Standards Council of Canada
Conseil canadien des normes

Standards to Support Climate Resilience in Infrastructure:

Taking stock and mapping the future

Interim Report 2016-2019

Canada

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Message from the CEO

In Canada, it is estimated that over a third of municipal infrastructure needs to be fixed or replaced. In fact, all our infrastructure—from the roads and bridges we drive on to the foundations of the houses we live in—may be at risk if we do not take steps to better prepare for the future that lies ahead. This is where the SCC is playing a crucial role.

In 2016, we launched the five-year *Standards to Support Resilience in Infrastructure Program*. Through this program, we are spearheading the creation of standardization strategies and solutions that will help do everything from ensuring roofs can withstand stronger storms to finding concrete ways to help homeowners manage flood risks. To do this, we are working with a wide range of stakeholders to ensure climate change adaptation and resilience is reflected in current building codes, guidelines and standards.

This report highlights our achievements in this area. For example, over the past three years we have developed new guidance to:

- help reduce flooding in residential communities;
- limit the damage to homes caused by high winds and tornadoes; and
- help design stronger building foundations in permafrost zones in Canada's north.

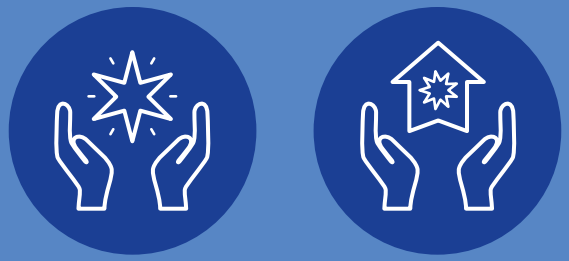
Yet, our work is far from done. As the leader of Canada's standardization network, we know standards matter to Canadians' quality of life and the future prosperity of our country—and research backs this up. In fact, standards are such an integral part of our everyday lives that most of us do not give them any thought at all. But with the challenges facing our world today—such as climate change—having effective standards in place is more important than ever before.

We look forward to continuing what we have started and welcome your opinion as we embark on the renewal of the program.

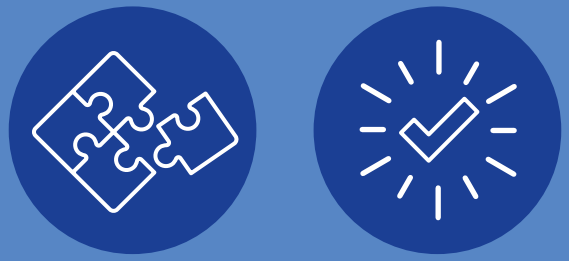
Chantal Guay

Chantal Guay, ing., P.Eng.
CEO, Standards Council of Canada

At SCC, a standardization strategy



is an idea or action



to fill a gap or solve a problem

by developing, improving, coordinating or using standards or related tools.

Introduction

Our world's climate is changing dramatically—and Canada is on the frontline of this change. The recent *Canada's Changing Climate Report* indicates that our country's climate is warming twice as fast as the global average. And Canadians are already dealing with the reality of this rapid change.

Today, we are seeing more forest fires, heatwaves and storms than we ever have in the past. Canadians across the country are losing their homes and their livelihoods, and their lives, as a result.

In the summer of 2018, 1,250,383 hectares (or 12,984 square kilometres) were lost to wildfires in British Columbia alone—the worst season on record. Record-setting flooding in Eastern Ontario, Quebec and Atlantic Canada in the spring of 2019 forced thousands of Canadians to flee their homes. Shorter, warmer winters are also melting protective coastal ice and thawing permafrost and eroding shorelines. This is threatening our roads, bridges, dams, drainage systems and communications infrastructure. It is also undermining building foundations, particularly in northern communities.

Extreme weather events caused by climate change also result in productivity losses, health impacts, environmental degradation and increased reconstruction costs for homeowners and communities. By planning ahead and working together, we can take concrete steps to mitigate and prevent these losses in the future. But standards need to be a central part of the plan.

ENSURING CANADA'S INFRASTRUCTURE IS CLIMATE-RESILIENT

In the 2016 federal budget, the SCC received $11.7 million over five years to support the Government of Canada's climate change agenda. Through the creation of the *Standards to Support Resilience in Infrastructure Program* (or Infrastructure Program for short) we have been putting that funding to good use.

As of March 31, 2019, we have launched 31 out of 36 planned projects related to climate change and climate resilience. These projects range from publishing foundational reports that identify priorities and best practices to supporting national and international standards committees to funding the development of these new standards and updating existing ones. Through the Infrastructure Program we are focusing on three key areas:

- **Developing standardization guidance for weather data, climate information and climate change projections.** Resilient infrastructure must be designed not for the climate of the past, but the climate of the future. SCC is developing strategies to support the sharing, interpretation and use of weather data, climate information and climate change projections—so that infrastructure planners can access the data they need to ensure infrastructure is resilient.
- **Funding new infrastructure standards and updating existing standards to ensure that infrastructure projects across Canada are climate-ready.** Hundreds of standards are referenced in federal, provincial, and territorial regulations to ensure the safety and reliability of Canadian infrastructure. But climate change introduces new stresses to infrastructure that may not be reflected in existing standards or regulations. We are updating a broad range of standards—and funding the development of new ones—to ensure infrastructure can withstand these stresses.
- **Investing in new technical standards targeted toward infrastructure adaptation and resilience in northern Canada.** Canada's North is particularly vulnerable to the effects of climate change, with annual average temperatures rising faster than any other region in the country. But due to the North's unique geography, population distribution and cultural characteristics, standards developed to address issues in other regions of Canada may be less relevant to northern communities. We are developing standards to ensure infrastructure in the North can withstand the effects of a changing climate now and in the future. A big part of our success in this area is thanks to our partnerships with northern communities. By working with people living in the North we can ensure our priorities and actions are meeting the needs of northern Canadians.

