From knowledge to action: defining future directions and increasing the impact of climate resilient infrastructure guidance in Canada: workshop report

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Housing, Infrastructure and Communities Canada | Logement, Infrastructures et Collectivités Canada | SCC CCN | National Research Council Canada | Conseil national de recherches Canada

From Knowledge to Action

DEFINING FUTURE DIRECTIONS AND INCREASING THE IMPACT OF CLIMATE RESILIENT INFRASTRUCTURE GUIDANCE IN CANADA

WORKSHOP REPORT

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Disclaimer

This report summarizes the views, opinions, and recommendations shared by participants during the workshop. The content does not necessarily reflect the views, positions, or official policies of the National Research Council of Canada (NRC), the Standards Council of Canada (SCC), or Housing, Infrastructure and Communities Canada (HICC), nor should it be interpreted as an official endorsement or statement from any of these organizations.

Additionally, this report is intended to capture a range of perspectives discussed during the workshop. It does not represent a comprehensive or exhaustive review of all ongoing initiatives or existing work in the adaptation and resiliency space. The perspectives presented are limited to those of the participants and may not reflect the views of all stakeholders. Further efforts may be required to align and coordinate these ideas with broader activities and developments in the field.

Terminology

This report makes reference to a variety of documents and frameworks that guide practice and regulation for construction in Canada. The following provides a brief description of the terms used.

National Model Codes

Canada's National Model Codes are: National Building Code of Canada (NBC), National Plumbing Code of Canada (NPC), National Fire Code of Canada (NFC), National Energy Code of Canada for Buildings (NEBC), and the National Farm Building Code of Canada (NFBC). The National Model Codes have no legal authority until they are adopted by a government authority (for example, a provincial or territorial government) with the appropriate jurisdiction. The Canadian Board for Harmonized Construction Codes develops the National Model Codes, and is made up of representatives from provincial, territorial, and federal public services. The National Research Council acts as the secretariat providing technical, policy, and administrative support, including publishing the National Model Codes.

National Building Code of Canada (NBC):

The NBC sets technical requirements for the design and construction of new buildings as well as alterations, change of use, and demolition. The requirements address safety, health, accessibility, energy efficiency and building protection.

National Standards of Canada:

A standard is a document that provides guidelines, characteristics or requirements for products, processes or services. National Standards of Canada are consensus-based documents developed by SCC-accredited standards development organizations. Standards are voluntary, but can be made mandatory when they are enforced by laws or regulations.

Specifications:

Specifications provide detailed, project-specific requirements—such as materials, dimensions, tolerances, performance metrics, and installation procedures—used in construction, procurement, and manufacturing. Specifications are typically contractual documents and legally enforceable in project delivery.

Guides, Guidance, and Guidelines:

Guides, guidance, and guidelines are all terms used to describe advisory documents that offer recommended practices and general direction. Typically, these documents are voluntary.

Executive Summary

The *"From Knowledge to Action"* Workshop, held on December 4, 2024, in Ottawa, engaged over sixty senior-level representatives from key organizations across Canada. Organized by the Standards Council of Canada (SCC), Housing, Infrastructure and Communities Canada (HICC), and the National Research Council of Canada (NRC), the event brought together participants from diverse sectors, including governments, professional associations, climate services providers, funders, insurers, non-governmental organizations, and more.

The workshop's primary objective was to identify short-term and long-term actions to enhance the resilience of communities, buildings, and infrastructure to climate change impacts. It aimed to foster dialogue and collaboration to define actionable solutions, increase the adoption of climate-resilient guidance, and establish a comprehensive approach to integrating climate resilience into infrastructure planning, development, and management.

The workshop was organized into two sessions of breakout groups, and concluded with a plenary discussion. The first breakout group session focused on identifying gaps in knowledge and guidance for increasing climate resilience related to nine priority areas: coastal flooding, urban flooding, extreme heat, permafrost thaw, high winds, wildfires, decarbonization, data management, and emergency preparedness. The second breakout group session focused on options to increase the uptake and impact of available guidance by different participant groups, including: scientists and researchers; advocates and civil society; engineers, architects and planners; funders; insurers; asset owners; and policymakers and regulators. A summary of the short- and long-term actions discussed during the discussion sessions is provided on page ***13*** and ***14***.

Three overarching types of recommendations emerged from the discussions: Integration, Knowledge, and Economics. Achieving climate resilience requires collective efforts across sectors to enhance knowledge, integrate resilience into existing systems, and develop tools that enable practical, sustainable solutions.

Under *Integration*, key recommendations include advocating for adaptation as a critical investment, making resilience mandatory through policy and procurement, and mainstreaming climate resilience. Showcasing best practices will inspire wider adoption of resilience measures.

Under *Knowledge*, actions focus on building capacity through education, integrating resilience into systems, and creating practical tools for real-world applications. Tailored communication for diverse groups is also essential.

Under *Economics*, the focus is on supporting decision-making with cost-benefit analyses, offering incentives for resilient infrastructure, and sharing the impacts of adaptation, including costs and co-benefits.

The types of recommendations in *Figure 1* emphasize overcoming barriers, fostering leadership, and embedding resilience as a fundamental consideration in decision-making processes.

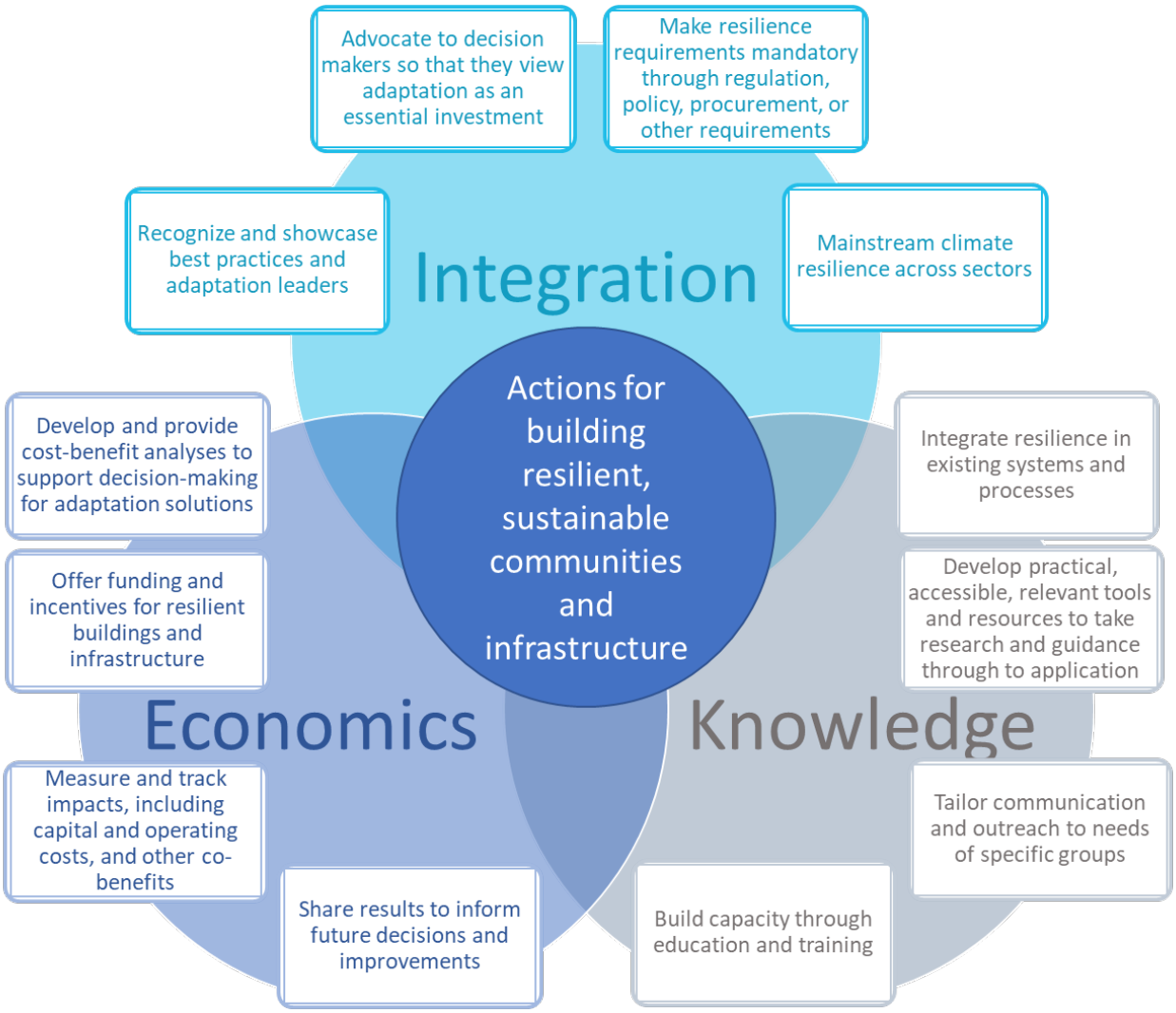

Figure 1: Summary of recommended actions for building resilient, sustainable communities and infrastructure

These strategic actions, when implemented, will help guide a nationwide shift toward building resilient, sustainable communities and infrastructure, ensuring that all sectors are equipped with the knowledge, tools, and resources needed to address the present and future impacts of climate change.

Moving forward on the recommendations received during the workshop requires collaboration and coordination between all interested parties, and offers opportunities for willing organizations to commit to- or lead on specific actions.

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Introduction

Since 2016, Housing, Infrastructure and Communities Canada (HICC, formerly Infrastructure Canada) has been collaborating with the National Research Council Canada (NRC) and the Standards Council of Canada (SCC) to develop guidance, such as standards, guidelines and decision-making tools, to increase the climate resilience of housing and infrastructure.

This guidance aims to help Canadians make better informed decisions about built and natural infrastructure (including housing), at the site- and community-scale in the context of a rapidly changing climate. Results of national relevance include the availability of future climate design values, and over 60 guidance documents, including construction specifications, guides, guidelines, standards and updates for model codes.

Efforts are needed to ensure that this guidance reaches intended users, including policy makers, communities, trades and professionals, to accelerate uptake and the application of climate resilience measures across many infrastructure assets and climate hazards.

To that end, HICC, NRC, and SCC co-hosted a one-day workshop in Ottawa, Ontario on December 4, 2024, to provide an overview of the guidance developed to date, and to welcome participants recommendations on:

- specific actions that can be taken together to increase the uptake and impact of existing guidance developed through NRC's Climate Resilient Built Environment Initiative (CRBE) and SCC's Standards to Support Resilience in Infrastructure Program (SSRIP), and
- remaining gaps in guidance and focus areas for future work.

Workshop Structure

The workshop agenda, including discussion questions, is provided in Appendix A: Agenda. Over sixty participants attended the workshop, representing a broad spectrum of interested parties from across Canada, including climate services providers, professional associations (including engineers, architects, planners, asset managers, and building owners), non-governmental organizations supporting sustainability and climate resilience, private sector organizations and governments. See Appendix B: List of Participants for the full list of participants.

The workshop opened with welcoming remarks and presentations from HICC, SCC, and NRC's senior officials and program managers (Appendix G: Presentations). The first breakout group discussion session focused on identifying the remaining gaps and priority areas for new research, guidance, and standards development. Participants selected two of nine discussion topics, including: coastal flooding, urban flooding, extreme heat, permafrost thaw, high winds, wildfire, decarbonization, data, and emergency preparedness. The second breakout group discussion session was organized by participant category (scientists and researchers; advocates and civil society; engineers, architects, and planners; funders; insurers; asset owners; policymakers and regulators). Each group aimed to identify actions they could take to enhance the impact and uptake of climate-resilient guidance. Breakout groups were supported by facilitators and notetakers. During the closing plenary session, participants presented and synthesized key recommendations and issues discussed in breakout groups, and participated in an open-floor discussion on specific actions to increase the adoption and application of guidance moving forward.

Following the workshop, members of the Infrastructure and Buildings Working Group under Natural Resources Canada's Adaptation Platform were invited to provide written responses to the Workshop discussion questions via an online questionnaire (December 16 - 19, 2024). Key gaps have been included in the tables below. A summary is provided in Appendix C: Input from Infrastructure & Buildings Working Group.

Discussion Highlights

This section highlights key gaps, barriers, and suggested solutions identified during the workshop, focusing on integrating climate resilience into infrastructure planning and policy development. Discussions emphasized the need to overcome obstacles related to infrastructure assets and hazard considerations, particularly in aligning technical standards and policies.

Solutions highlighted the importance of collaboration, innovation, and inclusivity, ensuring that resilience measures are incorporated into infrastructure designs while addressing the specific hazards communities face. By fostering a more coordinated approach, all interested parties can work together to enhance the resilience of infrastructure in the face of climate-related challenges. Discussion highlights by theme are provided below.

