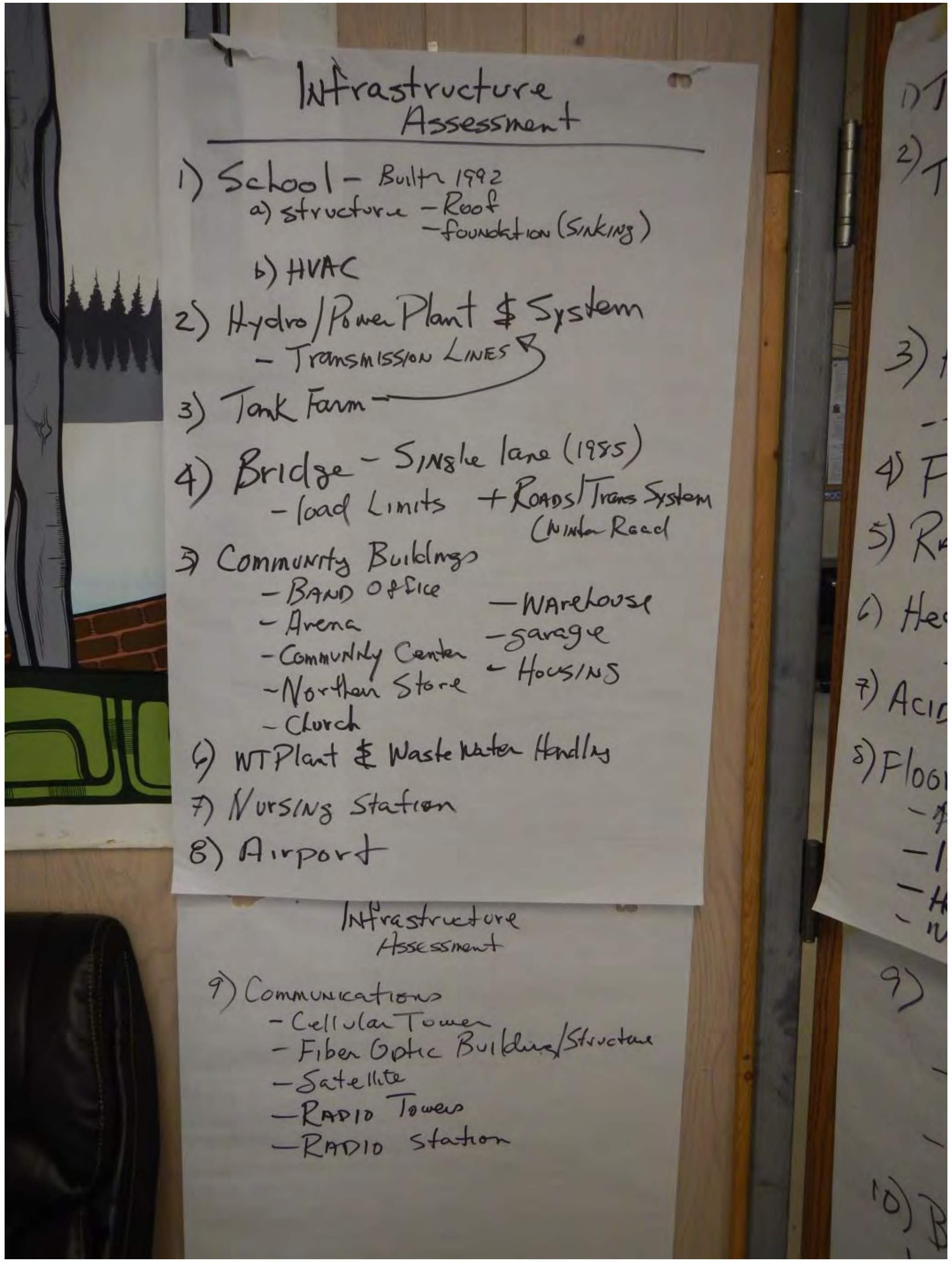
Agenda

June 12, 2019	Description	
1:00pm - 1:15pm	Welcome and introductions	KLFN and OFNTSC
1:15pm -2:30pm	Develop risk spreadsheet – infrastructure performance, climate event probabilities, severity scoring.	All participants
2:30pm – 2:45pm	Health break	
2:35pm – 4:00pm	Develop risk matrices – infrastructure performance, climate event probabilities, severity scoring.	All participants
June 13, 2019	**Description**	
9:00am – 10:15am	Review risk scores. Develop risk mitigation and adaptation measures.	All participants
10:15am – 10:30am	Health Break	
10:30am – 11:30am	Develop risk mitigation and adaptation measures.	All participants
10:45am – 12:00noon	Final Review – Next Steps	Consultants
12:00	Adjourn	