Now, halfway through the Infrastructure Program's five-year plan, SCC is well positioned to complete its overall goal of developing 36 **standardization strategies** and tools before 2021. By working with researchers, engineers, federal, provincial, territorial and municipal leaders, climate and weather scientists, and other stakeholders, we have already been able to take concrete steps to boost infrastructure resilience across the country to ensure stronger, safer and more prosperous communities for Canadians in the future.

The Cost of Extreme Weather Events

According to the Insurance Bureau of Canada, since the 1980s, property and casualty insurance payouts from extreme weather have more than doubled every five to 10 years.

$x2
every
5 to 10 years

In 2018 alone, this figure reached
$1.9 billion.

Canadian governments
$x3

For every dollar paid out in insurance claims to homeowners and businesses, it is estimated that Canadian governments pay three dollars to reconstruct public infrastructure damaged by severe weather.

"The long-term trends are clear. We're facing longer periods of drought, leading to more forest fires, and we're experiencing more storms, major hurricanes, and extreme rainfalls, leading to more frequent and intense flooding ... There's no question that we've entered an era of increased threat to life and property."

Don Forgeron,
CEO of the Insurance Bureau of Canada,
from Insurance Business Canada magazine

Arming Standards Writers with the Tools to Fight Climate Change

Our changing climate creates challenges when it comes to building new infrastructure and ensuring existing infrastructure is safe and structurally sound. Standards provide consistent frameworks and guidance to evaluate the risks and vulnerability to infrastructure, so we can implement improvements that will ensure long-term sustainability and safety. But the speed at which the climate is changing is creating new risks.

Typically, infrastructure standards incorporate values regarding climate and weather conditions (like temperature, precipitation and wind) as well as climate-related events (such as flooding and freeze-thaw cycles) that infrastructure must be built to withstand. Historically, these values were based on assumptions of a relatively stable climate. However, as the climate changes, these assumptions have become less valid.

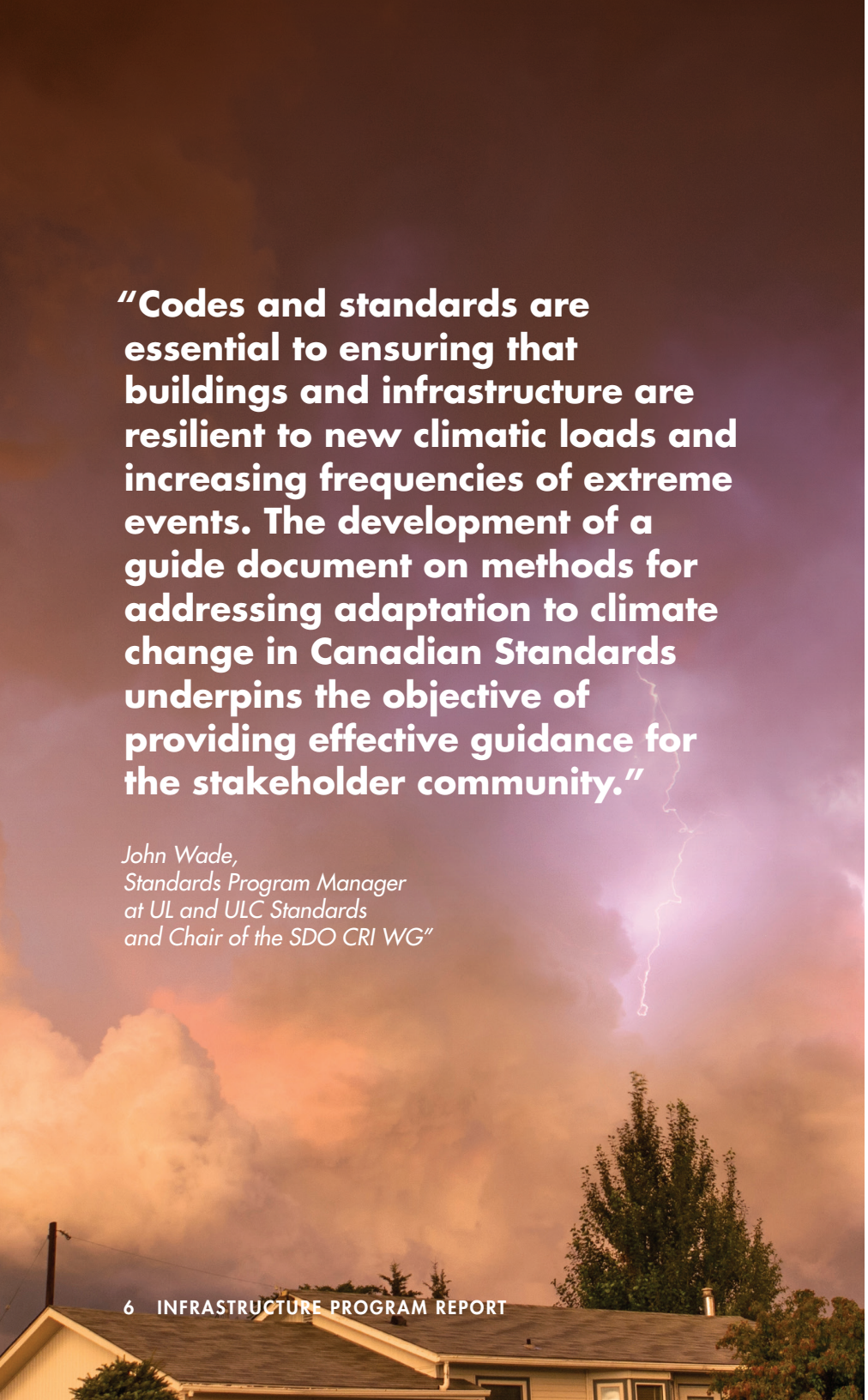
SHINING A LIGHT ON THE RISKS ASSOCIATED WITH CLIMATE CHANGE

SCC is funding key research to help standards writers make better assumptions—ones that reflect the risks of a changing climate, both today and in the future. This knowledge will allow subject matter experts who sit on technical committees and working groups to update and develop standards that boost the resilience of infrastructure. Technical committees need a strong understanding of the different climate change projections for the next 50 to 100 years—in all regions of Canada. Without this information, they will not be able to design standards that are able to address future challenges.