Several obstacles were identified in integrating climate resilience considerations into infrastructure planning and development. These challenges included limitations in funding, technical capacity, and misalignment between policies at different governmental levels. Participants noted that regional disparities contributed to varying capabilities to increase climate resilience. For example, Indigenous communities located in remote areas face unique barriers due to lack of infrastructure, limited technical resources, and inadequate funding for adaptation measures.

Knowledge and Guidance-related

Gaps in Guidance
Gaps in existing climate resilience infrastructure guidance were identified, including the need for more comprehensive technical standards, clearer guidelines, and updated best practices that reflect the latest climate science. Participants emphasized the need for more tailored guidance that incorporates the specific needs of professionals, reflects local knowledge, and provides localized resilience strategies.

Needs for Standardization
It was highlighted that climate risk assessments are not yet standardized across sectors, which leads to inconsistencies in data sources, methodologies, and the frequency of updates. Furthermore, there are no universally accepted procedures for monitoring the effectiveness of climate resilience measures after their implementation, nor consistent reporting on performance outcomes. In terms of infrastructure design, participants noted that while design criteria and techniques for adapting to climate impacts like extreme weather events and rising sea levels are either available or in development, there is a strong willingness to align these efforts more broadly among partners, increasing standardization. This gap contributes to uneven resilience across different regions, each with their unique climate challenges.

Opportunities for Strengthening Guidance
Emerging areas where enhanced guidance is needed include adaptation to extreme weather events, sea-level rise, and urban resilience. Technological and scientific advancements were seen as critical in informing future infrastructure development, but participants stressed that these innovations should be applied in ways that also respect traditional Indigenous knowledge and land stewardship practices, which offer valuable insights into climate adaptation.

Innovation and Funding

Innovation in Technology and Materials
The role of innovative technologies and materials in enhancing climate resilience was another prominent topic. Participants discussed the potential for new building materials, green infrastructure solutions, and digital tools to improve the adaptability and sustainability of housing and infrastructure. There was a call for innovation that draws from both technological advancements and Indigenous practices.

Funding and Resource Allocation
Adequate funding for climate resilience initiatives was noted as a critical factor for success. Workshop participants discussed various funding models, including public-private partnerships, and the need for flexible funding mechanisms to support local adaptation efforts. Ensuring that funding is allocated equitably, including for Indigenous communities, was highlighted as essential to overcoming the resource barriers these communities often face in addressing climate impacts

Governance, Policy and Planning

Policy, Governance, and Integrated Planning
Participants discussed the crucial role of integrated policy frameworks in supporting climate-resilient infrastructure. They highlighted the importance of integrated planning that aligns climate resilience goals with urban development and infrastructure investment across all levels of government to achieve long-term results. Participants also recommended to integrate climate resilience into existing building codes, regulations, and planning processes across all levels of government. A key part of the discussion focused on the need for all levels of government—federal, provincial, and municipal—to better coordinate efforts to advance climate resilience, while ensuring that Indigenous rights, lands, and traditional knowledge systems are central to the governance models.

Climate Risk Assessment and Vulnerability Mapping
Participants emphasized the need for comprehensive climate risk assessments, including up-to-date vulnerability maps, to identify areas most at risk from climate change. This mapping should guide the prioritization of resilience efforts in housing and infrastructure projects, particularly in regions experiencing multiple climate impacts concurrently, such as flooding, forest fires, or coastal erosion.

Collaboration and Knowledge Sharing
The importance of broad collaboration was emphasized including the need for improved communication and coordination among all interested parties—government, private sector, academia, and Indigenous communities—to create a more integrated approach to climate resilience. There was also strong support for establishing mechanisms for including Indigenous knowledge alongside technical expertise and for Indigenous participation in decision-making.

Community Engagement and Equity
Ensuring that climate resilience efforts are inclusive and equitable was a common recommendation. Participants stressed the importance of involving marginalized communities in decision-making processes and ensuring that resilience strategies address the needs of all community members, particularly those most vulnerable to climate impacts.

Breakout Group Summaries

Tables 1 and ***2*** provide a high-level summary of the discussions held in breakout sessions 1 and 2, synthesized into short- and long-term actions. For a detailed summary, see Appendix D: Breakout Group Summaries Remaining Gaps and Priority Areas for Research, Guidance and Standards and Appendix E: Breakout Group Summaries Increasing Impact and Uptake.

Closing the Gap on Guidance by Priority Areas

Table 1: Recommended actions from breakout session 1

Priority Area	Recommended Short-Term Actions	Recommended Long-Term Actions
Coastal Flooding	Develop user-friendly resources for various audiences, including guidebooks and case studies for developers and communities. Launch training programs on resilience strategies and improve access to decision-making tools.	Establish national standards for coastal resilience and integrate resilience into education curricula. Scale successful pilot projects, create a comprehensive risk assessment system, and develop national pollution control policies for coastal areas.
Urban Flooding	Improve regulations with latest guidance and provide financial incentives for resilient buildings. Strengthen partnerships to spread information and improve communication about flood risks. Focus on creating a home resilience rating system and include financial support in municipal plans.	Develop nationwide financial mechanisms for flood resilience, integrate flood resilience into urban planning standards, and create coordinated policies for managed retreat in flood-prone areas.
Extreme Heat	Launch programs for cooling stations, establish urban heat island mitigation strategies, and protect outdoor workers during heatwaves. Start retrofitting buildings for heat resilience.	Expand cooling infrastructure nationwide, implement nationwide worker protection policies for heat stress, and create national urban forest development programs.
Permafrost Thaw	Improve access to permafrost data, support retrofitting infrastructure in thawing regions, and provide resources for local communities. Begin designing financial models for permafrost resilience.	Establish a national permafrost database, develop long-term solutions for thawing infrastructure, and foster international collaboration on permafrost resilience.
High Winds	Begin structural evaluations of existing buildings, improve hazard mapping for wind risks, and strengthen infrastructure resilience, such as using guidance in new buildings and retrofits. Start developing regional wind resistance standards.	Implement national wind-resistance certification programs and coordinate efforts to improve the resilience of critical infrastructure nationwide.
Wildfires	Launch awareness campaigns and develop guidelines for wildfire and smoke resilience, particularly for homes and land use.	Create a national framework for wildfire risk management and real-time wildfire risk assessment tools.
Decarbonization	Start the development of low-carbon infrastructure systems, provide financial incentives for sustainable building practices, and increase education on decarbonization.	Transition to fully low-carbon infrastructure systems, implement nationwide decarbonization awareness campaigns, and establish long-term financing for sustainable projects.
Data: Standardization, Management, and Sharing	Develop guidelines for consistent data collection and establish a centralized hazard data platform.	Implement hybrid data systems that integrate local and national data for better risk assessment and decision-making.
Emergency Management	Provide resources for emergency planning and integrate climate adaptation into emergency management strategies, including Indigenous-led organizations.	Formalize national emergency planning and create adaptable, modular infrastructure for emergency responses, including Indigenous-led organizations and communities.

Key Findings and Recommended Actions by Participant Category

Table 2: Recommended actions from breakout session 2

Category	Recommended Short-Term Actions	Recommended Long-Term Actions
Scientists and Researchers	Establish clear governance structures for collaboration between public scientists working for federal, provincial, and local authorities. Make climate research accessible through infographics and other user-friendly formats. Launch educational programs on climate resilience at all educational levels. Foster partnerships across governments and research organizations. Develop tools and guidance for municipalities and asset owners to understand and adopt climate resilience practices.	Develop metrics for evaluating the success of resilience programs and initiatives. Institutionalize climate resilience training for professionals. Innovate research methodologies to improve the effectiveness of adaptation strategies.
Advocates and Civil Society	Provide region-specific climate resilience guidance, create accessible climate resilience documents, and remove barriers to information access. Enhance public outreach through diverse media channels to raise awareness about climate risks.	Advocate for regulatory measures (e.g., insurance incentives, climate risk disclosures) to encourage resilience adoption, for the integration of climate resilience into decision-making frameworks across sectors and ensure continuous education on resilience for professionals.
Engineers, Architects, and Planners	Develop joint curricula for climate resilience training between key professional organizations. Provide region-specific guidelines for resilience, especially addressing challenges in northern and Indigenous communities. Promote best practices through case studies of successful climate resilience projects.	Integrate climate resilience into professional accreditation programs. Advocate for resilient infrastructure standards through adoption and legislation. Develop a centralized knowledge portal for resilience resources.
Funders	Include resilience-focused criteria in procurement tenders for infrastructure projects. Fund innovative climate-resilient technologies and advocate to address legislative barriers that hinder resilient rebuilding efforts.	Institutionalize resilience criteria in all procurement processes. Develop merit-based funding systems that require resilience integration in projects. Establish frameworks for ongoing maintenance and resilience management post-construction.
Insurers	Use simplified messaging to educate homeowners on resilience practices. Develop validated checklists to ensure resilience standards are met by builders. Increase public awareness through multi-channel strategies.	Develop and promote insurance products that integrate resilience measures and adjust pricing models based on resilience factors. Push for updates to building codes and insurance pricing models to reflect resilience. Continue funding research for cost-effective resilience solutions.
Asset Owners	Provide simplified guidance on implementing resilience measures. Develop standardized assessment methods and tools for asset owners to understand and adopt climate resilience practices. Conduct early financial assessments to determine the lifecycle costs of resilience measures.	Standardize an assessment method and resilience roles in municipal planning and budgeting. Integrate climate resilience into long-term asset management plans. Establish national programs for workforce development in climate resilience and adaptation.
Policymakers and Regulators	Engage Indigenous communities and youth in resilience planning. Simplify climate resilience standards for non-experts and enhance local climate resilience tools. Develop cost-benefit frameworks to demonstrate the financial and social benefits of resilience investments.	Mainstream climate resilience into broader national and provincial policy frameworks. Foster resilience champions to promote best practices. Use technology, such as AI, to make resilience standards more accessible and adaptable across sectors. Regularly update resilience policies based on new evidence and monitoring.

Recommended Implementation Steps

Three overarching types of recommendations emerged from the breakout group discussions and in the final plenary: knowledge, funding, and driving action. Achieving climate resilience requires collective action across sectors to enhance knowledge, integrate resilience into existing systems, and develop tools that enable practical, sustainable solutions. These actions focus on overcoming barriers, fostering leadership, and ensuring that resilience becomes a fundamental consideration in decision-making processes. Figure 1 provides a high-level overview of recommendations; detailed recommendations follow in the next section.

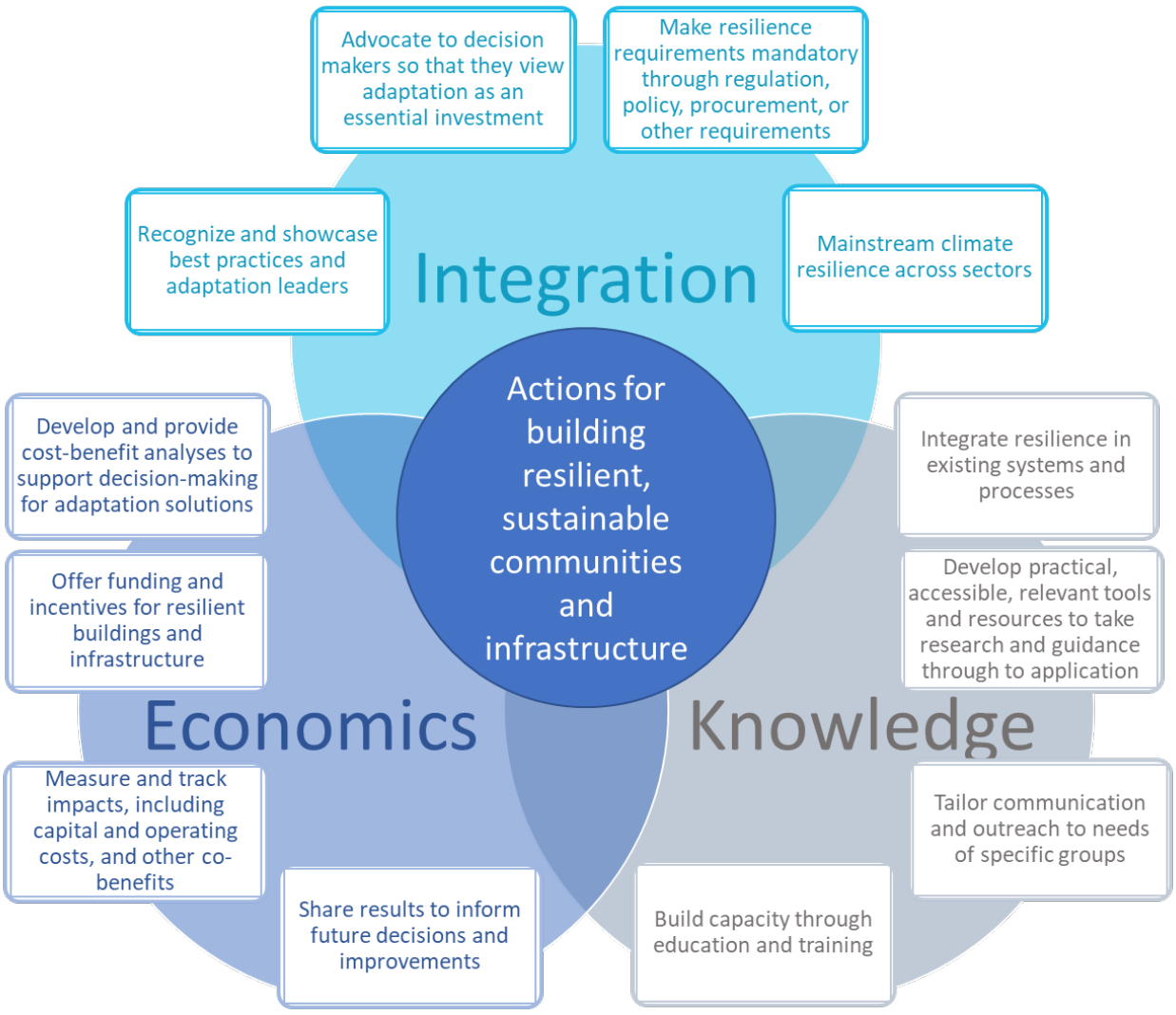

Figure 1: Summary of recommended actions for building resilient, sustainable communities and infrastructure

Integration Recommendations

Table 3 Short- and long-term actions and associated participant category (in bold) to carry out the action, grouped into 4 outcomes.