Objectives

- Review, revise as necessary, and agree on the current and future climate risk (risk matrices)
- Identify risk mitigation measures for the highest risks
- Recommend actions for immediate risks
- Discuss potential adaptation measures to reduce the risks under future climate conditions
- Next steps
- Adjoun

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																										



Infrastructure

Rating Scales

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	

Kasabonika Lake Impacts on Infrastructure

Score and Description	Consequence [Structural, Functional, Operations]
0 No effect	• Asset or component functions normally • 0% loss of Service
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Climate Events

RCP 8.5 scenario for future climate

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Climate Event	Description	Comment	Rating Current	Rating Future
HEAT WAVE	• Temps >30C in Day; • Temps >15C at Night • Min 3 consecutive days	Estimates of consecutive day heat waves – calculations to be completed	4 5 3	5 5 5
COLD SNAP	• Below -35C for 3-5 consecutive days		4	5
Freezing Index	• Total cold days insufficient to build ice thick enough to support a super B tanker with 50,000 liters fuel (110cm?)	How much cold weather required to make ice and frost in the ground. Estimate 30cm loss in ice thickness in 30-40 years	2	4
FREEZING RAIN	• >10mm accumulation	Estimated 15 mm causing local power line damage and damage to trees	4	5
Precipitation (downpour rainfall)	• Short Duration - High Intensity • >25mm in one hour	July 6/86 - 122mm in 12 hours or less	3	5

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KASABONIKA FIRST NATION

Climate Events (cont'd)

RCP 8.5 scenario for future climate

Climate Event	Description	Comment	Rating Current	Rating Future
DROUGHT	• Temp >20C during day • No Rain for >14 Days	Associated with forest fire threat	2	4
SNOWFALL	• >30 cm in 24 Hours • >200 cm (~8 feet total snowfall)		3 2	5 5
WIND GUSTS	• >100 Kph	Wind damages increase between square and cube of wind speeds	3	4
FOG			?	?
Forest Fires requiring evacuation		Evacuation threat, smoke issues, Impacts on power infrastructure	4	5

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Proposed risk rating

Impact/consequence on infrastructure if climate event occurs					
Catastrophic 5					HIGH
4					
3			MEDIUM		
2					
Insignificant 1	LOW				
	1 Highly unlikely	2	3	4	5 Likely / Frequent
	Likelyhood/probability of climate event occuring				

High: >= 15

Medium: 6 – 12

Low: =< 4

Special:

