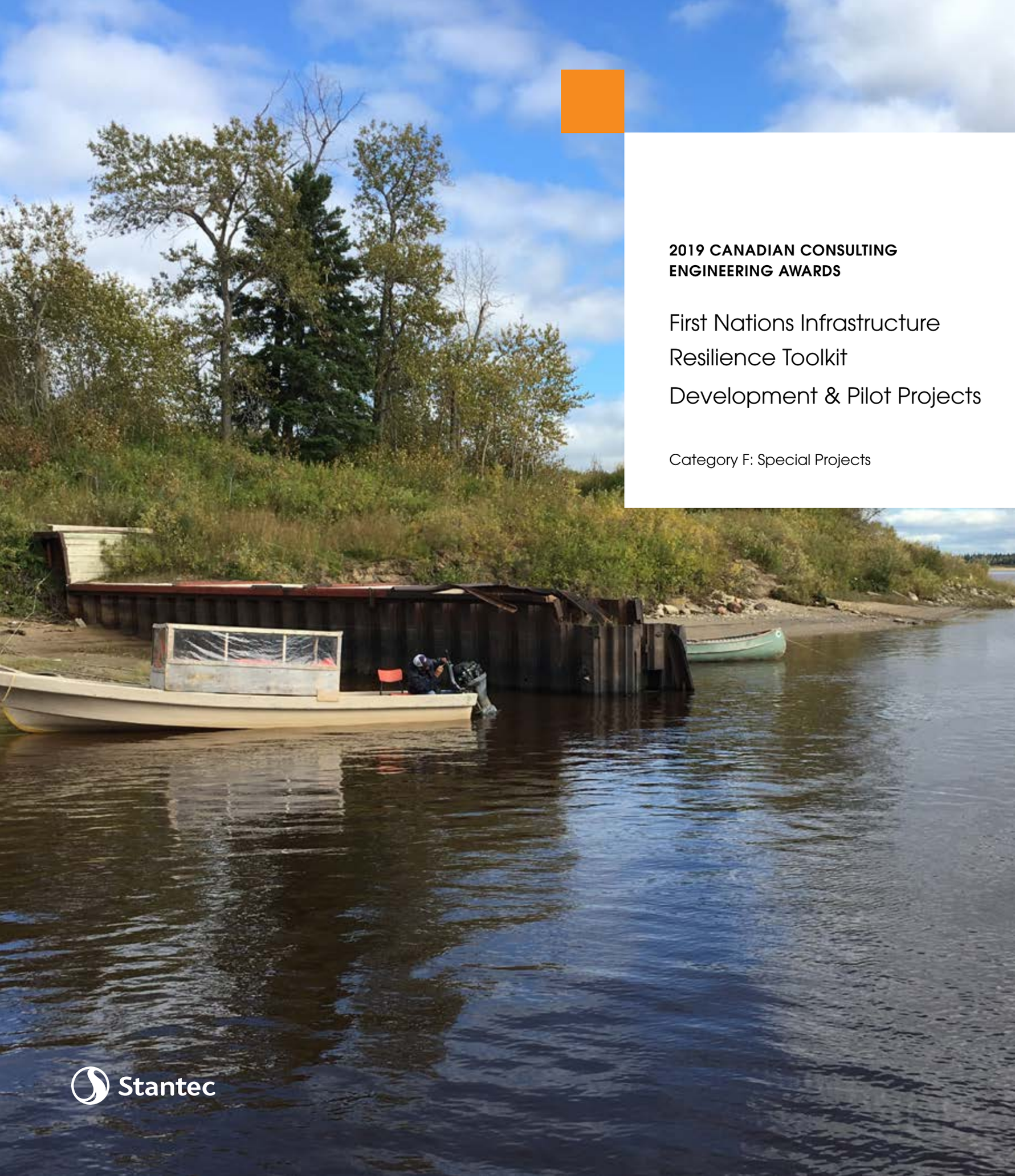


2019 CANADIAN CONSULTING ENGINEERING AWARDS

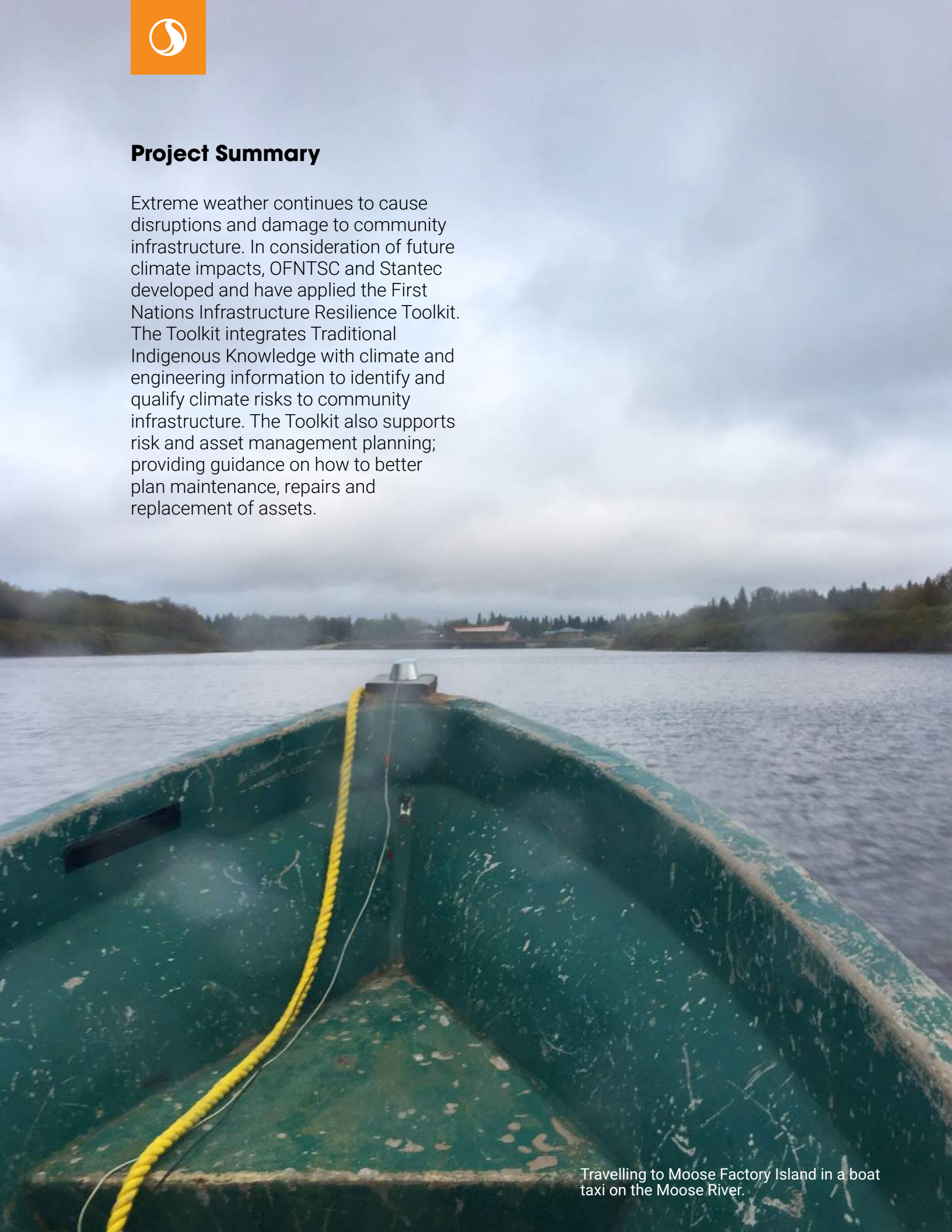
First Nations Infrastructure Resilience Toolkit Development & Pilot Projects

Category F: Special Projects

Stantec

Project Summary

Extreme weather continues to cause disruptions and damage to community infrastructure. In consideration of future climate impacts, OFNTSC and Stantec developed and have applied the First Nations Infrastructure Resilience Toolkit. The Toolkit integrates Traditional Indigenous Knowledge with climate and engineering information to identify and qualify climate risks to community infrastructure. The Toolkit also supports risk and asset management planning; providing guidance on how to better plan maintenance, repairs and replacement of assets.