I-1) Overcoming Barriers to Adoption and Integration	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Encourage clients and other interested parties to view resilience as an essential investment, not just an added cost. • **Policy Makers/Regulators:** Address jurisdictional and political barriers to embedding resilience in regulatory frameworks. • **Advocates/Civil Society:** Raise awareness of the tangible benefits of resilience to overcome public skepticism.	• **Funders and Insurers:** Support initiatives that prioritize resilience, even when short-term financial barriers exist. • **Asset Owners:** Streamline resilience integration into procurement processes and long-term strategic planning. • **Scientists and Researchers:** Translate research into recommendations for actionable policies to remove barriers to resilience adoption.
I-2) Mainstreaming Climate Resilience Across Sectors	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Promote the integration of resilience considerations into all planning, design, and construction projects. • **Advocates/Civil Society:** Advocate for resilience as a core objective in policy and decision-making, and strategically engage key forums. • **Insurers:** Align resilience with industry-wide risk management practices through partnerships with other sectors.	• **Policy Makers/Regulators:** Institutionalize resilience as a core element in national and local policy frameworks. • **Asset Owners:** Implement resilience as a guiding principle throughout the asset lifecycle. • **Funders:** Align funding decisions with broader climate resilience and sustainable development goals.
I-3) Championing Resilience Leadership	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Recognize and showcase best practices in resilient infrastructure design. • **Policy Makers/Regulators:** Promote leadership in resilience through incentives and recognition programs. • **Advocates/Civil Society:** Highlight successful resilience champions and local examples as models.	• **Scientists and Researchers:** Support research leaders in the field and promote their findings to wider audiences. • **Insurers:** Partner with leaders in resilience to spread best practices across the industry. • **Funders:** Invest in initiatives that celebrate leadership in climate resilience, inspiring others to adopt similar practices.
I-4) Regulatory and Legislative Approaches	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Advocate for flexible, region-specific regulations that allow for local adaptations of resilience measures. • **Funders:** Ensure financial frameworks are aligned with regulatory standards to facilitate compliance.	• **Policymakers/Regulators:** Develop national regulatory frameworks with flexible provisions for local resilience adaptations. • **Asset Owners:** Collaborate with policymakers to create phased implementation strategies for resilience measures, supported by financial incentives to reduce upfront costs.

Economics Recommendations

Table 4 Short- and long-term actions and associated participant category (in bold) to carry out the action, grouped into 4 outcomes.

E-1) Clearer Cost-Benefit Analysis (CBA)	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Integrate resilience CBA into the design and development of projects. Create procedures and tools for consistent application of CBA. • **Funders:** Support projects that feature a robust CBA to demonstrate the economic value of resilience. • **Policy Makers/Regulators:** Implement policies that encourage financial assessments of resilience measures during planning and development.	• **Scientists and Researchers:** Continue gathering and disseminating data on the economic impacts of climate resilience measures. • **Insurers:** Advocate for incorporating resilience costs into risk-based pricing and underwriting models. • **Asset Owners:** Focus on long-term financial assessments to ensure ongoing climate resilience in asset management.
E-2) Funding and Financial Incentives	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Funders:** Create joint funding mechanisms combining resilience goals with measurable financial outcomes. • **Asset Owners:** Work with funders to develop financial models that include resilience targets, easing access to funding.	• **Funders and Insurers:** Create shared funding and risk-pooling models to encourage long-term resilience investments. • **Insurers:** Partner with funders to offer lower premiums for resilient projects, reducing financial barriers for asset owners.
E-3) Measurement and Impact Tracking	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Scientists and Researchers:** Develop tools and methodologies to track the impacts of resilience measures, both qualitatively and quantitatively. • **Policymakers/Regulators:** Implement systems to monitor policy effectiveness, integrating case studies and traditional metrics.	• **Scientists and Researchers:** Create real-time monitoring systems to track resilience effectiveness, adapting strategies as needed. • **Policymakers/Regulators:** Incorporate continuous feedback mechanisms into policies, ensuring adaptability based on monitoring data.
E-4) Cost of Climate Resilience Measures	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Asset Owners:** Work with insurers to explore risk-based financial incentives like premium discounts for resilient infrastructure. • **Insurers:** Offer financial incentives such as rebates or lower premiums for properties that incorporate resilience measures.	• **Funders:** Develop funding mechanisms that account for the long-term financial savings from resilience measures, such as reduced maintenance costs. • **Asset Owners:** Collaborate with insurers and policymakers to demonstrate the financial viability of resilience measures over the long term.

Knowledge Recommendations

Table 5 Short- and long-term actions and associated participant category (in bold) to carry out the action, grouped into 8 outcomes.

K-1) Education and Capacity Building	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Scientists and Researchers:** Develop and deliver specialized training programs for municipalities and practitioners to improve their climate resilience capabilities. • **Engineers/Architects/Planners:** Advocate for the inclusion of climate resilience in professional curriculums and industry training to ensure future readiness. • **Policy Makers/Regulators:** Support resilience education for all interested parties, including youth and Indigenous communities, to foster wide-reaching awareness.	• **Funders:** Provide sustained financial support for resilience education programs and professional development over the long term. • **Insurers and Asset Owners:** Invest in continuous professional staff training on climate resilience and risk management. • **Advocates/Civil Society:** Strengthen public resilience education efforts, focusing on youth and community engagement.
K-2) Integration of Resilience into Existing Systems and Processes	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Start incorporating climate resilience considerations into all new planning, design, and construction projects. • **Policy Makers/Regulators:** Hold discussions to integrate resilience into existing policy and regulatory frameworks. • **Insurers:** Support the adoption of climate resilience practices through policy advocacy and incentives.	• **Scientists and Researchers:** Develop tools and resources that aid the integration of resilience into government planning processes. • **Advocates/Civil Society:** Advocate for resilience to be mainstreamed in governance and policymaking. • **Asset Owners and Funders:** Align funding and procurement processes with climate resilience objectives.
K-3) Implementation of Climate Resilience Guidance	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Scientists and Researchers:** Collaborate with engineers and architects to make data actionable and integrate it into infrastructure projects. • **Engineers/Architects/Planners:** Set up real-time knowledge transfer platforms and test resilience solutions with available climate data.	• **Scientists and Researchers:** Work with engineers and architects early on to ensure that research outputs are directly applicable to real-world projects. • **Engineers/Architects/Planners:** Develop standardized frameworks to ensure scientific data is accessible and usable by all interested parties.
K-4) Improved Tools and Resources	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Engineers/Architects/Planners:** Collaborate broadly to ensure resilience tools are practical and regionally relevant.	• **Scientists and Researchers:** Focus on developing simplified, user-friendly resilience tools for non-experts.

• **Insurers:** Work with other interest parties to establish clear standards for resilience that are validated and actionable. • **Policy Makers/Regulators:** Ensure that resilience codes and standards are accessible and widely understood by all sectors.	• **Funders:** Provide funding for the creation of comprehensive, cross-sector resilience tools. • **Asset Owners:** Implement actionable resilience tools within asset management strategies.
K-5) Tailored Communication and Outreach	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Advocates/Civil Society:** Craft targeted messaging and stories that resonate with diverse groups like youth and Indigenous communities. • **Engineers/Architects/Planners:** Develop localized outreach materials to address the unique needs of specific regions. • **Policy Makers/Regulators:** Tailor communication strategies to reach underrepresented and vulnerable communities.	• **Insurers and Asset Owners:** Expand outreach efforts to make resilience information widely accessible and understood. • **Funders:** Support communication campaigns targeting diverse audiences, including marginalized communities. • **Scientists and Researchers:** Partner with communication professionals to ensure research is easily understood by a broad audience.
K-6) Knowledge Mobilization, Dissemination and Accessibility	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Advocates/Civil Society:** Develop accessible, simplified climate resilience messaging for diverse audiences. • **Insurers:** Create educational materials linking resilience measures with financial incentives, like premium discounts.	• **Advocates/Civil Society:** Promote combined education campaigns with financial incentives to increase public awareness and participation. • **Engineers/Architects/Planners:** Collaborate with communities to integrate both technical and social aspects into infrastructure projects for greater inclusivity.
K-7) Role of the Federal Government	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Scientists and Researchers:** Present research in formats that align with policymakers' needs, making it easier to apply. • **Policymakers/Regulators:** Prioritize short-term adaptive policies that incorporate current scientific research findings.	• **Scientists and Researchers:** Foster ongoing communication between researchers and policymakers to ensure policies evolve with emerging data. • **Policymakers/Regulators:** Implement adaptive governance models that allow policies to evolve while maintaining long-term climate resilience goals.
K-8) Indigenous Communities' Role	
Short-term (1-2 years) Actions	**Long-term (5 years) Actions**
• **Indigenous Communities:** Share traditional ecological knowledge through co-design workshops to guide resilience strategies. • **All Participant Categories:** Build equitable partnerships with Indigenous communities, and include traditional knowledge in resilience planning.	• **Policymakers/Regulators:** Establish formal partnerships to co-create resilience guidelines and policies that include Indigenous knowledge. • **Engineers/Architects/Planners:** Collaboratively include Indigenous knowledge in modern infrastructure design, ensuring culturally sensitive and effective resilience solutions.

Navigating Diverging Views on Climate Resilience In Infrastructure

Several diverging views emerged among the participants in terms of priorities, approaches to implementation, and opinions on the roles and responsibilities for enhancing climate resilience of infrastructure. Below is an analysis of these differences and potential strategies for reconciling them moving forward:

1. **Prioritization of Climate Risks**: Different participant categories had conflicting views on which climate risks that should be prioritized. For example, local governments pointed to immediate, community-level concerns, while larger infrastructure project representatives emphasized long-term, systemic risks. This divergence could be addressed by engaging in more comprehensive risk assessment processes that consider both short-term and long-term impacts, with input from all parties concerned. Creating a shared framework for risk prioritization could help consider these competing concerns.

2. **Implementation Strategies**: Approaches to implementing climate-resilient infrastructure varied greatly. Some participants advocated for top-down, centralized planning, while others favored a more decentralized, community-driven approach. To bridge these differences, hybrid models could be developed, where high-level strategies are guided by central authorities but are adapted and executed with input from local communities to ensure relevance, impact and feasibility. Facilitating more collaborative planning sessions and pilot projects could foster mutual understanding and compromise.

3. **Role of Private vs. Public Sector**: A key point of contention was the role of the private sector in driving climate resilience efforts. Some participants believed that private sector involvement was essential for innovation and funding, while others expressed concerns over profit-driven motives undermining public welfare. This disagreement could be addressed by establishing clearer frameworks for public-private partnerships, ensuring that both sectors align on shared objectives for climate resilience. Additionally, transparent mechanisms for accountability and oversight could alleviate concerns about privatization of public resources.

By fostering open dialogue, facilitating collaborative decision-making processes, and establishing clear frameworks for cooperation, these diverging views can be reconciled, leading to a more unified and effective approach to enhancing climate resilience in infrastructure. A detailed summary of significant differences in opinions or approaches expressed by participants, and discussions of how these differences could be addressed or reconciled moving forward is provided in Appendix F: Diverging Views, Proposed Reconciliation Actions – Common/Shared Themes.