- P=1 and S=5
- P=5 and S=1

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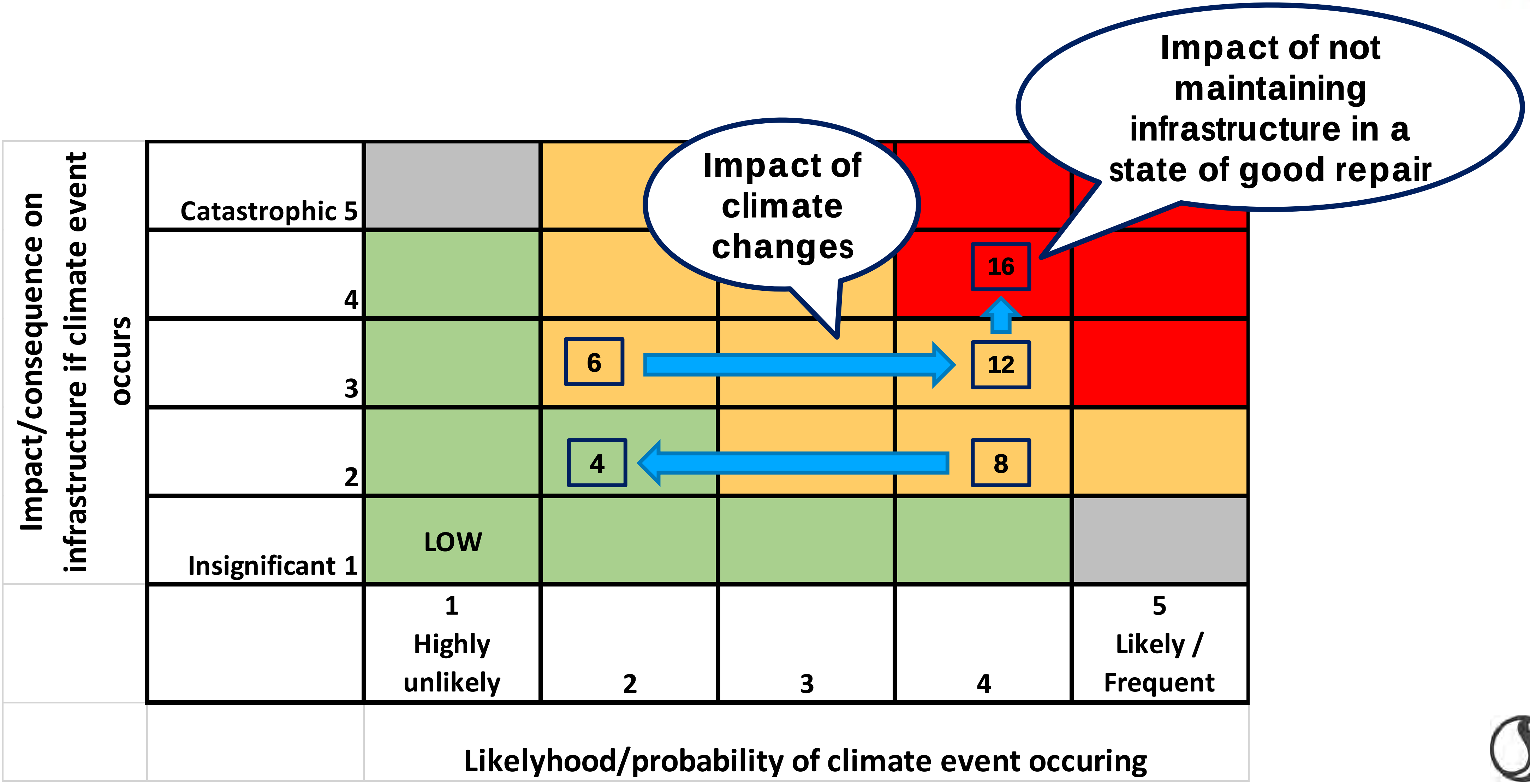
Review of the Risk Matrix

- Infrastructure list
- Performance considerations
- Climate parameters and probabilities
- Interactions: Y/N
- Severity if climate event occurs
- Risk

Asset/Infrastructure Elements	ACRS/ICMS Information					Performance Considerations					1 Max. Temp				2 Seasonal Temp variaions				3 Wind			
	Asset #	Quantity	Units	Year constructed	General condition	Structural	Operations	Functional	Environment (Land)	Environment (Water)	Days with Temp >XX deg. C				Heating and cooling degree days				Exceeding XX km.p.h			
											Y/N	P	S	R	Y/N	P	S	R	Y/N	P	S	R
Wastewater System																						
Lagoons	453000			1987	4																	
Lagoon blower building	003200			1986	7																	
Lagoon Road	601500			1985	7																	
Sanitary mains South	450100			1987	7																	
Sanitary mains Central	450200			1991	7																	
Sanitary mains North	450300			1997	7																	
Sanitary mains West	450400			2001	7																	
Sewage lift stations (4)	452000			1987	7-8																	
Potable water system																						
Intake structure																						
Water treatment plant - Building	003500			1990	7																	
Building envelope																						

Future Climate



Risk Summary - KLFN

Risk Rating	Current Climate	Future Climate	Future Climate + Infrastructure in worse condition
Low	12	0	
Medium	24	34	
High	4	6	

Impacts on the service or the community if the infrastructure fails

1. Emergency Response

With respect to the infrastructure or infrastructure component being assessed, a loss of performance or failure due to climate loading may affect:

- Procedures and systems to address:
  - Severe storm events
  - Flooding
  - Ice dams
  - Water damage

2. Insurance and Legal Considerations

With respect to the infrastructure or infrastructure component being assessed, a loss of performance or failure due to climate loading may affect:

- Insurance rates
- The ability to acquire insurance
- Insurance policy limitations and exclusions
- Legal impacts and liability

3. Policy Considerations

With respect to the infrastructure or infrastructure component being assessed, a loss of performance or failure due to climate loading may affect:

- Codes
- Guidelines
- Standards
- Internal operations and maintenance policies and procedures
- Levels of Service policy
- Land use planning

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4. Social Effects

With respect to the infrastructure or infrastructure component being assessed, a loss of performance or failure due to climate loading may affect:

- Accessibility to critical facilities such as hospitals, fire and police services
- Energy supply to a community
- Dislocation of affected populations
- Provision of basic services such as potable water distribution and wastewater collection
- Closure of schools and other public services
- Destruction or damage to heritage buildings, monuments, etc. or historically important resources

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5. Environmental Effects

With respect to the infrastructure or infrastructure component being assessed, a loss of performance or failure due to climate loading may cause:

- Release of toxic, controlled or deleterious substances
- Degradation of water quality
- Damage to sensitive ecosystems
- Physical harm to birds and animals
- Contamination of potable water supplies
- Public perception and interaction

6. Fiscal Impacts

With respect to the infrastructure or infrastructure component being assessed, a loss of performance or failure due to climate loading may cause:

- Drain on current/future financial resources to deal with unplanned repairs, maintenance and/or replacements
- Shifting financial resources from other community priorities
- Impacts on services and/or levels of service
- Community economic impacts and/or hardships

Mitigating Risks and Adaptation Measures

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KASABONIKA FIRST NATION

Wayne Penno, MBA, P.Eng, Stantec
Elmer Lickers, OFNTSC
Heather Auld, Risk Sciences International

Stantec

APPENDIX E

KASABONIKA LAKE RISK MATRIX WORKSHEETS

Current Climate

Asset/Infrastructure Element	ACRS/ICMS Information: Asset Number	Year Constructed	Condition Rating	Performance Considerations: Structural	Operational	Functional	Temperature – Climate 1: HEAT WAVE (Probability = 4)							Climate 2: COLD SNAP (Probability = 4)							Precipitation – Climate 3: RAINFALL - High Intensity (Probability = 2)							Climate 4: DROUGHT (Probability = 2)							Climate 5: FREEZING RAIN (Probability = 3)							Climate 6: SNOWFALL (Probability = 2)							Temperature – Climate 7: DECLINING FREEZING INDEX (Probability = 2)							Wind – Climate 8: WIND GUSTS >100 Kph (Probability = 3)							Mixed Effects and Other – Climate 9: FOG (Probability = 1)							Climate 10: FOREST FIRES (Probability = 3)						
				(s)	(o)	(f)	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf
Community Buildings																																																																												
Nursing Station		2018	10																																																																									
Building envelope				√																															√	1			3																																				
Building structure																																																																												
Roof (sloped roof/asphalt shingles)				√	√																														√		1			3																				√	3			9																
Foundations					√																√		1			2																																																	
Mechanical - Heating/Cooling						√	√			2			8	√			3			12																																																							
Drainage						√															√			2			4															√			1			2																												
Staff					√	√	√			3			12	√		3			12																	√		2			6																																√		3			9	
School		1992	5																																																																									
Building envelope					√	√								√			1			4															√		1			3																																			
Building structure				√	√																														√		1			3		√	2			4																														
Roof (sloped roof/asphalt shingles)				√																																						√	2			4																														
Roof Mounted Equipment																																																																											
Foundations				√																	√	2			4																																																		
Mechanical/HVAC System						√								√			2			8																																																								
Fuel (Diesel)																																																																											
Outdoor Equipment/Playground						√																													√			1			3																																		
Staff					√	√	√		2			8		√		2			8																√			2			6																																√		3			9	
SUPPORT ASSET/INFRASTRUCTURE																																																																											
Wastewater System																																																																											
Sewage Lagoons			3			√	√			3			12																																																															
Lagoon Blower Building																																																																											
Lagoon Aeration and Treatment Systems																																																																											
Lagoon Access Road																					√	1			2																																																		
Sanitary Force Mains/Pipes			6																																																																								
Sewage Lift Stations			4/5																																																																								
Staff					√																														√		2			6																																√		3			9	
Water Treatment		1992	5	√	√	√																																																																						
Raw Water Intake Structure																																																																											
Underground Reservoir																																																																											
WTP - Building **(Ugraded in 2006)**																																																																											
Building envelope				√		√								√			1			4															√	1			3																																				
Building structure																																																																											
Roof																																																																											
Foundations				√																	√	2			4																																																		
Heating/Cooling system						√								√			2			8																																																								
Fuel (Oil)																																																																											
Backup generator																																																																											
Staff					√																														√		2			6																																√		3			9	
Third-Party Services																																																																											
Electricity/Power (HORCI)																																																																											
Wires																																																																											
Poles																																																																											
Generator Station Building/Equipment																																																																											
Fuel																																																																											
Telecommunications (TBay Tel/Bell)																																																																											
Towers																																																																											
Signal Strength						√															√			1			2																																																	
Wires (Bell)				√																															√	3			9																																				
Fuel Supply/Tank Farm																																																																											
Tanks																																																																											
Delivery					√																														√		1			3																																				
Piping																																																																											
Airport																																																																											
Building				√																																																						√	2			6																
Runway/Taxiways					√	√															√			2			4								√		3			9																	√		2			6		√		2			6		√		3			9	
Bridge																																																																											
Bridge Deck						√																													√			1			3																																		
Steel Structure																																																																											
Footings/Foundation																																																																											
Flooding affects bridge footings																																																																											
Roads																																																																											
Surface				√	√	√															√	2			4			√		2			4		√			2			6	√			1			2																												
Road Bed				√																	√	2			4																																																		
Ditches/Culverts						√															√			2			4																																																		
WINTER ROAD				√		√																																				√	2		2	4		4	√	4		4	8		8	√			2			6														
NATURAL ASSETS																																																																											
Burial Grounds																																																																											
RISK SUMMARY			**TOTALS**																																																																										
Extreme (>= 20)			0								0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0
High (10 - 16)			4								0	0	2					0	1	1					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0
Moderate (8 - 9)			15								0	1	1					0	1	2					0	0	0					0	0	0					1	1	0					0	0	0					1	0	1					1	0	0					0	0	0					0	5	0
Low (3 - 6)			31								0	0	0					0	0	2					4	0	3					0	1	0					2	7	4					3	0	1					0	0	0					1	1	1					0	1	0					0	0	0
Negligible (< 3)			5								0	0	0					0	0	0					1	1	1					0	0	0					0	0	0					0	0	2					0	0	0					0	0	0					0	0	0					0	0	0