At SCC, we are helping to ensure national and international technical committees take climate change into account when developing standards. In 2017, we established the *Standards Development Organizations for Climate Resilient Infrastructure Working Group (SDO CRI WG)*, which has been instrumental in building the capacity of standards writers. With the participation of representatives from SCC-accredited standards development organizations, this group provides input and advice to SCC's Infrastructure Program and has been integral in delivering projects that aim to integrate climate change adaptation into the standards development process.

The first of these projects is a guidance document on *Addressing Climate Change Adaptation in Standards for Canada* (with publication expected in fall 2019). A second project, a report tentatively entitled *Understanding Climate Change Models for Standards Development*, will provide guidance on accessing, interpreting and incorporating climate change models and projection data when developing standards. Internationally, SCC is also supporting the secretariat of the ISO Technical Management Board's Climate Change Coordinating Task Force to draft a new guide on how to address aspects of climate change in ISO standards.

By specifying performance and material requirements, standards are a valuable tool that can integrate climate-related risks into infrastructure planning and development processes. That is why at SCC we are promoting the use of recognized, common standards across Canada that will serve as a credible framework for rulemaking and benchmarking environmental public policy in the challenging years ahead.



"Codes and standards are essential to ensuring that buildings and infrastructure are resilient to new climatic loads and increasing frequencies of extreme events. The development of a guide document on methods for addressing adaptation to climate change in Canadian Standards underpins the objective of providing effective guidance for the stakeholder community."

John Wade,
Standards Program Manager
at UL and ULC Standards
and Chair of the SDO CRI WG"

Getting the Most Out of Weather and Climate Data

Canadians are obsessed with the weather. We want to know if it will rain or snow, or if it is plus five or minus five. Having this information helps us make everyday decisions like whether to wear a jacket, take an umbrella or avoid going outside altogether. But having reliable weather and climate data is also key when designing infrastructure like roads, bridges and other buildings.

To determine the functionality, durability and safety of infrastructure, engineers and designers also depend on building codes and standards. But it is essential that this guidance be based on reliable, quality weather and climate data that considers both current and future conditions. If it is not, these structures may not remain resilient over the long term, increasing rehabilitation and reconstruction costs and jeopardizing the safety of Canadians.

In the past, the primary source for weather and climate information was Environment and Climate Change Canada (ECCC). Although ECCC has an extensive network of automatic surface weather observation and reference climate stations across the country, it does not collect data in many remote and northern regions of Canada. Without quality data, it is difficult for remote communities to generate the accurate climate projections needed to prepare for the future and build climate-resilient infrastructure.

There are currently thousands of additional weather and climate monitoring stations across the country—operated by provinces, territories, municipalities, industry, universities and other organizations—that are collecting useful information. The data they collect are not always usable or applicable for engineering purposes due to quality concerns, lack of compatibility and/or inconsistencies related to site selection, operation and instrumentation. But this is where standardization can help.

Standards provide a consistent approach to collecting climate and weather data and to assess the reliability and accuracy of that data. Having standards in place when it comes to gathering this information will ensure planners, designers, engineers, maintenance personnel and asset managers can confidently tap into data from any weather station or network adhering to those standards, whether it is operated by ECCC or another organization. Having access to a larger quantity of quality data across Canada enables them to design infrastructure that can withstand and adapt to our changing climate—no matter where in Canada that infrastructure is being built.

LOOKING TO STANDARDS TO ENSURE THE RELIABILITY OF CLIMATE DATA

The need to standardize weather and climate data was not always apparent. In 2017, SCC's Infrastructure Program broke new ground by commissioning research into weather and climate data issues in Canada, including looking at how standards could potentially increase the quantity of viable observations across Canada. The resulting report, *Standardization Guidance for Weather Data, Climate Information and Climate Change Projections*, provided specific recommendations for where standardized guidance could address current gaps in climate information and highlighted how it can be better integrated into designing climate-resilient infrastructure.

Based on this report, SCC held a roundtable with stakeholders such as owners, operators and users of Canadian weather networks to discuss how data collected outside of ECCC's network could be used in planning infrastructure design, and ultimately, how its collection could be standardized. Findings from this roundtable are now being used to develop a series of National Standards of Canada (NSC) to improve the quality, consistency and accessibility of non-ECCC data. CSA Group, a Standards Development Organization accredited by SCC, is currently in the process of developing four interlinked NSCs that will provide:

- guidance on metadata reporting for Canadian weather stations collecting atmospheric meteorological data;
- a data quality rating system and accompanying user's guide for applying the data quality rating system;
- protocols for sharing atmospheric meteorological data; and
- processes for the siting, design, operations and maintenance of Canadian weather stations.

Collectively, these standards will go a long way toward improving access to local and regional weather and climate data for infrastructure designers, planners, owners and operators. Having common standards for data collection will also increase the pool of quality data that users can draw from, so they will have the information they need to ensure infrastructure is resilient to the impacts of climate change.

In addition to these standards, SCC is supporting the update of a technical guide on developing, interpreting and using rainfall intensity-duration-frequency (IDF) information. IDF curves provide engineers and other professionals who design and build infrastructure with a clear picture of probable average rainfall intensity. These curves are particularly important when designing urban drainage systems. The updated guidance document will provide better information on how to take climate change into account in these curves, including risk-based design processes that define sources and types of uncertainty, and ways to address it.

Helping Northern Communities Adapt to a Rapidly Changing Climate

Climatic conditions in Canada's North are changing at rates that not even the most pessimistic models had predicted. In fact, according to *Canada's Changing Climate Report*, Canada is warming twice as quickly as the rest of the world and the North is warming at nearly three times the global rate.