Next Steps

The workshop generated a significant volume of observations and recommendations for increasing the uptake and impact of existing outputs from SCC and NRC's climate resilience initiatives, and for creating guidance on additional topic areas. Topics for action ranged from the development of financial mechanisms and incentives to support long-term resilience, to launching capacity-building initiatives to educate professionals, decision-makers and the public. Monitoring and impact tracking were also highlighted as essential components for assessing progress and improving strategies over time.

Moving from recommendations to implementation will require concerted efforts and commitments from all interested parties. This could be supported by the development of an implementation framework and committees.

Framework: Co-creating a cohesive framework for that collaboration and coordination across sectors could support effective implementation that is integrated, comprehensive, and inclusive. Such framework would integrate key objectives, such as engagement, knowledge mobilization, policy development, and the collaborative inclusion of Indigenous perspectives, while allowing flexibility and responsiveness to evolving practice and application of climate resilience in Canada. Defining leadership roles within relevant intergovernmental bodies and clarifying alignment with existing national strategies will facilitate the successful advancement of this effort.

Implementation committees: The creation of partner-led committees could be determinant in the successful implementation of these recommendations. Partners (workshop participants as well as other organizations) could form advisory committees, task forces, or project-specific expert teams. Cross-disciplinary committees could also be created to advance topics such as financing resilient buildings and infrastructure, knowledge translation needs, Indigenous engagement, and impact tracking. Implementation committees could operate out of processes already in place (e.g., Infrastructure and Buildings Working Group) or could be newly created, as needed, to address specific challenges.

The feedback received through the workshop is presented and synthesized in this report; however, it has not yet been assessed to determine whether some recommendations are already being addressed, such as through recent initiatives under the National Adaptation Strategy. A key next step is to identify ongoing efforts and connect stakeholders pursuing similar objectives related to climate resilience guidance and implementation. This would support the coordination of actions across sectors, help avoid duplication, and enable the identification of gaps in current activities. To guide this process, it will be important to outline both short- and long-term actions, supported by clearly defined monitoring, performance, and evaluation measures to track progress, assess effectiveness, and inform continuous improvement.

Conclusion

The discussions held during the workshop provided valuable insights into the pathways for advancing climate resilience in Canada's housing, infrastructure, and communities. The collaboration between HICC, NRC, and SCC, along with the diverse contributions from other interested parties will be essential in refining and implementing effective guidance for climate adaptation.

The discussions identified remaining gaps and needs for coastal flooding, urban flooding, extreme heat, permafrost thaw, high winds, wildfire, decarbonization, data, and emergency preparedness. The detailed summaries provided in Appendix D could be used as the basis to more deeply explore the specific needs for these climate hazards and specific asset types.

The workshop highlighted the essential role of cross-sector collaboration in advancing climate resilience across Canada. It outlined key actions for each participant category, emphasizing the need for knowledge mobilization, innovative research, region-specific guidance, and the integration of resilience principles into all levels of governance, education, and professional practice.

Finally, to increase the impact of climate-resilient infrastructure guidance, the participants emphasized engaging diverse and underrepresented audiences, improving the accessibility and usability of tools, integrating climate resilience into existing systems, and focusing on measurable outcomes like cost savings and health benefits. Through storytelling and using technology effectively, these initiatives can reach broader audiences and drive meaningful change.

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Appendix A
Agenda

Workshop "From Knowledge to Action"

Defining Future Directions and Increasing the Impact of Climate Resilient Infrastructure Guidance in Canada

Date

4 December 2024

Location

Delta Hotel
101 Lyon St. N, Ottawa, ON, K1R 5T9
Richelieu Room

Background

Since 2016, Housing, Infrastructure and Communities Canada (formerly Infrastructure Canada) has been collaborating with the National Research Council Canada (NRC) and the Standards Council of Canada (SCC) to advance climate resilient guidance. Such guidance aims to better inform decisions about built and natural infrastructure (including housing), at the site- and community-scale in the context of a rapidly changing climate. Results of national relevance include future climate design values, construction specifications, guides, guidelines, standards, and updates for model codes. The challenge remains to reach intended users, including policy makers, communities, trades and professionals, to drive uptake and impact of this wide array of guidance for many types of assets and climate hazards.

Objectives

The purpose of this workshop is to provide an overview of progress to date, and to identify:

- Specific actions that can be taken together to increase the uptake and impact of existing outputs from NRC's Climate Resilient Built Environment Initiative (CRBE) and SCC's Standards to Support Resilience in Infrastructure Program (SSRIP)
- Remaining gaps and focus areas for future work

Contact: infrastructure@scc.ca

Agenda

8:00 – 9:00	**Registration** (light breakfast provided)
9:00 – 9:30	**Welcome and Introductions**
	Land Acknowledgement **Welcoming Remarks** • Chantal Guay, CEO, Standards Council of Canada • Yasir Sultan, Executive Director, Built Environment Climate Change Initiatives, National Research Council Canada • Lo Cheng, Director General, Environment and Infrastructure Policy Directorate, Policy and Results Branch Housing, Infrastructure and Communities Canada
9:30 – 10:15	**Plenary Session 1: Progress in Climate Resilient Guidance**
	Presentation: Setting the Stage for Action on Climate Resilience • Erin Taylor, Director of Adaptation and Resilience, Environment and Infrastructure Policy Directorate, Policy and Results Branch, Housing, Infrastructure and Communities Canada **Presentation: Climate Resilient Built Environment: Building the Pipeline from Fundamental Research Through to Guidance and Codes** • Marianne Armstrong, Director, Climate Resilient Built Environment Initiative, National Research Council Canada **Presentation: Standards to Support Resilience in Infrastructure Program and Increasing Climate Resilience in Infrastructure: From Guidance Creation to Implementation** • Gillian Koh, Acting Manager, Climate Change and Sustainability, Standards Council of Canada Q & A period
10:15 – 10:30	**Break**

10:30 – 12:15	**Breakout Groups – Session 1: Remaining Gaps and Priority Areas for Research, Guidance and Standards**
10:30 – 10:40	Objective: Identify infrastructure climate change adaptation needs and gaps (e.g., standards, guidance, research and tools)
	Presentation: Remaining Gaps and Priority Areas for Research, Guidance and Standards • Marla Desat, Technical Outreach Officer, National Research Council Canada • Kala Pendakur, Manager, Strategic Partnerships and Government Relations, Office of the CEO, Standards Council of Canada
10:40 – 12:15	**Breakout group discussion** • What are the gaps in research and guidance (including standards, guidelines and tools) you are seeing in your field of work?
12:15 – 1:00	**Lunch**
1:00 – 2:30	**Breakout Groups – Session 2: Increasing Impact and Uptake**
1:00 – 1:10	Objective: Understand organizations' roles in implementing climate resilient guidance and identify barriers and enabling factors for increased use/uptake
	Presentation: Driving Uptake and Impact of Resilient Infrastructure Guidance • Chad Nelson, Principal Advisor/Manager, Environment and Infrastructure Policy Directorate, Policy and Results Branch, Housing, Infrastructure and Communities Canada
1:10 – 2:30	**Breakout group discussion** • What is your organization's role in implementing climate-resilient guidance? • What would it take (e.g., barriers and solutions) for your organization to implement or promote the use of guidance, standards or research upon publication? • What can your organization do to keep available guidance in the public eye and to keep it relevant and widely communicated among practitioners? • How can the federal government accelerate the uptake of climate-resilient guidance?

2:30 – 2:45	**Break**
2:45 – 4:00	**Plenary Session 2: Road to Concrete Actions**
2:45 – 3:15	Breakout session results and discussion Prioritization exercise
3:15 – 4:00	Discussion on next steps
4:00 – 4:15	**Closing Remarks**
4:15 – 6:00	Reception (outside the meeting room)

Appendix B
List of Participants

Workshop "From Knowledge to Action"

Defining Future Directions and Increasing the Impact of Climate Resilient Infrastructure Guidance in Canada

Atelier "De la connaissance à l'action"

Définir les orientations futures et augmenter l'impact des lignes directrices en matière de résilience climatique pour les infrastructures au Canada

Participants List / Liste des participants

Organization / Organisation	Name / Nom
Architectes sans frontières	Élène Levasseur
Asset Management Ontario	Jennifer Court
Atlantic Infrastructure Management Network (AIM)	Matt Delorme
BC Housing	Wilma Leung
Building Owners and Managers Association	Bala Gnanam
Canadian Climate Institute	Ryan Ness
Canadian Institute of Planners	Lesley Cabott
Canadian Society for Civil Engineering	Shahria Alam
Canadian Urban Institute	Jennifer Barrett
Canadian Urban Institute	Matt Buckman
Canadian Water and Wastewater Network / City of Ottawa	Hiran Sandanayake
Canadian Water Network	Nicola Crawhall
Cement Association of Canada	Tim Smith
Climate Risk Institute	Erik Sparling
Climate West	Kerra Chomlak
CLIMAtlantic	Sabine Dietz
Cloudpermit	Aubrey LeBlanc
Conservation Ontario	Angela Coleman
Crown-Indigenous Relations and Northern Affairs Canada	Nicolas Ouellette
Crown-Indigenous Relations and Northern Affairs Canada	Anita Walker
Department of National Defense	Jean Ghanem
Ecohabitation	Emmanuel B. Cosgrove
Engineering Institute of Canada	Guy Gosselin

Organization / Organisation	Name / Nom
Engineers Canada	Phil Rizcallah
Environment and Climate Change Canada	Jeff MacDonald
Federation of Canadian Municipalities	Dustin Carey
Health Canada	Michelle Deveau
Housing, Infrastructure and Communities Canada	Lo Cheng
Housing, Infrastructure and Communities Canada	Catherine Hallmich
Housing, Infrastructure and Communities Canada	Lindsay Matthews
Housing, Infrastructure and Communities Canada	Chad Nelson
Housing, Infrastructure and Communities Canada	Erin Taylor
Housing, Infrastructure and Communities Canada	Alice Tremblay
Housing, Infrastructure and Communities Canada	Abderrahmane Yagouti
ICLEI Canada	Ewa Jackson
Indigenous Services Canada	Rob Bellizzi
Institute for Catastrophic Loss Reduction	Dan Sandink
Insurance Bureau of Canada	Jason Clark
Intact Centre on Climate Adaptation	Blair Feltmate
National Research Council Canada	Marianne Armstrong
National Research Council Canada	Marla Desat
National Research Council Canada	Bruno Di Lenardo
National Research Council Canada	Adam Pantelimon
National Research Council Canada	Yasir Sultan
Natural Assets Initiative	Donna Chiarelli
Natural Resources Canada	Jill Hull
Natural Resources Canada	Catherine Lafleur
Ordre des architectes du Québec	Raymond Carrier
Ontario First Nationals Technical Services Corp	Drew Hill
Otipemisiwak Métis Government	Andres Filella
Ouranos	Clara Champalle
Parks Canada	Ed Jager
Pembina Institute	Monica Curtis
Public Safety Canada	Matthew Godsoe
Public Services and Procurement Canada	Kelby Hamilton
Royal Architectural Institute of Canada	Giovanna Boniface
Société québécoise des infrastructures	Catherine Dubois

Organization / Organisation	Name / Nom
Standards Council of Canada	Brady Allin
Standards Council of Canada	Pierre Bilodeau
Standards Council of Canada	Marie-Hélène Carrier
Standards Council of Canada	Chantal Guay
Standards Council of Canada	Gillian Koh
Standards Council of Canada	Anneke Olvera
Standards Council of Canada	Kala Pendakur
Standards Council of Canada	Stephanie Poirier
Standards Council of Canada	Peter Raaymakers
Treasury Board of Canada	Luke Maybury

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Appendix C
Input from Infrastructure & Buildings Working Group

From December 16 to December 19, 2024, members of the Infrastructure and Buildings Working Group under Natural Resources Canada's Adaptation Platform were invited to provide written responses to the discussion questions posed at the workshop through an online questionnaire. The following provides a summary of the feedback received.

Gaps in Research and Guidance:

- **Flooding:** Guidance on hydrology and new residential flood resilience measures in provincial building codes.
- **Real-Life Implementation:** Development of case studies showcasing practical applications of standards and guidelines tailored to user needs.
- **Natural Assets:** Focus on condition assessments, risk evaluation, financial valuation, and overall natural asset management processes.
- **Data Guidance:** Clear recommendations on which data sources to use and their relevance.