Future Climate

Asset/Infrastructure Element	ACRS/ICMS Information: Asset Number	ACRS/ICMS Information: Year Constructed	ACRS/ICMS Information: Condition Rating	Performance Consideration: Structural (s)	Performance Consideration: Operational (o)	Performance Consideration: Functional (f)	Temperature – Climate 1 – HEAT WAVE – Probability = 5							Temperature – Climate 2 – COLD SNAP – Probability = 5							Precipitation – Climate 3 – RAINFALL - High Intensity – Probability = 3							Precipitation – Climate 4 – DROUGHT – Probability = 4							Precipitation – Climate 5 – FREEZING RAIN – Probability = 5							Precipitation – Climate 6 – SNOWFALL – Probability = 5							Temperature – Climate 7 – DECLINING FREEZING INDEX – Probability = 4							Wind – Climate 8 – HIGH WINDS – Probability = 4							Other – Climate 9 – FOG – Probability = 2							Other – Climate 10 – FOREST FIRES – Probability = 5						
				(s)	(o)	(f)	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf
BUILDINGS																																																																											
Nursing Station		2018	10																																																																						
Building envelope				√																															√	1			5																																	
Building structure																																																																											
Roof (sloped roof/asphalt shingles)				√	√																														√		1			5																√	3			12																	
Foundations					√																√		1			3																																															
Mechanical - Heating/Cooling					√	√	√		2			10		√			3			15																																																				
Drainage						√															√			2			6															√			1			5																											
Staff					√		√		3			15		√		3			15																√		2			10																												√		3			15	
School		1994	4																																																																							
Building envelope					√	√								√			1			5															√		1			5																																	
Building structure				√	√																														√		1			5		√	2			10																												
Roof (sloped roof/asphalt shingles)				√																																						√	2			10																												
Roof Mounted Equipment																																																																											
Foundations				√																	√	2			6																																																
Mechanical/HVAC System						√								√			2			10																																																					
Fuel (Diesel)																																																																											
Outdoor Equipment/Playground						√																													√			1			5																																
Staff					√	√	√		2			10		√		2			10																√			2			10																												√		3			15	
SUPPORT ASSET/INFRASTRUCTURE																																																																											
Wastewater System		1992	5																																																																										
Sewage Lagoons			3							3			15																																																															
Lagoon Blower Building																																																																											
Lagoon Aeration and Treatment Systems																																																																											
Lagoon Access Road				√																	√	1			3																																																
Sanitary Force Mains/Pipes			6																																																																								
Sewage Lift Stations			4/5																																																																								
Staff					√	√																						√			1			4	√		2			10																												√		3			15	
Water Treatment		1992	5																																																																										
Raw Water Intake Structure						√															√			1			3								√			1			5																																
Underground Reservoir				√																															√	1			5																																			
WTP - Building **(Ugraded in 2006)**		1992?	5																																																																								
Building envelope				√		√								√			1			5															√	1			5																																	
Building structure																																																																											
Roof																																																																											
Foundations				√																	√	2			6																																																
Heating/Cooling system						√								√			2			10																																																					
Fuel (Oil/Propane/Electric)																																																																											
Backup generator																																																																											
Watermains/Pipes		1992	5																																																																								
Staff					√																														√		2			10																												√		3			15	
TRIRD PARTY SUPPLIED SERVICES																																																																											
Electricity/Power (HORCI)																																																																											
Wires																																																																											
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Generator Station Building/Equipment																																																																											
Fuel																																																																											
Telecommunications (TBay Tel)																																																																											
Towers																																																																											
Signal Strength						√															√			1			3																																																
Wires (Bell)				√																															√	3			15																																			
Fuel Supply/Tank Farm																																																																											
Tanks																																																																											
Delivery					√																														√		1			5																																	
Piping																																																																											
Airport																																																																											
Building				√																																																					√	2			8																	
Runway/Taxiways					√	√															√			2			6								√		3			15																√		2			8									√		3			15	
Bridge																																																																											
Bridge Deck						√																													√			1			5																																
Steel Structure																																																																											
Footings/Foundation																																																																											
Flooding affects bridge footings																																																																											
Roads																																																																											
Surface				√																	√	2			6																																																
Road Bed				√																	√	2			6																																																
Ditches/Culverts						√															√			3			9																																																
WINTER ROAD				√		√																																				√			2			10	√	4		4	16		16																					
NATURAL ASSETS																																																																											
Burial Grounds																																																																											
RISK SUMMARY	**Totals**																																																																											
Extreme (>= 20)	**0**										0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0
High (10 - 16)	**26**										0	3	1					0	2	3					0	0	0					0	0	0					1	4	1					2	0	1					1	0	1					1	0	0					0	0	0					0	5	0
Moderate (8 - 9)	**3**										0	0	0					0	0	0					0	0	1					0	0	0					0	0	0					0	0	0					0	0	0					1	1	0					0	0	0					0	0	0
Low (3 - 6)	**24**										0	0	0					0	0	2					5	1	4					0	0	1					3	4	3					0	0	1					0	0	0					0	0	0					0	0	0					0	0	0
Negligible (< 3)	**0**										0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0					0	0	0