As temperatures in the North increase, the area is seeing more permafrost[1] thaw, severe storms, precipitation, melting sea ice and coastal erosion. Another recent report shows that permafrost is thawing so quickly in Canada's North that several metres of soil can now destabilize in days, whereas in the past, only a few centimetres would thaw in a year. In addition, coastal erosion is happening at an alarming rate. Canada's far North is losing its coastline 20 to 30 times more quickly than anywhere else in Canada as the result of warming air temperatures and coastal waves. Large sections of the coastline are even falling into the sea. These changes are creating significant challenges for those tasked with maintaining, designing and building infrastructure in the North.

DEVELOPING STANDARDS TO ENSURE THE RESILIENCE OF NORTHERN INFRASTRUCTURE

In the past, engineers and planners were able to anticipate the weather that infrastructure would likely face during its lifetime. But climate change is making this much more challenging. Environmental conditions like extreme wind and changing temperatures and precipitation patterns are impacting the integrity of buildings and other infrastructure in northern communities.

Adapting and repairing buildings in the North can create a heavy financial burden for communities with very small populations. According to the Northwest Territories Association of Communities, permafrost thaw impacts are likely to cost around $51 million annually in the Northwest Territories alone. Northern communities need mechanisms to help them reduce infrastructure's vulnerability to the impacts of climate change—and that is where standards and the SCC are making a real difference.

Since 2011, SCC has been working with northern communities and stakeholders within the standardization network to adapt standards and codes to ensure infrastructure is climate-resilient in the future. Through our leadership of the Northern Infrastructure Standardization Initiative (NISI), we have helped create a suite of standards and training videos that support infrastructure resilience and take into account the unique climatic, geographic, socio-economic and cultural circumstances of the North. Developed through our partnerships with northern policymakers, engineers, designers and other stakeholders, NISI standards have filled important gaps when it comes to infrastructure in the region and have provided valuable tools to boost climate resilience. These standards are now being incorporated into local building guidance and land use planning measures to help increase climate resilience and build safer, longer-lasting, infrastructure in the North.

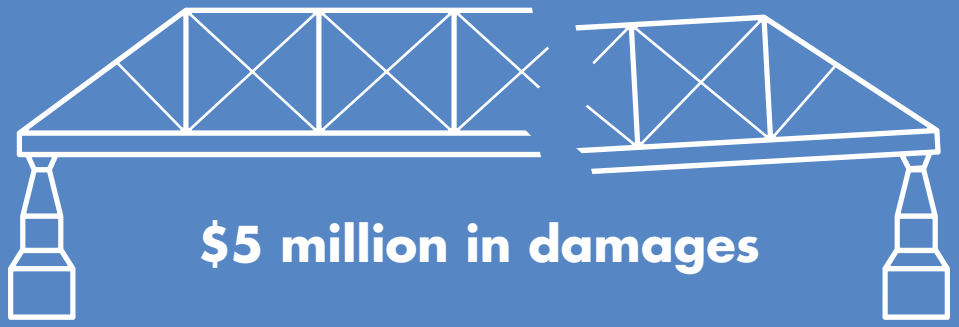
1. Permafrost is any ground that remains completely frozen—0°C or colder—for at least two years straight. It is the foundation for many buildings in the North.

"The knowledge and tools developed through NISI are facilitating the adaptation and mitigation of climate change to northern built infrastructure, while truly meeting the needs of northern communities in ensuring sustainable and quality infrastructure."

Nelson Pisco, Director,
Technical Services,
Department of Community
and Government Services,
Government of Nunavut and NAC Chair

The Real Impacts of Climate Change for Northern Communities

In 2008, high winds, heavy rains, and flash flooding caused



$5 million in damages

when they made two bridges collapse in **Pangnirtung, Nunavut.** The small community on Baffin Island was forced to call a state of emergency after the closure of the bridges cut off access to the local water reservoir and sewage treatment facility. The town was forced to dump raw sewage into the Duvall River until the bridge was reopened.

HELPING NORTHERN COMMUNITIES ADAPT TO CLIMATE CHANGE

During the first phase of NISI (2011–2016), SCC commissioned the development of five standards to address critical infrastructure issues facing the North. Among other things, these standards will help to:

- ensure appropriate community drainage systems;
- address changing snow loads on roofs;
- improve thermosyphon foundations;
- manage the effects of permafrost degradation on existing buildings; and
- support geotechnical site investigations for building foundations in permafrost.

In recent years, we have witnessed firsthand the impacts of a warming climate as the foundations of many buildings have not been able to withstand changing land conditions. But the NISI standard on supporting geotechnical site investigations for building foundations is helping to address this issue and is already being used in sites across the North. For instance, in 2018, the Nunavut Housing Corporation (NHC) made use of the standard to determine the best sites to build new housing in several communities, including in Iqaluit. NHC's work is helping to set a precedent for northern infrastructure planning in a changing climate—and providing communities with tools to save on repairs in the future.

Building on the success of the first phase of NISI, SCC is continuing to develop standards to counter the impacts of climate change on northern infrastructure. In January 2017, we re-established the Northern Advisory Committee (NAC) to provide strategic advice, input and guidance as we work to boost climate resilience in the North. First established in 2011, the NAC is made up of representatives from the Northwest Territories, Nunavut, Yukon and Nunavik. Their input and insights are critical as we continue to look for ways to adapt to climatic challenges in the northern communities.

For instance, in 2018, the NAC identified the need for a standard to ensure the reliability of wastewater treatment facilities. Lagoons and wetlands in the North are particularly sensitive to climate change-related impacts. As northern communities continue to grow, new systems are being planned and many existing systems are due for upgrades or expansions. The new NISI wastewater treatment standard, being developed by CSA Group, will help prevent the failure or underperformance of these systems and will prevent the possible loss of critical services and high repair costs.