Barriers:

- **Awareness:** Greater promotion is needed to reach target audiences through channels like provincial engineering associations, municipalities, events, webinars, and social media. Dedicated ambassadors, such as the Intact Centre, can play a key role.
- **Subject Matter Expertise:** Technical documents are highly specialized and require expertise that may not align with the target audience's needs.
- **Budget:** Limited resources present a barrier to implementation.
- **Roles and Responsibilities:** Clarify and document how municipalities and private parties are implementing standards, what is being adopted, and which aspects are feasible for municipalities, private citizens, or developers.

Role of Federal government to accelerate uptake:

- **Clarity on Municipal Roles:** Provide municipalities with clear guidance on applicable standards, implementation processes, and responsible parties. Address cases where external triggers, such as provincial building codes, dictate adoption or legally restrict municipal action.
- **Collaboration with Provinces and Local Governments:** Work with other government levels to require the use of standards in projects funded by federal, provincial, or local governments.
- **Financial Incentives:** Offer funding or financial support to encourage the adoption of standards.
- **Mandates:** Require the use of standards across all government levels or as criteria for federal funding eligibility.

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Appendix D
Breakout Group Summaries:
Remaining Gaps and Priority Areas for Research, Guidance and Standards

This appendix summarizes the findings from the first breakout group session. Summaries are presented for each of the nine topics discussed:

1. Coastal Flooding
2. Urban Flooding
3. Extreme Heat
4. Permafrost Thaw
5. High Winds
6. Wildfire
7. Decarbonization
8. Data, and
9. Emergency Preparedness.

The **consensus outcomes** are presented where consensus was reached among participants (e.g., key priorities, common challenges, shared goals).

Consensus Outcomes

- Participants across different sectors have shared key actions, common challenges, and shared goals to address these issues. After each topic is discussed, the key points of agreement and consensus outcomes are summarized. This is a common approach in collaborative decision-making, strategic planning, or discussions where multiple perspectives are involved.

The **diverging views** were identified and are of any significant differences in opinions or approaches among participants.

Diverging Views

- Diverging views among participants are based on differences in priorities, approaches, resource allocation, and specific needs. To identify diverging views, we break down the potential conflicting perspectives and suggest possible ways to reconcile these differences. After each discussed topic, some significant differences and how they might be addressed are summarized.

Coastal Flooding

Definition of Topic: Coastal flooding refers to the inundation of land along coastlines due to the rising water levels of oceans or seas. This phenomenon can be caused by a variety of factors, including storm surges, high tides, and long-term sea level rise, which may be influenced by climate change. Coastal flooding can lead to significant damage to infrastructure, ecosystems, and communities, especially in areas with low-lying terrain. It is particularly a concern for coastal cities, as it can result in the displacement of populations, loss of property, and disruptions to local economies.

Consensus Outcomes: Coastal Flooding

a. **Key Priorities:** Improve accessibility to coastal standards, enhance training for communities, create site-specific risk assessments, and focus on vulnerable communities.
b. **Common Challenges:** Ensuring resources are accessible for small communities and addressing socio-economic disparities in flood-prone areas.
c. **Shared Goals:** Strengthen decision-making through tailored regional and local practical solutions, and establish consistent national guidelines for managing coastal flood risks.

Diverging Views: Coastal Flooding

a. **Accessible Coastal Standards**:
   - **Diverging Views**: Developers and practitioners might prioritize technical precision, while communities may favor simpler, accessible products. This could create tension between clarity versus comprehensibility.
   - **Reconciliation**: Collaborative development of standards where technical experts work alongside community representatives to create materials that balance simplicity with accuracy.

b. **Risk Assessment and Site-Specific Solutions**:
   - **Diverging Views**: Urban planners might focus on large-scale, one-size-fits-all solutions, while communities may demand more localized, tailored approaches.
   - **Reconciliation**: A flexible approach that combines national guidance with community-level customization, encouraging local involvement in identifying risk and crafting solutions.

c. **Cost-Benefit Tools and Green vs. Grey Solutions**:
   - **Diverging Views**: Environmental groups may favor green infrastructure, while funders and asset owners may prioritize grey infrastructure due to its perceived cost-effectiveness.
   - **Reconciliation**: Development of hybrid models that blend both approaches, with clear, transparent cost-benefit analysis frameworks to show the long-term value of green infrastructure.

Key research priorities and guidance need to support development of resilient coastal infrastructure in Canada that were identified by workshop participants include:

1. **Accessible Coastal Standards:** Developing user-friendly products such as guidebooks, case studies, and best practices to make coastal standards more accessible to diverse audiences.
2. **Training and Capacity Building:** Offering training for both communities and practitioners. This includes teaching communities to identify their needs, particularly for green infrastructure solutions, and equipping practitioners with the skills to implement these solutions.
3. **Risk Assessment and Site-Specific Solutions**: Research into understanding the level of risk in various coastal areas and providing tailored solutions, including the possibility of managed retreat in some locations. Site-specific roadmaps or processes are needed to guide decision-making.
4. **Tools and Resources:** Expanding the availability of accessible tools, such as the Environment and Climate Change Canada (ECCC) adaptation map, to aid in decision-making, along with more integrated, community-specific risk assessment tools, especially for small coastal communities.
5. **Vulnerable Communities:** Focusing on the impacts of climate resilience strategies on vulnerable communities, including considerations of socio-economic disparities, particularly between low-income historical dwellings and vacation homes.
6. **Case Studies and Pilot Projects:** Developing and disseminating case studies that show adaptation strategies for buildings, especially in relation to storm surge risks and safety hazards (e.g., basement flooding). Pilot projects can facilitate learning and offer practical examples.
7. **Cost-Benefit Tools and Green vs. Grey Solutions**: Creating tools to assess the cost-effectiveness of green versus grey infrastructure solutions, helping communities understand the trade-offs involved, such as incremental costs.
8. **National Guidance and Risk Assessment Standards**: Establishing national guidance on risk assessments with consistent terminology and definitions to support municipalities. This includes asset-specific guidance for coastal infrastructure, considering the impacts on local livelihoods, tourism, and property values.
9. **Pollution and Salinity Risks:** Research into pollution hazards from storm surges and the cascading effects of salinity changes, including their impact on coastal ecosystems and infrastructure.
10. **Wind and Coastal Flooding:** Investigating the impact of wind on coastal flood extents, the uncertainty around timelines for climate impacts, and balancing costs for risk resilience with shared socio-economic pathways.
11. **Coastal Erosion Management:** Developing guidance on safely managing coastal erosion, recognizing the coast as a valuable asset to be protected while allowing for natural processes.

Urban Flooding

Definition of Topic: Urban flooding refers to the inundation of urban areas due to an excess of water that the drainage systems are unable to handle. This can be caused by heavy rainfall, poor drainage infrastructure, rapid urbanization, or even blockages in stormwater systems. In cities, the high surface area occupied by buildings, roads, and other impervious surfaces means that water has fewer places to absorb into the ground, leading to faster and higher volume of runoff, leading toa higher risk of flooding. Urban flooding can disrupt daily life, damage property, affect transportation networks, and pose health and safety risks to residents. It is becoming more frequent in some areas due to climate change, which can lead to more intense and unpredictable rainfall events.

Consensus Outcomes: Urban Flooding

a. **Key Priorities:** Accelerate adoption of resilience measures through regulation and incentives, develop equitable mitigation strategies, and address knowledge gaps in hazard mapping and modeling.
b. **Common Challenges:** Overcome financial and regulatory barriers and addressing gaps in flood hazard data, particularly for smaller municipalities.
c. **Shared Goals:** Increase flood resilience adoption, enhance knowledge-sharing, and build inclusive strategies to protect vulnerable groups.

Diverging Views: Urban Flooding

a. **Regulation and Incentives:**
   - **Diverging Views:** Municipalities and private developers may resist stringent regulations, citing increased costs, while environmental groups and vulnerable communities push for stronger resilience measures.
   - **Reconciliation:** Offering financial incentives and phased implementation schedules could balance the need for resilience with the financial capabilities of municipalities and developers.

b. **Equity and Vulnerability:**
   - **Diverging Views:** Property owners in wealthier areas might resist changes that would disproportionately impact their land value, while marginalized communities may push for more inclusive measures.
   - **Reconciliation:** Implementing equity-based policies that prioritize vulnerable areas, while offering financial mechanisms (e.g., subsidies or grants) to ensure the wealthier communities also contribute.

c. **Financing and Adaptation Measures:**
   - **Diverging Views:** Local governments and private organizations may argue against the burden of funding resilience measures, whereas environmental organizations and disadvantaged communities may stress the urgency of investment.
   - **Reconciliation:** Public-private partnerships and cost-sharing models can help distribute the financial burden more evenly, coupled with clear financial incentives and rebates.

Gaps and priorities related to urban flooding emphasize the need for integrated, equity-focused, and incentivized approaches to building climate resilience, with an emphasis on knowledge-sharing, regulatory improvements, and financial support for adaptation. These include:

1. **Regulation and Incentives**: There is a need to accelerate the adoption of resilience measures through better regulation and financial incentives. Many interested parties, including builders, homeowners, and municipalities, face barriers like lack of funding and no clear incentives for implementing resilience measures.
2. **Knowledge Gaps and Guidance**: A major gap is the lack of technical knowledge and clear guidance on topics like "build back better," flood hazard mapping, and modelling for pluvial flood hazards. Additionally, there is a need for improved understanding of how water flows in homes and effective flood mitigation strategies.
3. **Equity and Vulnerability**: Marginalized communities, including low-income groups, are disproportionately impacted by flooding. There is a pressing need for equitable flood mitigation strategies, liability equity, and solutions to ensure that people, particularly those without access to insurance, are protected.
4. **Home Resilience Rating System**: Establishing a home resilience rating system that is linked to broader community resilience frameworks is crucial. This could incentivize homeowners to take resilience actions, especially if it is backed by insurance discounts or rebates.
5. **Data and Mapping**: Updated and comprehensive flood hazard data, along with better tools for municipalities to model and map flood risks, are essential. This includes more accurate pluvial flood hazard mapping and flood exposure reduction strategies.
6. **Partnerships and Information Mobilization**: Mobilizing knowledge and resources effectively to key audiences, such as municipalities, insurers, professional associations, and homeowners, is necessary. Partnerships with organizations like Home Depot and banks can help bring resilience information to the public, especially in smaller municipalities that lack resources.
7. **Transparency and Risk Communication**: Greater transparency about risks and better communication on risk exposure are needed to drive better decision-making in the market and among policymakers. Communities must have access to site-specific risk information, including flood maps and cost-benefit data for resilience measures.
8. **Building Codes and Procurement**: Aligning building codes with resilience objectives is critical, with insurance companies potentially playing a role in lobbying for such changes. Municipal procurement practices also need to be adjusted to prioritize climate adaptation and green infrastructure.
9. **Financing and Adaptation Measures**: Government funding for housing and infrastructure must consider flood risks, and financing for adaptive measures needs to be integrated into asset management discussions. Standardized measures with financial incentives, such as rebates or "resilience discounts," should be developed to encourage adoption.
10. **Managed Retreat and Jurisdictional Coordination**: Developing standards for managed retreat from high-risk flood zones and ensuring that planning and guidance are coordinated across jurisdictions will help manage climate risk more effectively.

Extreme Heat

Definition of Topic: Extreme heat refers to periods of unusually high temperatures that significantly exceed the average for a given region, often posing risks to human health, the environment, and infrastructure. This can include heatwaves or sudden, intense spikes in heat. Extreme heat events can lead to heat-related illnesses like heatstroke, dehydration, and heat exhaustion, particularly affecting vulnerable populations such as the elderly, children, and those with pre-existing health conditions. Additionally, extreme heat can strain energy systems, damage crops, and increase the risk of wildfires. Climate change is expected to make extreme heat events more frequent and severe in Canada.

Consensus Outcomes: Extreme Heat

a. **Key Priorities:** Develop cooling solutions, promote green infrastructure, create guidelines for adaptation strategies, and protect outdoor workers.
b. **Common Challenges:** Limited understanding of the long-term health effects of heat, especially on vulnerable populations.
c. **Shared Goals:** Promote cooling measures, improve heat resilience, and ensure access to adaptive resources for all communities.

Diverging Views: Extreme Heat

a. **Urban Heat Island Mitigation:**
   - **Diverging Views:** Developers may be reluctant to change land use and building codes due to increased costs, while environmental advocates emphasize the need for immediate intervention to address heat-related health impacts.
   - **Reconciliation:** Incremental policy changes that allow for phased adaptation, paired with incentives for green infrastructure, can help mitigate concerns over costs while promoting health benefits.

b. **Water Reuse:**
   - **Diverging Views:** Industry may see water reuse as technically challenging and expensive, while communities facing water scarcity may push for quick implementation.
   - **Reconciliation:** Providing clear guidelines on cost-effective, scalable water reuse solutions, and creating pilot programs that demonstrate the feasibility of such systems.

c. **Indoor Cooling Design:**
   - **Diverging Views:** Architects and building owners may prioritize energy use, aesthetic or cost concerns, while public health experts stress the importance of cooling measures for vulnerable populations.
   - **Reconciliation:** Collaboration between health experts and architects to create designs that balance resilience, comfort, and cost-effectiveness with potential subsidies or incentives for retrofitting existing buildings.