Asset/Infrastructure Element	ACRS/ICMS Information			Performance Consideration			Temperature													
							Climate 1							Climate 2						
Infrastructure Not Replace at End of Service Life	Asset Number	Year Constructed	Condition Rating	Structural	Operational	Functional	HEAT WAVE							COLD SNAP						
							Probability = 5							Probability = 5						
				(s)	(o)	(f)	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf
BUILDINGS																				
Nursing Station		2018	10																	
Building envelope				√																
Building structure																				
Roof (sloped roof/asphalt shingles)				√	√															
Foundations					√															
Mechanical - Heating/Cooling					√	√	√		3			15		√			4			20
Drainage						√														
Staff					√		√		3			15		√		3			15	
School		1994	4																	
Building envelope					√	√								√			2			10
Building structure				√	√															
Roof (sloped roof/asphalt shingles)				√																
Roof Mounted Equipment																				
Foundations				√																
Mechanical/HVAC System						√								√			3			15
Fuel (Diesel)																				
Outdoor Equipment/Playground						√														
Staff					√	√	√		2			10		√		2			10	
SUPPORT ASSET/INFRASTRUCTURE																				
Wastewater System		1992	5																	
Sewage Lagoons			3							4			20							
Lagoon Blower Building																				
Lagoon Aeration and Treatment Systems																				
Lagoon Access Road				√																
Sanitary Force Mains/Pipes			6																	
Sewage Lift Stations			4/5																	
Staff					√	√														
Water Treatment		1992	5																	
Raw Water Intake Structure						√														
Underground Reservoir				√																
WTP - Building **(Ugraded in 2006)**		1992?	5																	
Building envelope				√		√								√			2			10
Building structure																				
Roof																				
Foundations				√																
Heating/Cooling system						√								√			3			15
Fuel (Oil/Propane/Electric)																				
Backup generator																				
Watermains/Pipes		1992	5																	
Staff					√															
TRIRD PARTY SUPPLIED SERVICES																				
Electricity/Power (HORCI)																				
Wires																				
Poles																				
Generator Station Building/Equipment																				
Fuel																				
Telecommunications (TBay Tel)																				
Towers																				
Signal Strength						√														
Wires (Bell)				√																
Fuel Supply/Tank Farm																				
Tanks																				
Delivery					√															
Piping																				
Airport																				
Building				√																
Runway/Taxiways					√	√														
Bridge																				
Bridge Deck						√														
Steel Structure																				
Footings/Foundation																				
Flooding affects bridge footings																				
Roads																				
Surface				√																
Road Bed				√																
Ditches/Culverts						√														
WINTER ROAD				√		√														
NATURAL ASSETS																				
Burial Grounds																				
RISK SUMMARY		**Totals**																		
Extreme (>= 20)		**4**									0	0	1					0	0	1
High (10 - 16)		**34**									0	3	0					0	2	4
Moderate (8 - 9)		**10**									0	0	0					0	0	0
Low (3 - 6)		**5**									0	0	0					0	0	0
Negligible (< 3)		**0**									0	0	0					0	0	0