We are also funding the development of a new NSC to support a risk-based approach for community planning in northern regions. This standard, being developed by the Bureau de normalisation du Québec (BNQ), will provide an additional tool to support, in a risk management framework, the siting, and design of expansions to communities.

As well, SCC is working with CSA Group and BNQ to develop new standards that will:

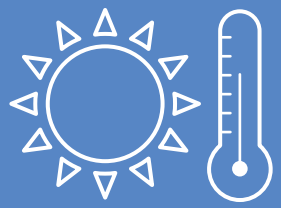
- help communities consider fire resilient designs and materials when constructing new infrastructure;
- lay out techniques for dealing with the effects of high winds and snow drifts on northern infrastructure;
- guide growing communities to consider current and future climate risks when determining the best areas to build; and help communities assess erosion risks to infrastructure, and improve and modify existing foundation types to make them more resilient.

These standardization strategies are just some of the concrete actions we've taken to ensure Canada's North can withstand the impacts of climate change. But we aren't just developing new standards. We are also ensuring all standards and guides developed under the NISI banner are current and based on the most up-to-date climate considerations.

We are also now revising guidelines on building infrastructure in permafrost areas to include recent climate data and projections. The update of *CSA PLUS 4011 Infrastructure in Permafrost: A Guideline for Climate Change Adaptation* will help non-technical experts to be more aware of the different foundation types that exist so they can consider permafrost as an environmental variable when designing resilient infrastructure in the region. In addition, we are updating several standards developed under the first phase of NISI that consider new climate trends, permafrost knowledge, and technologies.

Standards can help Canada Adapt

Wind resilient design



Weather & climate data quality & use

Snow management

Flood resilience & stormwater management

Fire resilient design

Building on permafrost

Designing Infrastructure That Can Stand up to Extreme Weather Events

The challenge facing Canada—and other nations around the world—is to find concrete solutions to address the effects of climate change today so we are better prepared to deal with the emerging issues in the years ahead. Over the past three years, SCC's Infrastructure Program has made significant inroads in developing innovative standardization strategies to help mitigate some of the most pressing challenges resulting from changes to our climate, such as heat, wildfires, permafrost thaw and flooding.

REDUCING THE IMPACTS OF FLOODING ACROSS THE COUNTRY

Every year in Canada, flooding alone causes millions of dollars in property damage. Approximately 1.7 million Canadian homes are currently at risk of riverine or overland flooding. In fact, in the past decade, flooding has emerged as the most pervasive and costly natural disaster in the country, causing financial and psychosocial distress to hundreds of thousands of Canadians. Over the past few decades, urban flooding has also become a growing problem, resulting in more than $20 billion in flood damage between 2003 and 2012.

As our climate continues to change, the risk of flooding—and the costs associated with it—is only expected to increase. A recent study by the Fraser Basin Council states that if there was a major flood event (1-in-500 year) in British Columbia's Lower Mainland between now and 2100, it would trigger economic losses estimated between $20 to $30 billion—and it would be the largest natural disaster in Canadian history. But standards offer an invaluable tool in addressing the impacts of flooding.

Through our Infrastructure Program, we have worked with key stakeholders to launch several projects to help our nation's infrastructure withstand the effects of flooding. In 2017, we partnered with the Intact Centre on Climate Adaptation at the University of Waterloo to produce a report entitled *Preventing Disaster Before it Strikes: Developing a Canadian Standard for New Flood-Resilient Residential Communities – 20 Best Practices* that identified best practices in designing and building new residential communities that are more flood-resilient.

In January 2019, SCC and the National Research Council Canada funded another report by the Intact Centre, called *Weathering the Storm: Developing a Canadian Standard for Flood-Resilient Existing Communities*, that highlights a range of simple, practical and cost-effective solutions that homeowners can implement to prevent flooding, such as:

- installing backwater valves on basement sewer lines;
- disconnecting downspouts from eavestroughs to prevent sewer back-ups; and
- clearing leaves and debris from catch basins.

This report also includes solutions communities can implement to prevent flooding, such as regrading roadways to carry water away from properties, constructing storm water storage tanks and ponds within and around communities, and installing pipes that direct excess stormwater away from vulnerable areas.

Collectively, these reports are providing the insights necessary to develop new standards that will help mitigate the effects of flooding across the country and ensure a safer environment for all Canadians in the future. In fact, SCC is currently funding the development of the first standard based on the recommendations of these reports: *CSA W204 Flood-Resilient Design for New Residential Communities*. This standard will provide guidance and outline requirements to incorporate climate resilience in greenfield developments to prevent flooding. It will cover general principles such as community level design, planning principles, siting and elements that help support resilient stormwater system design.

While Canada already has national standards for drinking water and wastewater systems, there are no similar standards for stormwater systems. That is why SCC is also supporting the development of new NSCs to help set a consistent level of service for stormwater across the country. The standard will be based on a 2018 report called *Developing a Stormwater Quality Management Standard (QMS) in Light of a Changing Climate*, which was commissioned by SCC and produced by Engineers Canada, Credit Valley Conservation, and Zizzo Strategy (now Mantle314). This standard will help municipalities, engineers, and local decision-makers to better manage the growing strains on Canada's aging stormwater systems caused by climate change-related factors such as heavier rainfall and more frequent freeze-thaw cycles. Better stormwater system management will result in fewer sewer backups and basement floods; lower the cost of repairing, maintaining and replacing infrastructure; and reduce the impacts to ecosystems and wildlife.

PREPARING COMMUNITIES TO DEAL WITH INCREASED WILDFIRES

Flooding is just one of the increasing risks to infrastructure created by our changing climate. Wildfires are another serious concern in many regions of Canada. Hotter summers and more severe storms lead to lightning strikes that increase the risk of wildfire—and these events are only expected to increase as our climate changes. In fact, a 2014 US report showed that for every degree of climate warming, the number of lightning strikes that can ignite wildfires will increase by about 12 per cent.