Participants identified several key needs and focus areas for improving the effectiveness and equity of climate adaptation measures, particularly in relation to urban heat islands, cooling solutions, and water management. These include:

1. **Cooling Measures:** There is a need for comprehensive guidance on the installation and design of cooling stations, including indoor temperature and humidity thresholds, the use of natural infrastructure, and health monitoring for user's post-use.
2. **Urban Heat Island Mitigation:** Guidance is required on modifying by-laws to allow for more natural and complex yards that can mitigate urban heat islands. This could involve adaptive reuse of spaces and incorporating green infrastructure.
3. **Water Reuse:** Standardization of water reuse practices (e.g., greywater collection, blue roofs) is important, with a particular focus on water storage to enhance climate resilience.
4. **Urban Forests:** Tools and guidelines are needed to maximize the heat-reducing impact of urban forests while considering equity and resilience. This includes identifying the best tree planting locations and species composition to address urban heat islands and support vulnerable populations.
5. **Decision-Maker Knowledge:** Improving the literacy of decision-makers, such as municipalities, to better assess adaptation proposals and develop questions to guide consultations will improve decision-making for climate resilience.
6. **Practical Guidelines for Adaptation Consultants:** Clear and actionable guidelines are necessary to support consultants in implementing effective adaptation measures.
7. **Outdoor Worker Safety:** A risk-based framework to respond to heat waves and safeguard outdoor workers' health, incorporating temperature thresholds and existing provincial regulations, is a priority.
8. **Case Studies:** More case studies are needed to showcase successful implementation of climate adaptation measures and their effectiveness.
9. **Systems-Level Tools:** Tools to assess the costs, benefits, and knock-on effects of different climate adaptation measures are essential for informed decision-making.
10. **Indoor Cooling Design:** Designing cooling spaces inside buildings to improve indoor temperature management is crucial, especially in the context of climate risks.
11. **Building Resilience During Power Outages:** Retrofitting buildings to reduce health risks during heat waves, especially during power outages, is a key concern. This includes addressing the limited generator capacities in many buildings.
12. **Climate Risk Mitigation Prioritization:** Tools are needed to help prioritize climate risk mitigation measures in building design, considering multi-hazard scenarios and trade-offs.
13. **Climate Risk Decision-Making:** A decision-making tool is needed to evaluate climate resilience strategies based on cost-benefit trade-offs, such as designing for 85% versus 100% resilience.
14. **Long-Term Health Impacts of Heat:** Research is needed to understand the long-term health effects of extreme heat, particularly on vulnerable populations.
15. **Indoor Temperature Studies:** A comprehensive compilation of studies on indoor temperatures, combining data from different locations, will help guide building design and adaptation efforts.
16. **Drought and Water Supply**: Research on the impact of drought on water use, particularly groundwater supply and aquifer stress, is essential for sustainable water management.

17. **Urban Vegetation Resilience**: Understanding urban vegetation's resilience to drought and its role in cooling is necessary to inform landscaping and tree planting decisions that maximize long-term climate resilience.
18. **Customer Journey in Adopting Guidance**: Research to map the customer "journey" and identify key decision points will help identify barriers to adopting climate adaptation guidance and improving uptake.
19. **Unintended Consequences of UHI Reduction**: Investigating the potential negative impacts of urban heat island reduction measures, such as the unintended effects of white roofs on building performance, is important.
20. **Asset and Hazard Thresholds**: Identifying risk thresholds for different assets and hazards across communities will aid in more targeted climate adaptation strategies.

Permafrost Thaw

Definition of Topic: Permafrost thaw refers to the process of the gradual melting of permanently frozen soil, rock, and organic material found in polar and high-altitude regions. Permafrost typically remains frozen year-round, but as global temperatures rise due to climate change, it begins to thaw. This can have significant environmental and structural consequences, as thawing permafrost can release large amounts of greenhouse gases like carbon dioxide and methane that were previously trapped in the frozen soil. It can also destabilize the ground, leading to the collapse of buildings, roads, and other infrastructure. Thawing permafrost affects ecosystems, alters hydrological patterns, and accelerates the overall impacts of climate change.

Consensus Outcomes: Permafrost Thaw

a. **Key Priorities:** Address data gaps, engage communities in adaptation planning, and create sustainable financial models for northern regions.
b. **Common Challenges:** Lack of local expertise and challenges in conveying technical solutions to northern communities.
c. **Shared Goals:** Improve data accessibility, strengthen local capacity, and integrate community input into adaptation strategies.

Diverging Views: Permafrost Thaw

a. **Data Gaps and Accessibility:**
   - **Diverging Views:** Scientists may push for more data collection, but remote communities could be wary of external researchers or lack the technical capacity to engage with data.
   - **Reconciliation:** Ensuring OCAP (ownership, control, access, and possession) principles are followed, local communities are involved in the data collection process, with training provided on how to interpret and use the data for localized decision-making.

b. **Infrastructure and Climate Change Challenges:**
   - **Diverging Views:** Governments may resist the high cost of retrofitting infrastructure in northern regions, while local communities face the immediate impact of climate change on their infrastructure.
   - **Reconciliation:** Engaging in joint planning with local communities to prioritize infrastructure investments and seek targeted funding or incentives from the government.

c. **Funding and Costing Models:**
   - **Diverging Views:** Governments and financial institutions may be reluctant to allocate sufficient resources to northern infrastructure, while communities demand urgent funding for adaptation.
   - **Reconciliation:** Collaborative funding models that combine government support, private investment, and community-based initiatives to ensure sufficient financial resources for climate adaptation.

Gaps identified in the area of permafrost thaw emphasize the need for a holistic, community-centered approach that includes more local expertise, improved data collection and sharing, better communication, and targeted financial and technical support for northern infrastructure projects. These include:

1. **Data Gaps and Accessibility**:
    - There is a lack of comprehensive, accessible data, especially for remote northern communities. Issues include the absence of permanent data ownership and databases that remain within communities (e.g., water, soil, permafrost depth, subsurface geology).
    - The need for data on local conditions (e.g., permafrost characteristics, soil data) and methodologies to interpret and make it publicly available is emphasized.
2. **Infrastructure and Climate Change Challenges:**
    - The impact of climate change on infrastructure, especially in northern regions (e.g., thawing of winter roads, water sources like wells and rivers), remains a critical concern. Future challenges include ensuring continued access to these infrastructures during changing climates.
3. **Local Capacity and Expertise**:
    - There is a shortage of local experts, particularly in fields like engineering, which is exacerbated by insufficient local or regional training opportunities.
    - Northern communities need tailored resources that reflect their specific conditions, with a focus on community-based designs and solutions.
4. **Community Engagement and Communication**:
    - Northern communities are not always connected or informed about the technical solutions that are being applied to their infrastructure, and there is a need for clearer communication and streamlined information-sharing.
    - Ensuring that community voices, especially from the north, are central to the development of infrastructure solutions is crucial, rather than imposing solutions from southern experts who may not fully understand local needs.
5. **Funding and Costing Models**:
    - There is a lack of understanding about costing models, financial incentives, and how to support communities with the resources needed for implementing climate-resilient infrastructure.
6. **Tools for Risk Assessment and Retrofitting**:
    - The need for quick, efficient assessments of existing infrastructure to support retrofitting is critical, especially with a focus on mapping key risks to available tools and solutions.
7. **Toolkit and Collaboration**:
    - A priority is the development of toolkits for project managers, as well as establishing communities of practice that can foster shared learning and support the development of best practices for infrastructure resilience in northern communities.

High Winds

Definition of Topic: High winds refer to wind speeds that are significantly stronger than typical or average conditions, often associated with severe weather events like storms, hurricanes, or tornadoes. These winds can reach speeds of 39 miles per hour (63 kilometers per hour) or higher, and can cause extensive damage to infrastructure, trees, power lines, and vehicles. High winds can also lead to dangerous conditions such as flying debris, downed trees, and power outages, and they can amplify the destructive effects of storms. In the context of climate change, high winds may become more frequent or intense in certain areas due to changes in weather patterns and the increasing severity of extreme weather events.

Consensus Outcomes: High Winds

a. **Key Priorities:** Retrofit existing buildings for wind resilience, create wind resistance standards, improve hazard mapping, and protect emergency routes.
b. **Common Challenges:** Retrofitting costs and the lack of qualified contractors, along with inconsistent access to resilient products.
c. **Shared Goals:** Strengthen resilience in buildings and infrastructure, enhance data for risk assessments, and promote wind resistance across various structures.

Diverging Views: High Winds

a. **Insurance and Incentives:**
   - **Diverging Views:** Homeowners may resist proactive resilience measures, believing insurance will cover them after a disaster, while insurers and regulators push for stricter standards.
   - **Reconciliation:** Creating incentives for homeowners to take pre-emptive action, such as insurance discounts or rebates for retrofitting, alongside clearer communication about the risks of waiting for insurance payouts.

b. **Wind Resistance Standards:**
   - **Diverging Views:** Builders and developers may resist more stringent wind load standards due to cost concerns, while climate adaptation experts stress the necessity of these standards to reduce future disaster costs.
   - **Reconciliation:** Gradual implementation of stricter wind resistance standards, coupled with financial incentives or rebates to help offset additional costs for builders and homeowners.

c. **Trees and Urban Vegetation:**
   - **Diverging Views:** There may be conflicts between the need for trees to provide cooling and the need to minimize wind risk, particularly in urban planning.
   - **Reconciliation:** Urban tree planning that increases functional diversity to increase the urban forest's resilience to multiple climate hazards (e.g., high wind, flooding, ice and pests) and strategic placement to balance both needs.

Overall, identified gaps related to high wind suggest a need for improved guidance, standardized resilience measures, and better incentives to ensure that infrastructure and buildings are adequately prepared for the increasing impacts of climate change. These include:

1. **Existing Buildings:**
   - **Building Evaluation and Retrofitting**: Many existing buildings, particularly older ones that predate national building codes, may not be adequately resilient to climate risks. Structural evaluations, especially for wind resistance, are needed. Retrofitting these buildings is challenging, requiring cost-benefit analyses to justify investments. There is a need for guidance on appropriate retrofits, access to qualified contractors, and the development of a registry for these service providers. Additionally, integrating resilience into existing energy efficiency programs could help incentivize upgrades.
   - **Insurance and Incentives**: Home and business owners may not prioritize proactive measures if they believe insurance will cover disaster recovery. However, this often results in rebuilding to the previous standards rather than upgrading resilience. Clear incentives, financing models, and insurance reform are needed to encourage proactive action.
   - **Structural vs. Behavioral Adaptations**: Preparing for major storms involves not only physical building improvements but also behavioral adaptations, such as securing outdoor items to prevent flying debris.
2. **Products and Certifications:**
   - **Regional Variations**: There is a gap in the availability of resilient products across different regions, with some areas relying on less resilient solutions like asphalt shingles rather than metal roofs. Products need to be better aligned with regional risks.
   - **Wind Resistance Standards**: A need exists for wind load requirements that consider extreme winds, especially for windows and roofing in regions prone to hurricanes, such as Atlantic Canada. Programs like the IBHS' Fortified Home program in the U.S. could serve as a model for improving wind resilience.
   - **Resilience Rating Systems**: Developing a resilience rating system similar to "Energy Guide" could help provide clear guidelines for improving resilience in homes and buildings.
3. **Trees**:
   - **Urban Trees and Conflicting Priorities**: Trees contribute to urban heat reduction, but may conflict with other needs, such as wildfire prevention and wind risk mitigation. Better planting strategies, including consideration of tree functional groups, health, and strategic planting location are needed to optimize their benefits and long-term survival in urban settings.

4. **Systems**:
    - **Electrical Infrastructure**: High winds can damage aboveground power lines, leading to power outages that exacerbate other weather-related risks. Decisions about whether to place lines above or below ground need to consider resilience, costs, and seismic risks.
    - **Debris and Emergency Routes**: Large debris from damaged infrastructure can block emergency routes. Additionally, even if one building is resilient, nearby structures may become sources of impact debris.

5. **Data and Modeling**:
    - **Improved Hazard Mapping and Data**: Accurate modeling of high winds, tornadoes, and hurricanes is difficult, and there is a need for better data on storm surge, wind speeds, and their relationship to other hazards. Hazard maps specific to wind and urban challenges (such as windy corridors) are needed.
    - **Cost-Benefit Analysis**: Tools to assess the cost-effectiveness of different adaptation measures, along with decision making frameworks, are critical. This would help prioritize interventions and avoid conflicts between different resilience measures.