Asset/Infrastructure Element	Precipitation																				
	Climate 3							Climate 4							Climate 5						
	RAINFALL - High Intensity							DROUGHT							FREEZING RAIN						
	Probability = 3							Probability = 4							Probability = 5						
	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf
BUILDINGS																					
Nursing Station																					
Building envelope															√	2			10		
Building structure																					
Roof (sloped roof/asphalt shingles)															√		2			10	
Foundations	√		2			6															
Mechanical - Heating/Cooling																					
Drainage	√			3			9														
Staff															√		2			10	
School																					
Building envelope															√		2			10	
Building structure															√		2			10	
Roof (sloped roof/asphalt shingles)																					
Roof Mounted Equipment																					
Foundations	√	3			9																
Mechanical/HVAC System																					
Fuel (Diesel)																					
Outdoor Equipment/Playground															√			2			10
Staff															√			2			10
SUPPORT ASSET/INFRASTRUCTURE																					
Wastewater System																					
Sewage Lagoons																					
Lagoon Blower Building																					
Lagoon Aeration and Treatment Systems																					
Lagoon Access Road	√	2			6																
Sanitary Force Mains/Pipes																					
Sewage Lift Stations																					
Staff								√			1			4	√		2			10	
Water Treatment																					
Raw Water Intake Structure	√			1			3								√			1			5
Underground Reservoir															√	2			10		
WTP - Building **(Ugraded in 2006)**																					
Building envelope															√	2			10		
Building structure																					
Roof																					
Foundations	√	2			6																
Heating/Cooling system																					
Fuel (Oil/Propane/Electric)																					
Backup generator																					
Watermains/Pipes																					
Staff															√		2			10	
TRIRD PARTY SUPPLIED SERVICES																					
Electricity/Power (HORCI)																					
Wires																					
Poles																					
Generator Station Building/Equipment																					
Fuel																					
Telecommunications (TBay Tel)																					
Towers																					
Signal Strength	√			1			3														
Wires (Bell)															√	3			15		
Fuel Supply/Tank Farm																					
Tanks																					
Delivery															√		1			5	
Piping																					
Airport																					
Building																					
Runway/Taxiways	√			2			6								√		3			15	
Bridge																					
Bridge Deck															√			3			15
Steel Structure																					
Footings/Foundation																					
Flooding affects bridge footings																					
Roads																					
Surface	√	3			9																
Road Bed	√	3			9																
Ditches/Culverts	√			4			12														
WINTER ROAD																					
NATURAL ASSETS																					
Burial Grounds																					
RISK SUMMARY																					
Extreme (>= 20)					0	0	0					0	0	0					0	0	0
High (10 - 16)					0	0	1					0	0	0					4	7	3
Moderate (8 - 9)					3	0	1					0	0	0					0	0	0
Low (3 - 6)					2	1	3					0	0	1					0	1	1
Negligible (< 3)					0	0	0					0	0	0					0	0	0