Travelling to Moose Factory Island in a boat taxi on the Moose River.

Project Highlights

Q.1 INNOVATION

The Government of Canada has indicated that the First Nations infrastructure deficit may be as high as $30 billion. Additionally, changing climate patterns are adding to the toll on First Nations assets and communities, accentuating the need for careful asset and climate risk management practices.

In consideration of extreme weather and future climate uncertainty, Ontario First Nations Technical Services Corporation (OFNTSC) and Stantec developed the First Nations Infrastructure Resilience Toolkit (FN-IRT) to help First Nations communities identify and develop risk management measures to address climate change risks to their infrastructure. The FN-IRT is unique as it combines guidance on how to incorporate climate risks into sound asset management practices to better plan maintenance, repairs and replacement of community assets.

The Toolkit is adapted from Engineers Canada's PIEVC (Public Infrastructure Engineering Vulnerability Committee) Protocol to make it applicable to First Nation communities. The FN-IRT was developed in collaboration with the Mohawk Council of Akwesasne, Oneida Nation of the Thames, Moose Cree First Nation of Moose Factory, Engineers Canada, and Risk Sciences International (RSI). Funding was provided by Crown-Indigenous Relations and Northern Affairs Canada – First Nation Adapt Program (Formerly INAC) and OCCIAR (Ontario Centre for Climate Impacts and Adaption Resources).

There are 3 modules which are a part of the FN-IRT: Module 1 - Built Environment, where information on the condition of community infrastructure is collected; Module 2 - Climate Risk Assessment; and Module 3 - Asset Management.

The following features outline the innovative attributes of the FN-IRT:

1. The Toolkit is customizable and can be easily used. The FN-IRT was designed so engineers and non-engineers can apply it to one or all of a community's infrastructure systems or assets. The Toolkit can be customized by developing community specific climate risks based on current and future climate change data. The climate risk assessment module allows users to develop a customized community-specific risk tolerance scale to create the infrastructure risk profile.

Sawpit Island on the Moose River, southwest of Moose Factoy.

Mohawk Council of Akwesasne water intake.

2. The Toolkit incorporates Traditional Indigenous Knowledge and community engagement supplemented by weather station data and future climate scenarios. Infrastructure data is extracted from the First Nation Asset Condition Reporting System (ACRS) – a report required by INAC every 3 years for all Department funded assets, and Integrated Capital Management System (ICMS) databases. Leveraging existing data sources, the Toolkit allows First Nations communities to cost-effectively develop a risk profile and identify adaptation measures for their infrastructure. The process also allows the user to identify data gaps that may need to be addressed in the future.

3. Since climate change risks occur over the life-cycle of the infrastructure, the Toolkit incorporates an asset management module to help communities plan their financial needs to efficiently manage, operate and maintain their assets over their intended life-cycles.

4. Use of the Toolkit involves a collaborative community-based process that combines climate change science to assess risks to infrastructure with community-based adaption solutions. This approach results in a greater understanding of emerging risks with increased acceptance and ownership of the outcomes by the community membership.

The Toolkit was developed based on lessons learned from a PIEVC Protocol application in Akwesasne. The draft Toolkit was tested through pilot applications in Oneida Nation of the Thames and the Moose Cree First Nation communities. Currently OFNTSC, Stantec and RSI are conducting a series of ten 2 ½ days Toolkit capacity development training sessions for First Nation communities across Ontario.

Temporary raw water intake for the Moose Factory water treatment plant.