6. **General Issues:**
    - **Comprehensive Hazard Considerations**: High winds should be considered alongside other climate hazards, such as flooding, storm surges, ice, and snow, as they often occur in tandem.
    - **Pressure to Build Quickly**: The demand for rapid, low-cost construction can conflict with the time needed for proper climate adaptation assessments. More time is needed to evaluate and implement effective resilience measures.
    - **Regulatory Barriers**: Existing regulatory frameworks sometimes limit the use of innovative resilience measures by enforcing minimum standards that do not accommodate new or better solutions. Flexibility in regulations is needed to foster innovation.

Wildfire

Definition of Topic: A wildfire is an uncontrolled, rapidly spreading fire that typically occurs in natural areas like forests, grasslands, or savannas, but can also affect urban or rural areas. Wildfires can be ignited by various factors, including lightning strikes, human activities (such as campfires, discarded cigarettes, or arson), and extreme heat. These fires spread quickly due to dry vegetation, high winds, and steep terrain. Wildfires can cause significant damage to ecosystems, property, and communities, and pose serious risks to human health and safety through smoke inhalation and direct exposure to flames. Climate change, with its increasing temperatures and prolonged droughts, is expected to contribute to the frequency and intensity of wildfires in many regions around the world.

Consensus Outcomes: Wildfire Management and Mitigation

a. **Key Priorities:** Develop wildfire risk guidelines, improve public awareness, standardize post-fire assessments, and enhance fire management policies.
b. **Common Challenges:** Limited detailed wildfire risk maps, lack of standardized fire-resistant materials, and insufficient public awareness of fire codes.
c. **Shared Goals:** Build resilience against wildfires, integrate international best practices, and address wildfire smoke impacts on vulnerable populations.

Diverging Views: Wildfire Management

a. **Land Use and Building Codes:**
   - **Diverging Views:** Some organizations focus on improving land use policies and creating more stringent building codes for wildfire-prone areas. On the other hand, there may be opposition from local governments or developers who feel that imposing such stringent measures could restrict growth and raise costs.
   - **Reconciliation:** Interested parties can work together to create guidelines that offer flexibility while still ensuring safety. A balanced approach that combines local knowledge with broader regional standards can be established.

b. **Local Authority Empowerment:**
   - **Diverging Views:** There's a divide on the amount of power local authorities should have. Some believe in empowering local governments to address wildfire risks due to their local knowledge, while others argue for more centralized control to ensure consistency and prevent regulatory fragmentation.
   - **Reconciliation:** Financial incentives for developers and homeowners to adopt fire-resistant materials and practices may help reduce resistance.

Overall, the gaps identified by participants in relation to wildfire highlight the need for more comprehensive guidelines, education, risk mapping, and improved wildfire management policies to build resilience and mitigate wildfire risks effectively. These include:

1. **Guidelines and Education:**
   - **Land Use and Hazard Guidance**: Clearer guidelines are needed for land use in wildfire-prone areas, particularly in relation to community landscape design to mitigate wildfire risks.
   - **Education for Builders and Homeowners**: There is a significant need for better education **for** builders on adopting crucial wildfire risk mitigation measures and for homeowners to increase their understanding of wildfire risks and mitigation strategies.
   - **Building Materials**: More fire-resistant building materials are needed, and standardization in post-fire forensic assessments should be developed.
   - **Retrofitting and Public Awareness**: Guidance is required on retrofitting homes to withstand wildfires. Additionally, practical training, public awareness campaigns, and education on fire codes, regulations, and mitigation strategies are essential.
2. **Risk Mapping and Planning:**
   - **Wildfire Risk Mapping**: More detailed and accessible wildfire risk maps are needed, along with greater attention to forest modeling and future wildfire projections.
   - **Severity of Wildfires**: Understanding the role of duff and litter layers in wildfire intensity and spread requires further research.
3. **Post-Wildfire Response:**
   - **Post-Fire Safety**: Safe access to buildings post-wildfire, especially in severely impacted areas, needs attention.
   - **Forensic Assessments and Road Safety**: Standardization of post-fire forensic assessments and the need for safety measures on roads during and after wildfires are identified.
   - **Cascade Effects**: Further research into cascading wildfire-related effects, such as socio-hydrological contamination and ecological damage, is necessary.
4. **Wildfire Management and Regulations:**
   - **Building Codes and WUI**: There is a call for a more standardized and clear approach to integrating wildfire resilience into building codes and addressing the wildland-urban interface (WUI).
   - **Fire Risk Modeling Tools**: The development of better tools for wildfire resistance modeling and assessing building fire resistance is required.
   - **Local Authority Empowerment**: Local authorities should be given more authority in managing fire risks.
5. **Approaches from Other Nations/Regions:**
   - **International Best Practices**: Approaches from California's Chapter 7A building code, BC's wildfire interface management, and UBC's monitoring projects offer valuable insights.
   - **New Regulations**: BC's new developer permit laws focus on high-risk areas, emphasizing local authority involvement, while the building code's lack of focus on hail risks needs to be addressed.

6. **Identified Gaps in Wildfire Management:**
    - **Health and Vulnerability**: The health impacts of wildfire smoke, particularly on vulnerable populations, need more focus. Attention should also be given to health concerns related to wildfire contaminants and fire suppression chemicals.
    - **Emergency Management**: Guidelines are required for creating cooling stations during heatwaves and for post-wildfire re-entry and evacuation plans.
    - **Community and Building Resilience**: Expanding FireSmart programs, community resilience ratings, and home resilience rating systems for better preparedness and insurance evaluation is necessary. New community developments should not increase wildfire risks for existing communities.
    - **Policy, Regulation, and Funding**: There is a need for more effective regulation, awareness campaigns, and post-action funding for learning from past responses to wildfires.
    - **Insurance and Fire Management**: Changes in insurance policies and better understanding of how small measures, like moving patio furniture, can influence insurance rates are required. Barriers to implementing FireSmart measures, such as privacy concerns and the desire for shade, should be addressed.

Decarbonization

Definition of Topic: Decarbonization refers to the process of reducing or eliminating carbon dioxide (CO2) and other greenhouse gas emissions from various sectors, such as energy, transportation, industry, and agriculture, in order to combat climate change. The goal of decarbonization is to transition to a low-carbon economy by shifting away from fossil fuels (like coal, oil, and natural gas) and replacing them with renewable energy sources (such as solar, wind, and hydropower) and energy-efficient technologies. This also involves adopting practices like carbon capture and storage, reducing waste, and improving energy efficiency in various industries. Achieving decarbonization is crucial to meeting international climate goals, such as those outlined in the Paris Agreement, to limit global warming and mitigate the impacts of climate change.

Consensus Outcomes: Decarbonization and Climate Action

a. **Key Priorities:** Transition to low-carbon systems, promote whole life-cycle analysis, and encourage interdisciplinary approaches to decarbonization.
b. **Common Challenges:** Integrating decarbonization into existing policies and filling gaps in financial models for sustainable housing.
c. **Shared Goals:** Achieve net-zero emissions, incorporate carbon-conscious decisions, and foster collaboration between public and private sectors for decarbonization.

Diverging Views: Decarbonization and Climate Action

a. **Cost vs. Sustainability:**
   - **Diverging Views:** There's often a tension between the immediate costs of implementing decarbonization measures and the long-term sustainability benefits. Industries and municipalities may argue that the upfront investment is prohibitive.
   - **Reconciliation:** Based on a Long-Term Cost-Benefit Analysis, interested parties could focus on demonstrating the long-term financial savings and societal benefits of decarbonization, such as reduced healthcare costs and greater energy independence.

b. **Private Sector vs. Government Role:**
   - **Diverging Views:** There is debate on whether the private sector should lead decarbonization efforts, or if government should take a more active role in driving regulation and financial incentives.
   - **Reconciliation:** A combination of private sector innovation and government regulation and financial support could be used to address the cost concerns and drive widespread adoption, such as Public-Private Partnerships.

Key areas identified on the topic of decarbonization underscore the importance of interdisciplinary collaboration, long-term thinking, and integrated approaches to address climate-resilient infrastructure challenges. These include:

1. **Decarbonization and Climate Action**:
   - Focus on transitioning to low-carbon, resilient systems in sectors like buildings, transportation, and waste management.
   - Emphasize the importance of addressing embodied and operational carbon in infrastructure, utilizing whole life-cycle analysis to promote sustainability, and integrating decarbonization with broader societal benefits such as health, housing, and energy security.
   - Support the development of Environmental Product Declarations (EPDs) and other tools to compare embodied carbon of materials.

2. **Net-Zero Water and Wastewater Management**:
   - Address emissions mitigation (e.g., methane, nitrous oxide) from wastewater systems and challenges in measuring and standardizing these emissions.
   - Drawing on international examples (Australia, the EU, Singapore) to achieve net-zero water systems.
   - The Canadian Water Network (CWN) works on measuring and mitigating fugitive methane and nitrous oxide emissions from wastewater. Recent analysis cited by the World Economic Forum suggests that global wastewater emissions are on par with total emissions from the world's shipping industry. CWN's Net Zero Water project, funded by Environment and Climate Change Canada, will develop a made-in-Canada pathway to net zero for the water sector, engaging Canada's largest municipal water utilities, cleantech network and private sector innovation partners.

3. **Carbon Data and Lifecycle Analysis**:
   - Strengthen the collection and use of carbon data throughout product and project lifecycles, with particular attention to embodied carbon, which requires standardized Product Category Rules (PCRs).
   - Bridge data collection gaps during construction and operations (A4, A5 stages).
   - Improve access to standardized and comparable carbon data to support material selection, policy development, and performance benchmarking.

4. **Policy, Regulation, and Decision-Making**:
   - Address challenges in integrating decarbonization into municipal and federal policies, advocating for performance-based standards and procurement practices.
   - Recognize the influence of political cycles on sustainability goals and incorporate carbon footprint metrics into financial models and budgets.

5. **Financial Models and Incentives**:
   - Shift focus from initial cost evaluation to lifecycle costs and total cost of ownership.

- Introduce financial incentives for sustainable housing, such as preferential mortgage rates, and encourage collaboration between government and the private sector to fund decarbonization efforts.

6. **Knowledge Gaps and Education**:
   - Enhance knowledge translation to audiences such as architects, developers, municipalities, and homeowners.
   - Invest in retooling the current workforce and preparing future generations for sustainable design and building practices while increasing public awareness of carbon-conscious decisions.
   - Education efforts should reflect both Western science and Indigenous knowledge systems, where appropriate.
   - Establish a multilingual, regionally tailored knowledge hub for guidance documents, technical resources, case studies, and tools to support practitioners in making low-carbon, resilient construction decisions.

7. **Resilience and Adaptation**:
   - Balance the need for rapid construction with long-term resilience and sustainability, focusing on innovations in materials and prefabrication.
   - Incorporate mitigation and resilience considerations into cost models, particularly for housing.

8. **Housing and Indigenous Communities**:
   - Address affordable housing challenges, ensuring energy efficiency and resilience, and adopt culturally sensitive approaches to infrastructure development in Indigenous communities.
   - Integrate climate goals with broader community needs, such as jobs, health, and food security, to avoid siloed approaches.

9. **Waste Management and Energy**:
   - Promote recycling and circular economy approaches in water and energy management.
   - Leverage waste as an untapped resource for energy recovery and sustainability.

10. **Systems Thinking and Interconnected Solutions:**
    - Recognize the interdependencies between decarbonization, climate action, and social factors, moving away from siloed objectives to holistic solutions.
    - Strengthen regulatory frameworks and prioritize systemic approaches to meet climate goals.

Data

Definition of Topic: Data refers to raw facts, figures, or information that can be collected, analyzed, and interpreted to gain insights or make decisions. It can come in various forms, such as numbers, text, images, audio, or video, and can be structured (organized in a specific format like databases or spreadsheets) or unstructured (more free-form, like social media posts or emails). Data is crucial in many fields, including science, business, healthcare, and technology, as it provides the foundation for analysis, trends, and patterns that help inform strategies, solutions, and discoveries. With advancements in technology, data is being generated at an increasingly rapid pace, leading to the rise of fields like big data and data science.

Consensus Outcomes: Data Collection, Management, and Sharing

a. **Key Priorities:** Establish standardized data collection systems, improve data sharing, and ensure inclusivity in data practices.
b. **Common Challenges:** Lack of standardized data management systems and gaps in data governance, especially regarding ownership and privacy.
c. **Shared Goals:** Standardize hazard data collection, improve access to information, and develop comprehensive databases to support climate resilience planning.