Asset/Infrastructure Element	Precipitation							Temperature							Wind						
	Climate 6							Climate 7							Climate 8						
	SNOWFALL							DECLINING FREEZING INDEX							HIGH WINDS						
	Probability = 5							Probability = 4							Probability = 4						
	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf
BUILDINGS																					
Nursing Station																					
Building envelope																					
Building structure																					
Roof (sloped roof/asphalt shingles)															√	4			16		
Foundations																					
Mechanical - Heating/Cooling																					
Drainage	√			1			5														
Staff																					
School																					
Building envelope																					
Building structure	√	3			15																
Roof (sloped roof/asphalt shingles)	√	3			15																
Roof Mounted Equipment																					
Foundations																					
Mechanical/HVAC System																					
Fuel (Diesel)																					
Outdoor Equipment/Playground																					
Staff																					
SUPPORT ASSET/INFRASTRUCTURE																					
Wastewater System																					
Sewage Lagoons																					
Lagoon Blower Building																					
Lagoon Aeration and Treatment Systems																					
Lagoon Access Road																					
Sanitary Force Mains/Pipes																					
Sewage Lift Stations																					
Staff																					
Water Treatment																					
Raw Water Intake Structure																					
Underground Reservoir																					
WTP - Building **(Ugraded in 2006)**																					
Building envelope																					
Building structure																					
Roof																					
Foundations																					
Heating/Cooling system																					
Fuel (Oil/Propane/Electric)																					
Backup generator																					
Watermains/Pipes																					
Staff																					
TRIRD PARTY SUPPLIED SERVICES																					
Electricity/Power (HORCI)																					
Wires																					
Poles																					
Generator Station Building/Equipment																					
Fuel																					
Telecommunications (TBay Tel)																					
Towers																					
Signal Strength																					
Wires (Bell)																					
Fuel Supply/Tank Farm																					
Tanks																					
Delivery																					
Piping																					
Airport																					
Building															√	3			12		
Runway/Taxiways															√		2			8	
Bridge																					
Bridge Deck																					
Steel Structure																					
Footings/Foundation																					
Flooding affects bridge footings																					
Roads																					
Surface																					
Road Bed																					
Ditches/Culverts																					
WINTER ROAD	√			3			15	√	5		5	20		20							
NATURAL ASSETS																					
Burial Grounds																					
RISK SUMMARY																					
Extreme (>= 20)					0	0	0					1	0	1					0	0	0
High (10 - 16)					2	0	1					0	0	0					2	0	0
Moderate (8 - 9)					0	0	0					0	0	0					0	1	0
Low (3 - 6)					0	0	1					0	0	0					0	0	0
Negligible (< 3)					0	0	0					0	0	0					0	0	0

Asset/Infrastructure Element	Other													
	Climate 9							Climate 10						
	FOG							FOREST FIRES						
	Probability = 2							Probability = 5						
	Y/N	Ss	So	Sf	Rs	Ro	Rf	Y/N	Ss	So	Sf	Rs	Ro	Rf
BUILDINGS														
Nursing Station														
Building envelope														
Building structure														
Roof (sloped roof/asphalt shingles)														
Foundations														
Mechanical - Heating/Cooling														
Drainage														
Staff								√		3			15	
School														
Building envelope														
Building structure														
Roof (sloped roof/asphalt shingles)														
Roof Mounted Equipment														
Foundations														
Mechanical/HVAC System														
Fuel (Diesel)														
Outdoor Equipment/Playground														
Staff								√		3			15	
SUPPORT ASSET/INFRASTRUCTURE														
Wastewater System														
Sewage Lagoons														
Lagoon Blower Building														
Lagoon Aeration and Treatment Systems														
Lagoon Access Road														
Sanitary Force Mains/Pipes														
Sewage Lift Stations														
Staff								√		3			15	
Water Treatment														
Raw Water Intake Structure														
Underground Reservoir														
WTP - Building **(Ugraded in 2006)**														
Building envelope														
Building structure														
Roof														
Foundations														
Heating/Cooling system														
Fuel (Oil/Propane/Electric)														
Backup generator														
Watermains/Pipes														
Staff								√		3			15	
TRIRD PARTY SUPPLIED SERVICES														
Electricity/Power (HORCI)														
Wires														
Poles														
Generator Station Building/Equipment														
Fuel														
Telecommunications (TBay Tel)														
Towers														
Signal Strength														
Wires (Bell)														
Fuel Supply/Tank Farm														
Tanks														
Delivery														
Piping														
Airport														
Building														
Runway/Taxiways								√		3			15	
Bridge														
Bridge Deck														
Steel Structure														
Footings/Foundation														
Flooding affects bridge footings														
Roads														
Surface														
Road Bed														
Ditches/Culverts														
WINTER ROAD														
NATURAL ASSETS														
Burial Grounds														
RISK SUMMARY														
Extreme (>= 20)					0	0	0					0	0	0
High (10 - 16)					0	0	0					0	5	0
Moderate (8 - 9)					0	0	0					0	0	0
Low (3 - 6)					0	0	0					0	0	0
Negligible (< 3)					0	0	0					0	0	0