In Canada, we have seen firsthand the devastating and costly effects of wildfires in recent years. For example, the 2016 wildfire in Fort McMurray, Alberta destroyed 1,800 buildings and forced more than 80,000 people to flee their homes. The wildfire is estimated to have had almost $10 billion in direct and indirect costs. This includes the expense of replacing buildings and infrastructure as well as lost income and profits for the oilsands and forestry sectors. The Insurance Bureau of Canada also reported that the Fort McMurray wildfires resulted in approximately $3.7 billion in insured damages—more than double the previous costliest natural disaster on record.

Through our Infrastructure Program, SCC is working with key stakeholders to develop foundational reports that will inform the development of future standards that can help to reduce the damage and costs from wildfires. For example, we are collaborating with the Institute for Catastrophic Loss Reduction (ICLR) to produce a report outlining techniques for investigating the aftermath of fires in areas where homes are built near or among lands prone to wildfires (known as the Wildland Urban Interface or WUI). These techniques include best practices for collecting data before and after these events.

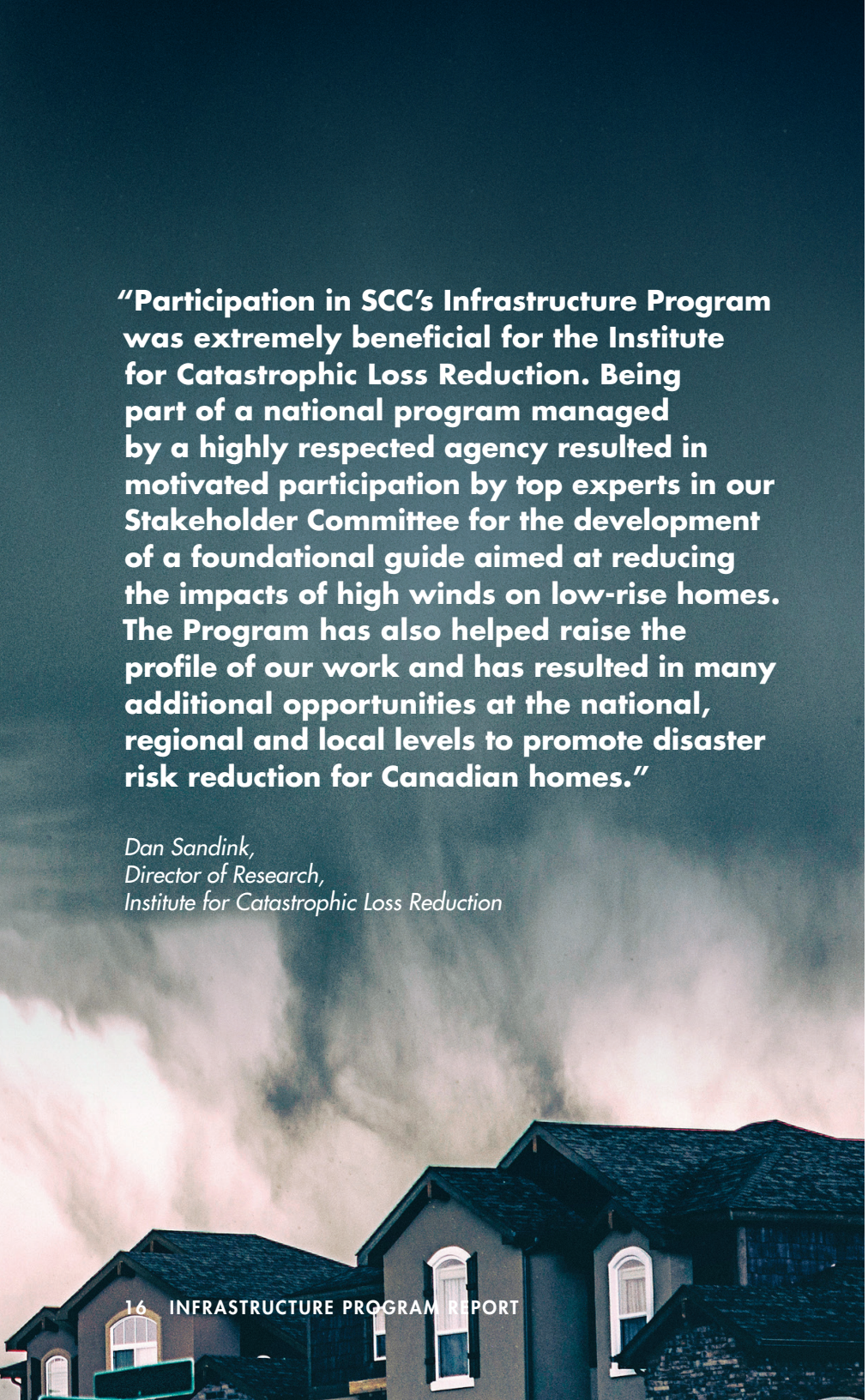
Based on the report's recommendations, SCC will be exploring funding the development of a new standard on collecting and interpreting structure loss data from WUI fires to minimize future risks to communities. Along with the new NISI standard on fire resilient community planning in the North, these standards will go a long way in improving Canadians' ability to protect their homes and communities against future losses due to wildfires.

MITIGATING THE IMPACTS OF HIGH WINDS ACROSS CANADA

We are also supporting the development of standards that will help address damages to buildings and infrastructure from high winds—a weather event that has caused considerable losses across Canada in recent years. The May 2018 windstorm in southern Ontario and Quebec, followed by tornadoes in the National Capital Region in September 2018, caused close to $1 billion in insured losses.

Working with the ICLR, SCC released a report in April 2019 entitled *Increasing High Wind Safety for Canadian Homes: A Foundational Document for Low-rise Residential and Small Buildings*. This report provides the basis for the development of a set of commonly acceptable, relatively straightforward measures that can be incorporated into new single-family home construction and renovations projects to reduce the risk to Canadians and their property from high winds associated with tornadoes, hurricanes, and other types of extreme weather events.