Q.2 COMPLEXITY

Creating a new toolkit through the adaptation of the Engineers Canada PIEVC Protocol posed several challenges:

1. To create a toolkit that would address diverse community and cultural needs for all First Nation (FN) communities, the toolkit had to be scalable, adaptable, and use available local sources of information. This was achieved using Traditional Indigenous Knowledge and available infrastructure data (ACRS and ICMS databases.)

2. To improve adoption of the Toolkit, it needed to be understood and easily applied by non-engineers, making it applicable to a broad base of FN community infrastructure assets. To address this challenge, the original PIEVC Protocol was first tested with water and wastewater treatment systems in Akwesasne resulting in identified areas of simplification, improvement and modifications for application to the FN context. The goal was to deliver a tool that was flexible but also stays true to the principles and rigor of the PIEVC Protocol, built upon data and information sources specific to FN communities.

3. Many FN communities are remote, and therefore climate data from Environment Canada's weather station network is often not available. The incorporation of Traditional Knowledge, community engagement in the risk assessment process and additional climate training for communities to identify observed climate changes, provide an effective means of filling these data gaps. The element of engagement also serves to create and enhance community ownership of the process, resulting in broader acceptance of the Toolkit.

4. To verify the toolkit was flexible, scalable, and applicable to a variety of FN communities, two pilot projects were completed. With the assistance of OFNTSC leadership, which represents more than 130 FN communities in Ontario, the communities of the Oneida Nation of the Thames (housing assets) and the Moose Cree FN of Moose Factory (W/WW infrastructure) were selected as pilot projects. The engagement and commitment of these two communities allowed the project team to refine the tool and incorporate meaningful recommendations to manage current and future climate risks in these communities.

5. By using a life-cycle approach, it became apparent that the integration of changing climate risks into asset management planning had significant benefits. These included reduced costs to replace assets prematurely, reduced interruption of critical infrastructure services (e.g. drinking water) and potential for fewer community emergencies and less need to reallocate other infrastructure funds to address declared emergencies. This resulted in the development of the "Asset Management" module in the toolkit.

Guy Felio (Stantec) and Elmer Lickers (OFNTSC) in a boat taxi on Moose River.

Q.3 SOCIAL AND/OR ECONOMIC BENEFITS

The FN-IRT was developed to help Ontario First Nations communities better prepare and respond to the impacts of a changing climate. First Nations have a strong cultural connection to their surrounding environment and ensuring their communities can thrive in a changing environment are integral to the long-term social well-being and quality of life of community members.

By creating a toolkit that promotes risk identification and prioritization, communities can better focus future efforts and funds to create communities that are resilient. This will allow better management of the potentially devastating impacts of climate change, while helping communities prepare a financial plan using asset management principles that help the community achieve the full life-cycle value of their community assets and infrastructure.

The integration of traditional knowledge and other local inputs within the tool helps build a sense of trust, credibility and ownership of the toolkit within the community, it also builds on First Nations storytelling, which provides a foundation for developing a record of community specific climate events that have impacted a community's traditional ways. The social interaction and collaboration with community members is a key factor to the success of the FN-IRT.

The three First Nations communities that were part of this project were integral in its success and have developed a method for managing the future effects of climate change on the infrastructure and people of their communities. As the Toolkit was also created to be applied by engineers and non-engineers, these communities can also train and assist other communities in the application of the FN-IRT.

Acceptance and application of the FN-IRT has been swift, illustrated by the fact the Toolkit has been endorsed by Indigenous Services Canada (ISC) as a tool to be used to support their First Nation Adapt program. In addition, OFNTSC and Stantec are now completing 10 training sessions on the use and application of the toolkit to First Nations communities across Ontario. If successful, the training may be expanded Canada wide. The toolkit is already being applied with First Nations communities in Saskatchewan and Quebec.

Treated water pumps, Oneida Nation of the Thames water treatment plant.

Q.4 ENVIRONMENTAL BENEFITS

Living close to the land and water, some of Canada's first climate observers and weather forecasters lived in Indigenous communities. First Nations communities were also among the first to notice and express concerns on the changing climate and its impacts on sustainability.

The development of the FN-IRT enables First Nations communities to anticipate climate change impacts and plan for serious risks to their infrastructure and the local environment.

The inclusion of Traditional Knowledge in the Toolkit has led to broader community involvement and a unique partnership with the First Nations communities we worked alongside for the pilot projects. Within each of these pilot projects, the Toolkit enabled the identification of potential risk management actions to enable communities to address risks that could pose challenges to their committees and the environment. The recommended risk management tools are designed to consider the impacts on the environment, as First Nations people strive to protect Mother Earth. For example, in Akwesasne, part of the risks identified related to changing climate impacts on a large number of Butternut trees around their public utility buildings. Since strong winds and ice storms will be an ongoing and growing concern into the future, the recommendation was not to remove the trees, but to implement a tree inspection and pruning program to ensure the trees remain healthy and can better resist the impacts of extreme weather events.

Sustainability issues are addressed through the application of Module 3 of the toolkit which deals with asset management. By using asset management principles to develop a proper Operations and Maintenance schedule, community assets can achieve their full life cycle without the need for premature replacement.

Spring flooding on the Moose River, Moose Factory Island.

Q.5 MEETING CLIENT'S NEEDS

The Ontario First Nations Technical Services Corporation's (OFNTSC), an agency created by the Chiefs of Ontario, assists First Nation communities to achieve a path to self-reliance and self-sufficiency by providing technical services and professional advice, while encouraging youth to become technical leaders in their communities. The development of the FN-IRT helps meet OFNTSC's mission by assisting First Nation communities to build local capacity and create a financial path to manage and maintain their infrastructure to withstand the impacts of a changing climate. Use of the FN-IRT will help build more resilient communities.

By embracing a collaborative approach to the development and application of the FN-IRT, we have taken great steps to achieve OFNTSC's goals — by listening, learning and incorporating indigenous knowledge and ways and by engaging youth to be part of the process. We listened and learned valuable lessons through the gathering of Traditional Knowledge from community Elders. We will need to further strengthen and broaden the engagement and capacity of the community's youth to continue to build resilience against the long-term impacts of climate change.

The application of the PIEVC protocol with the Mohawk Council of Akwesasne enabled us to develop the first iteration of the FN-IRT as well as to help the community to assess the risks to their water and wastewater infrastructure. The pilot for Moose Cree First Nation enabled us to implement the FN-IRT and assist the community in creating an assessment of the risks to their water and wastewater systems. Finally, the pilot of the FN-IRT with the Oneida Nation of the Thames enabled us to assist this community to create an assessment of the risks to their housing assets.

Additional Project Background

The development of the FN-IRT was informed from initial applications of the PIEVC Protocol and pilot projects which were integral to the successful development of this Toolkit. To demonstrate the complexity of these individual pilots, we have provided a summary of each below.

Pilot 1: Mohawk Council of Akwesasne

Application of Engineers Canada's PIEVC Protocol which informed the first draft of the FN-IRT

Project Description

Akwesasne is a community of approximately 12,300 people (2016) distributed over an area of 11,720 acres and governed by the Mohawk Council of Akwesasne (MCA). The community comprises three districts: Kawehno:ke (Cornwall Island, Ontario), Kana:takon (St. Regis, Quebec) and Tsi Snaihne (Snye, Quebec).

The Mohawk territory of Akwesasne is jurisdictionally unique in that the Akwesasne Territory includes portions that are in Ontario and Quebec within Canada and parts that are within New York State (USA). No other First Nation community in Canada has these unique jurisdiction and geographic features.

MCA operates the Community's water and wastewater system to service the population of the three districts. As with many other communities in Canada, Akwesasne is not immune to extreme weather and climate uncertainty and has experienced meteorological events that have caused service disruptions and damage to its infrastructure. Detailed information on the W/WW assets was provided by MCA Technical Services and was complemented by INAC's Asset Condition Rating System (ACRS) and Integrated Capital Management System (ICMS) data.