As already mentioned, we are also supporting the development of a NISI standard to improve the wind resilience of infrastructure in Canada's North. Together, these standards will assist Canadians in protecting their homes and communities from the increasing risks posed by high wind events.



"Participation in SCC's Infrastructure Program was extremely beneficial for the Institute for Catastrophic Loss Reduction. Being part of a national program managed by a highly respected agency resulted in motivated participation by top experts in our Stakeholder Committee for the development of a foundational guide aimed at reducing the impacts of high winds on low-rise homes. The Program has also helped raise the profile of our work and has resulted in many additional opportunities at the national, regional and local levels to promote disaster risk reduction for Canadian homes."

Dan Sandink,
Director of Research,
Institute for Catastrophic Loss Reduction

USING STANDARDS TO PROTECT CANADIANS FROM A RANGE OF HAZARDS

SCC is also supporting the update of existing standards to ensure they consider the need for climate change adaptation. Updates are already underway to both *CSA Z240.10.1-16 Site Preparation, Foundational, and Installation of Buildings*, and *CSA S37-18 Antennas, Towers, and Antenna-Supporting Structures*—both of which are referenced in the National Building Code of Canada. These updates will ensure that the standards account for extreme weather events associated with climate change such as heavy rain, flooding, high winds, increased snow and ice, and temperature fluctuations.

Summers in many regions of the country are becoming more unpredictable, and hotter. In fact, three of the past five years have been the warmest on record in Canada. In the summer of 2018, more than 93 people died from extreme heat in Quebec alone. A study published in 2018 predicts that heat waves like the one that hit Quebec are only expected to get worse across much of Canada—and up to five times deadlier. But through our Infrastructure program, SCC is supporting work that will result in standardization solutions to address some of the effects of rising temperatures across the country.

For example, with input from Health Canada's Climate Change Innovation Bureau, SCC is supporting the development of a report by the National Program for Playground Safety on how to ensure children's playgrounds and other equipment are safe as the climate changes. This is another critical issue, as hotter summers are reducing the safety of our community playgrounds and putting our children at risk. For example, in 2017, a two-year-old girl in Toronto suffered a second-degree burn from a slide when its metal surface heated up under the sun. Integrating climate change adaptation considerations into standards such as *CAN/CSA Z614 Children's playspaces and equipment* can help protect our children and keep their playgrounds safe and enjoyable, and even help counter the "heat island" effect in cities during the summer months.

Looking Ahead: Ensuring We Are Prepared for the Future

When it comes to weather, Canada is a country of extremes. Our often harsh and varying climate has always had a significant impact on infrastructure. But climate change is creating new challenges for maintaining and building that infrastructure. Extreme wind, fluctuating temperatures, permafrost thaw and changing precipitation patterns are threatening the integrity of buildings, roads, bridges and other infrastructure across the country—putting the safety of Canadians at risk. These extreme weather events are resulting in ever-increasing costs for governments, businesses and ultimately, all Canadians.

Not doing anything to address the impacts of climate change is not an option. If we do not act now to adapt and change how we build and maintain infrastructure, we will face crumbling foundations, roads, bridges, dams, sewers and drainage systems in the future. This will jeopardize the safety of Canadians and create increased costs. In fact, one government report states that if we do not change the way we build infrastructure to ensure it is climate-resilient, it could cost Canada $300 billion over the next decade.

By working with communities, governments, industry experts and stakeholders within the standardization network, SCC is taking concrete steps to ensure building and infrastructure codes across Canada are developed, maintained and upgraded to ensure climate resilience. We are also recruiting our nation's top experts to help lead the development of new standards that address the environmental issues facing us. And we are empowering those experts by providing them with the information they need to consider climate change in the development of those standards.

We will continue to work towards raising awareness of the standards developed under SCC's infrastructure program and encouraging their inclusion in relevant Canadian regulations, codes and best practice guides. We are also working to increase infrastructure planning capacity in Canada by providing training to key communities on the standards developed under our Infrastructure Program.

HELPING CANADA TO BECOME A GLOBAL LEADER IN INFRASTRUCTURE RESILIENCE

In Canada, our work supports federal government policies like the Pan-Canadian Framework on Clean Growth and Climate Change and the Federal Sustainable Development Strategy. But climate change is a global problem and the Canadian expertise being developed through our Infrastructure Program can help our nation to become an international leader in this area. SCC's work in developing climate resilient standards for infrastructure also supports global priorities and initiatives like the United Nation's 2030 Agenda for Sustainable Development, (particularly *Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*).

Creating standards that incorporate climate risks will not only ensure the resilience of infrastructure over the long term, but could also help address the root cause of the problem. Changing how we build infrastructure—by using lower-carbon energy sources and making better design and operational choices—could actually decrease the need for costly maintenance and repairs and reduce future greenhouse gas emissions, the main cause of climate change.

Taking steps to ensure Canada's infrastructure is able to withstand the impacts of a changing climate is crucial to our nation's future. With continued government support, SCC is committed to working with climate experts, industry leaders, engineers, communities and other stakeholders to identify innovative ways to integrate climate change adaptation into Canada's standardization system and building codes. By doing so, we are helping to protect all Canadians and providing them with peace of mind that their homes and communities will be safe and resilient in the years ahead.