The relevant climate events Stantec and the project stakeholders identified as potentially having impacts on the W/WW infrastructure and facilities in Akwesasne included:

- High temperature combined with low precipitation: data showed increases in June and July precipitation totals but decreases in August totals. Other evidence indicated maximum temperatures rising and ongoing into the future.
- Precipitation: hail; freezing rain and ice storms; significant snowfall events.
- Fog: visibilities below ½ statute mile that can potential result in the closing of the two international bridges to Cornwall Island.
- Extreme wind: days with gusts greater than 125 km/h (the National Building Code 50-year return period climatic design gust with wind gust factor applied) occurred every 2 years in the past. The US town of Massena (approximately 18km south-west of Akwesasne) has experienced days with gusts greater than 140 km/h. Tornados in the area (50km radius) have occurred regularly (average every 3 years).
- Lightning: strikes have, in the past, caused damages to the control and communications equipment.

Process and Outcomes

The risk assessment for current and future climate involved two scenarios regarding the future condition of the infrastructure: one in which the assets are maintained in a state of good repair and replaced at the end of their service life, the other considering the assets deteriorate beyond their service life and therefore are more vulnerable to climate impacts than at present.

The comparison of these scenarios showed that the most extreme risks to climate could increase by close to 30% under climate change (by the 2050s) if the infrastructure is not maintained or replaced when required.

Based on the highest risks identified for the current climate and in future climate conditions, potential risk management actions were identified by Stantec and the project stakeholders, such as:

- Improve the weather alert system to support operational staff and emergency first responders; allowing them to be pro-active in anticipation of severe weather, for example, ensuring back-up power (fixed and portable) units are ready for use.
- Identify risk management or risk avoidance

measures for strong to extreme wind events, such as securing (anchoring) asset components including roofs, light structures, etc. Select tree locations and species to minimize risks of property damage in case they would fall down.

- Install weather stations on Cornwall Island and in St. Regis to ensure timely and relevant local data are collected going forward. These stations should have the capability to at least provide hourly records. Note that data from the Cornwall climate station at times is missing and then only provides daily averages, thus representing a gap where short duration/high intensity rainfall events may be missed. This data will allow tracking of trends and validation of the climate change projections for this study.
- Plan for reduced mobility of operators and suppliers due to severe or extreme events, including warning, stock-piling, etc. This could include coordination at border crossings to accelerate passage during emergencies.
- Anticipate and plan collaborations for high risk weather events, such as interactions with emergency and community services, external agencies, and the community itself.

Case 2: Moose Cree First Nation

First Pilot of the FN-IRT

Project Description

Moose Factory Island is located on the Moose River, 20 km south of James Bay in Northern Ontario and is home to approximately 1500 residents. It was an excellent example of the unique needs and capacities of remote and northern First Nations communities in Ontario and elsewhere in Canada.

The Community selected all the infrastructure in its water and wastewater (W/WW) systems for the pilot application of the FN-IRT Toolkit. Stantec led the vulnerability assessment through four workshops that took place between September to November 2017:

- Workshop 1: Provided the background of the Project and the FN-IRT process, the vulnerability assessment of the water and wastewater system in Akwesasne, and the methodology that will be followed in Moose Factory. The Project Team selected the infrastructure to be assessed.
- Workshop 2: Details of the infrastructure, policies, condition reports (e.g., 2016 ACRS report), climate events that have caused malfunctions or damage to the infrastructure, and other relevant information was gathered in preparation for the risk assessment. The team also developed the severity rating scale for the assets – a critical step in the process that is indicative of the risk tolerance of the community and is used to score the impacts of climate events on the infrastructure.
- Workshop 3: The Project Team initiated the risk assessment process by identifying the relevant climate infrastructure interactions, assessing the severity of the impacts if the selected climate events occurred, and calculating risks.
- Workshop 4: The completed risk matrix was validated by the Project Team who discussed risk mitigation and adaptation measures. Following are examples of the high risks identified by the Project Team for the W/WW assets and supporting services:
    - Extreme cold: affecting electricity and the functionality of the hydrants; impacts on the capacity of the heating system in the garage.
    - Freezing rain: impacts on the power grid.
    - Shift in seasonal temperatures (lengthening of air only transportation and river flow variability): affecting the availability of parts and chemicals; impacts on the water source (Moose river) and the drinking water intake.