Annex:

List of Projects Under the *Standards to Support Resilience in Infrastructure Program* (2016-2021)

LEGEND

Type of Deliverable

- S Standard
- US Updated Standard
- F Foundational Document
- G Guidance Document
- UG Updated Guidance Document

Status

- P Planned
- I In progress
- C Completed

SCC's Infrastructure Program is delivering concrete standardization strategies and tools to help Canadians adapt to climate change. Below is a full list of completed, ongoing, and planned projects. They are generally organized by the following themes:

- Arming Standards Writers with the Tools to Fight Climate Change
- Getting the Most Out of Weather and Climate Data
- Helping Northern Communities Adapt to a Rapidly Changing Climate
- Designing Infrastructure that Can Stand Up to Extreme Weather Events

Arming Standards Writers with Tools to Fight Climate Change

Title	Type	Status	Hazards Addressed
A New Guide on How to Address Aspects of Climate Change in All ISO Standards	G	I	General
A New Guide for Addressing Climate Change Adaptation in Standards for Canada	G	I	General
New Guidance on Understanding Climate Change Models for Standards Development	G	P	General

Getting the Most Out of Weather and Climate Data

Title	Type	Status	Hazards Addressed
Standardization Guidance for Weather Data, Climate Information and Climate Change Projections	F	C	General
Development and Implementation of an Engagement Strategy with Weather Monitoring Stations Owners and Operators	F	C	General
Series of National Standards of Canada for Canadian Weather Stations - Part 1: Metadata Self-Declaration for Canadian Weather Stations Collecting Atmospheric Meteorological Data	S	I	General
Series of National Standards of Canada for Canadian Weather Stations - Part 2 (a): Data Quality Rating System and Part 2 (b): User's Guide: Applying the Data Quality Rating System	S	I	General
Series of National Standards of Canada for Canadian Weather Stations - Part 3: Protocols for Sharing Atmospheric Meteorological Data	S	I	General
Series of National Standards of Canada for Canadian Weather Stations - Part 4: Siting, Design, Operations and Maintenance of Canadian Weather Stations	S	I	General
CSA PLUS 4013 Technical Guide: Development, interpretation, and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners	UG	I	Extreme Precipitation / Flooding
NCC Study - Standards and Capital Planning Process to Address Impacts of Climate Change on NCC Assets	F	I	General

Helping Northern Communities Adapt to a Rapidly Changing Climate

Title	Type	Status	Hazards Addressed
CAN/CSA-S500-14 Thermosyphon Foundations for Buildings in Permafrost Regions	US	I	Permafrost Thaw
CAN/CSA-S501-14 Moderating the Effects of Permafrost Degradation on Existing Building Foundations	US	I	Permafrost Thaw
CAN/CSA-S502-14 Managing Changing Snow Load Risks for Buildings in Canada's North	US	I	Extreme Precipitation (Snow)
CAN/CSA-S503-15 Community Drainage System Planning, Design and Maintenance in Northern Communities	US	I	Permafrost Thaw
CSA W203-19 Planning, Design, Operation, and Maintenance of Wastewater Treatment in Northern Communities Using Lagoon and Wetland Systems	S	I	Permafrost Thaw
BNQ 9701-500 Risk-Based Approach for Community Planning in Northern Regions	S	I	Permafrost Thaw
CSA W205 Erosion and Sedimentation Management for Northern Community Infrastructure	S	I	Permafrost Thaw
CSA S504 Fire Resilient Planning for Northern Communities	S	I	Wildfire
CSA PLUS 4011-10: Infrastructure in Permafrost: A Guideline for Climate Change Adaptation and the Development of Complementary Enhanced Technical Guidance for Highly Technical Users	UG	I	Permafrost Thaw
Solid Waste Sites in Northern Communities: From Design to Closure (CSA Group)	S	I	Permafrost Thaw
CSA S505 Techniques for Dealing with High Winds and Snow Drifting as it Pertains to Northern Infrastructure	S	I	High Winds

Designing Infrastructure That Can Stand up to Extreme Weather Events

Title	Type	Status	Hazards Addressed
CSA S37-18, Antennas, Towers, and Antenna-Supporting Structures	US	C	General
CSA Z240.10.1-16 Site Preparation, Foundation, and Installation of Buildings	US	I	General
Developing a Stormwater Quality Management Standard (QMS) in Light of a Changing Climate	F	C	Extreme Precipitation / Flooding
Stormwater Quality Management Standard in Light of a Changing Climate	S	P	Extreme Precipitation / Flooding
Weathering the Storm: Developing a Canadian Standard for Flood-Resilient Existing Communities	F	C	Extreme Precipitation / Flooding
Standard for Prioritizing Flood-Resilience Work in Existing Residential Communities	S	P	Extreme Precipitation / Flooding
Preventing Disaster Before It Strikes: Developing a Canadian Standard for New Flood-Resilient Residential Communities	F	C	Extreme Precipitation / Flooding
CSA W204 Flood Resilient Design for New Residential Communities	S	I	Extreme Precipitation / Flooding
Guidelines to Reduce the Risk of Inflow and Infiltration in New Construction in Canadian Wastewater Systems	F	I	Extreme Precipitation / Flooding
Best Practices to Reduce Inflow and Infiltration in Sanitary Sewers	S	P	Extreme Precipitation / Flooding
Increasing High Wind Safety for Canadian Homes: A Foundational Document for Low-rise Residential and Small Buildings	F	C	High Winds
Climate Resilience Standard for New Houses - Wind	S	P	High Winds
Wildland Fire/Post-Fire Structure Investigation Papers	F	I	Wildfire
Wildland Fire/Post-Fire Structure Investigation Standard	S	P	Wildfire
Organizational Competencies for Health Care Facilities and Infrastructure Management	US	P	General
Designing Thermally Comfortable Playgrounds in Canada	F	I	Extreme Heat

Projects at a Glance

BY TYPE OF DELIVERABLE

Type of Deliverable	Count
New Standard	16
Foundational Document	10
Updated Standard	7
Guidance Document	3
Updated Guidance Document	2
TOTAL	**38**

BY STATUS

Status	Count
In Progress	24
Planned	7
Completed	7
TOTAL	**38**

BY HAZARD

Hazards Addressed	Count
General	13
Extreme Precipitation / Flooding	9
Permafrost Thaw	8
Wildfire	3
High Winds	3
Extreme Heat	1
Extreme Precipitation (Snow)	1
TOTAL	**38**

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