Process and Outcomes

Based on the highest risks identified for the current climate and in future climate conditions, potential risk management actions were identified by Stantec and the Project Team, such as:

- A new plan for the water intake is at the predesign stage. It will consider potential impacts such as flow variations; a secondary intake should be considered; monitor the water levels in the river to warn of potential impacts on the structure and of changes in raw water quality;
- Continue the program to insulate fire hydrants to prevent freeze-ups during extreme cold temperatures;
- Plan back-up electricity supply for the water

treatment plant to replace the Hospital emergency back-up generators when the Hospital will move to Moosonee; and

- Evaluate options to increase the heating capacity in the Old Fire Hall which is currently under-utilized because of temperature control problems – space needed for storage.

Case 3: Oneida Nation of the Thames

Pilot of the FN-IRT

Project Description

The Oneida Nation of the Thames is home to 2,159 residents and has a total membership of 6,108. Located in southwestern Ontario, the Oneida Nation Settlement borders agricultural lands on the Eastern shore of the Thames River, 30 kilometers south of the City of London. It was chosen as a representative community in southern Ontario which is far more connected with surrounding communities. The Community selected its housing assets for the pilot application of the FN-IRT, focusing on the climate impacts to their Seniors Complex, a quadplex, a duplex, and individual housing units representative of those found in the community.

Stantec led the vulnerability assessment through four workshops that took place between October 2017 and January 2018:

- Workshop 1: Provided the background of the Project and the FN-IRT process, the vulnerability assessment of the water and wastewater system in Akwesasne, and the methodology that will be followed in Oneida. The Project Team selected the infrastructure to be assessed.
- Workshop 2: Details of the infrastructure, policies (e.g., Oneida's Housing Policy), condition reports, climate events that have caused malfunctions or damage to the housing, and other relevant information was gathered in preparation for the risk assessment. The team also developed the severity rating scale for the assets – a critical step in the process that is indicative of the risk tolerance of the community and is used to score the impacts of climate events on the infrastructure.
- Workshop 3: The Project Team initiated the risk assessment process by identifying the relevant climate infrastructure interactions, assessing the severity of the impacts if the selected climate events occurred, and calculating risks.
- Workshop 4: The completed risk matrix was validated by the Project Team who discussed risk management and adaptation measures. The Project Team identified the following high risks for the housing assets:
  - All facilities:
    - » Tornado risks
    - » Strong winds: potential damage to roofs; loose material around properties that could fly off and damage the residence
  - Seniors complex:
    - » High temperatures: affecting potential for cooling the building with more vulnerable seniors
    - » Freezing rain:impacts on the fuel storage, access road, and backup generator
    - » Winter rain: flooding the access road
  - Housing units:
    - » High winds: impacts on houses with asphalt shingles
    - » Freezing rain: fuel storage; street and lot drainage
    - » Winter rain: street and lot drainage

The Community expressed concerns about regional climate events that caused significant rainwater run-off and increased drainage in the South-West area of City of London, which impacts downstream Oneida.

Process and Outcomes

Based on the highest risks identified for the current climate and in future climate conditions, potential risk mitigation actions were identified by Stantec and the Project Team, such as:

• Implementing a tornado warning system that could use the local radio station;

• Installing and requiring the installation of hurricane ties – an inexpensive added protection to roofs subjected to high winds.; and

• Preparing for higher summer temperatures in the Seniors Complex by planning rotating cooling areas and higher capacity A/C at the time of retrofits.