Diverging Views: Data Collection, Management, and Sharing

a) Centralized vs. Decentralized Data Systems:

- **Diverging Views:** Some organizations argue for a centralized, national database to standardize climate data, while others worry about the administrative burden and advocate for decentralized data systems that allow local customization.
- **Reconciliation:** A hybrid model of centralized standards with decentralized implementation may help accommodate both local specificity and the need for nationwide consistency.

b) Data Inclusivity:

- **Diverging Views:** There's a divide between those calling for more culturally inclusive data collection that reflects diverse communities and those who feel that this approach may complicate the data gathering process.
- **Reconciliation:** After an Inclusive Data Guidelines, efforts should be made to create data collection
  standards that explicitly include cultural considerations while maintaining usability and relevance across all sectors.

Overall, data-related gaps and priorities underscore the need for standardized data, improved governance, and better data sharing systems to support climate-resilient infrastructure in Canada. These include:

1. **Data Collection and Management**
   - **Clear, reliable, and defined data**: There is a need for consistent, high-quality data for assessing climate impacts, particularly in resilience and mitigation efforts. Defining standards for data collection will help ensure its relevance and reliability.
   - **Cultural inclusivity**: The lack of culturally sensitive data undermines the inclusivity and relevance of climate information, requiring attention to diversity in data gathering.
   - **Updating and certification**: Official climate data may be outdated, and there is a need for guidelines to certify the quality of proprietary data sources.
   - **Forensic assessments**: Standardizing post-climate event forensic assessments can provide valuable insights into the real-world impacts and recovery processes, helping to inform future resilience strategies.

2. **Data Sharing**
   - **Centralized database**: A robust, centralized database encompassing hazard data at all levels, from local to national, is needed to standardize content, measurements, and accessibility.
   - **Improved government communication**: Enhancing inter- and intra-governmental data sharing and communication will be vital, especially in the absence of a centralized climate data repository.
   - **Case studies for adoption**: A centralized databased of adaptation case studies can help demonstrate the practical benefits of standardized data sharing, encouraging wider adoption of guidelines.
   - **Knowledge translation**: Efforts to make data more accessible and digestible to a broader range of audiences—leveraging multi-faceted strategies—are critical. Insights from sectors like healthcare on operationalizing effective data awareness could be useful.

3. **Data Governance and Interoperability**
   - **Standardization of data management**: Defining standards for data collection, analysis, and interpretation, along with metadata standardization, is essential for local governments to better utilize data for climate action.
   - **Data ownership protections**: Clear standards on data ownership would help protect vulnerable populations, safeguard against unauthorized use, and mitigate unintended consequences of data misuse. Data ownership should be built into individual standards, to ensure consistent consideration and implementation.
   - **Asset lifecycle standards**: A standardized approach to measuring and managing assets throughout their lifecycle will support climate resilience and facilitate the creation of business cases that justify climate mitigation investments.

4. **Specific Hazards and Asset Types**
   - The discussion highlighted key hazards and asset types requiring targeted attention, including:
     - Groundwater/aquifer monitoring
     - Marine flooding and flood mapping
     - Public drainage systems
     - Hail impact

Emergency Management

Definition of Topic: Emergency management refers to the coordinated efforts and strategies used to prepare for, respond to, mitigate, and recover from emergencies or disasters. This can include natural disasters (like hurricanes, earthquakes, and floods), man-made events (such as industrial accidents or terrorism), and public health crises (like pandemics). The goal of emergency management is to minimize the impact of these events on people, property, and communities. It involves four key phases:

- **Mitigation:** Reducing or eliminating risks before a disaster occurs.
- **Preparedness:** Planning and training to ensure communities are ready to respond.
- **Response:** Actions taken during and immediately after a disaster to protect lives and property.
- **Recovery:** The process of rebuilding and restoring normalcy after a disaster.

Effective emergency management involves collaboration between government agencies, first responders, communities, and organizations, as well as the use of technology and data to guide decision-making and improve response efforts.

Consensus Outcomes: Emergency Management and Resilience

a. **Key Priorities:** Shift to flexible emergency infrastructure, involve communities (including Indigenous populations), access to more data, mappings and forecasts (climate change, past crises and past responses), and focus on long-term resilience through "build back better."
b. **Common Challenges:** Coordination gaps between agencies, and need for better training to handle simultaneous crises.
c. **Shared Goals:** Strengthen community resilience, improve emergency management infrastructure, and integrate cross-disciplinary approaches to adaptation and mitigation.

Diverging Views: Emergency Management and Resilience

a. Indigenous Involvement:

- **Diverging Views:** Some view Indigenous communities' involvement in emergency management as essential, respecting their self-determination and incorporating traditional knowledge. Some want prescriptive, proactive detailed guidance, whereas others were asking for the communities to have the right to develop their own plans, so less prescriptive.
- **Reconciliation:** Engage Indigenous leaders in discussions to co-develop emergency management frameworks that integrate both traditional knowledge and modern practices.

b. Infrastructure Flexibility:

- **Diverging Views:** There's debate about the level of emphasis on flexible, portable infrastructure solutions, such as portable energy systems, as opposed to traditional, fixed infrastructure, especially in regions with existing heavy investments in the latter.
- **Reconciliation:** Promote the potential of flexible solutions alongside traditional infrastructure, showing how both can complement each other in a resilient emergency management system, finding technology-driven solutions.

There is a need for a holistic, integrated approach to emergency management that accounts for community involvement, accurate data, cross-disciplinary coordination, and long-term resilience in infrastructure and systems. This will require the alignment of policies, funding, and communication strategies to build stronger, more resilient communities across Canada. Key points include:

1. **Community Involvement & Indigenous Knowledge**:
    - Communities, including Indigenous populations, must be more actively involved in emergency response and preparedness plans. Indigenous communities should lead their own priorities, respecting self-determination and traditional practices.
    - There is a need for resources and funding to help Indigenous communities develop their own emergency plans and integrate traditional practices.
    - Social cohesion and community networks should be fostered to enable neighbors to help one another during crises.

2. **Infrastructure Focus Shift**:
    - The focus should shift from traditional, grey infrastructure (e.g., concrete) to more flexible, portable solutions such as portable backup energy systems for targeted crises.
    - Flood mitigation technologies already exist and need to be codified and incorporated into emergency planning.
    - Attention should be given to assessing and maintaining municipal infrastructure interdependencies, such as evacuation routes, power, and water supply systems, which are critical to supporting recovery.

3. **"Build Back Better" and Recovery Funding**:
    - Recovery efforts must focus on "build back better," which requires clear guidance on what this entails and how to measure the additional costs and benefits. This includes addressing the long-term cost of not building resilient infrastructure, which is often not factored into decision-making.
    - Provinces should intervene to ensure that municipalities are not granting permits for developments in high-risk areas (e.g., floodplains) without adequate mitigation measures.

4. **Data and Risk Mapping**:
    - There is a critical need for accurate, up-to-date hazard maps (e.g., flood maps) and climate data to inform planning. These maps should account for future climate risks.
    - Existing building condition assessments must be improved to reflect the full lifecycle costs and future risks, including the combined impacts of multiple, simultaneous extreme events.

5. **Education, Communication, and Trust**:
    - Public education on climate risks and emergency preparedness should be more widespread, with resources tailored for different demographic groups and more effective communication strategies.
    - Transparency and trust-building are essential for effective emergency response. Communities need better communication from authorities to foster trust, especially in situations involving misinformation or conspiracy theories at the local level.
    - Success stories and near-misses should be celebrated to build community confidence in emergency management.

6. **Cross-Disciplinary/Holistic Coordination**:
    - Emergency management guidance should integrate multiple disciplines, including architecture and infrastructure management, to address both climate adaptation and mitigation.
    - There is a need for better coordination between emergency teams, government agencies, and community leaders to ensure efficient and responsive action during crises.
    - Need trained emergency response teams who are on stand-by (i.e. the Federal Emergency Management Agency)

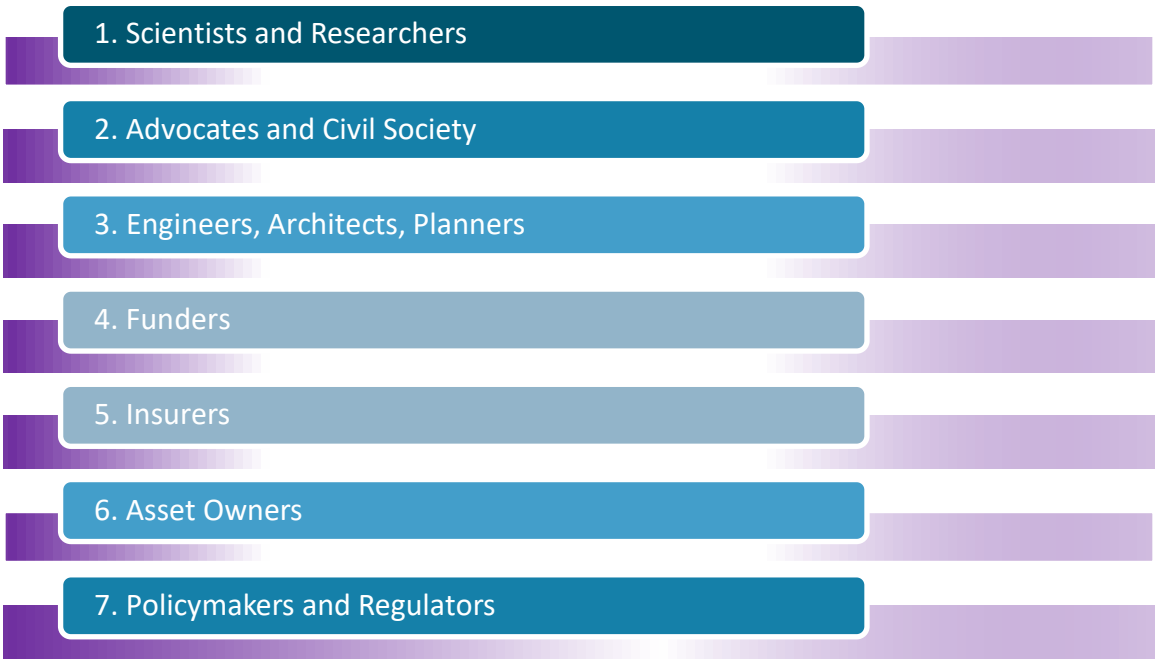
7. **Human Resource and Capacity Issues**:
    - Staff burnout in emergency management roles is a significant concern. There needs to be more focus on staff resilience, redundancy, and training.
    - The need for additional external resources, particularly in specialized areas like infrastructure management, should be addressed, possibly through provincial standards.

8. **Simultaneous Events and Long-Term Crises**:
    - Emergency plans must be flexible enough to respond to multiple simultaneous events (e.g., extreme weather combined with health crises) and adapt to long-lasting disruptions.
    - Guidance should be more prescriptive and proactive, with clear action steps and defined roles in anticipation of various emergency scenarios.

Housing, Infrastructure and Communities Canada | Logement, Infrastructures et Collectivités Canada | SCC CCN | National Research Council Canada | Conseil national de recherches Canada

Appendix E
Breakout Group Summaries:
Increasing Impact and Uptake

This appendix summarizes the findings from the second breakout group session. One-to-two-page summaries are presented for each of the seven participant categories discussed:



1. Scientists and Researchers

There are several key points regarding the roles of different science and research organizations and their approaches to implementing climate resilience. These include:

1. **Roles in Climate Resilience:**
   - BC Housing focuses on providing guidance, education, and research for the private sector, leading pilot studies, and creating resources like videos and roundtables.
   - Indigenous Services Canada manages infrastructure programs for reserves, focusing on investment and maintenance. There's a need for more tailored guidance to help communities request the right information from contractors, especially to integrate resilience.
   - *Architecture Sans Frontière* specializes in flood research and offers tools for building updates. They also advocate for incentives for landlords to improve buildings and for renters to adopt resilience behaviors.
   - Ouranos produces climate data and provides training and support for municipal organizations in Québec to help municipalities integrate resilience into their planning.

2. **Information Flow and Decision Making:**
   - Participants emphasized the importance of filtering and dispatching information based on specific needs. The flow of information is often adjusted for different audiences, and it is crucial to translate research findings into accessible formats. One challenge is defining roles and responsibilities in implementing climate change resilience, with clear distinctions between governance, accountability, and responsibility.

3. **Federal Government's Role:**
   - There is a consensus that the federal government should create a foundation for resilience initiatives, build partnerships between provinces, and connect initiatives across Canada. Education on climate change in schools and universities was also highlighted as a critical need, with suggestions for curriculum changes starting from kindergarten to higher education.

4. **Measuring Impact:**
   - Measuring the success of climate resilience efforts remains difficult, particularly at the government level, due to challenges in tracking the impact of programs. Success is often recognized when people remember past efforts, like a specific architecture model in Québec, but failures, such as ineffective retrofits or interventions, are more commonly reported. Ouranos is working on developing methods to measure climate adaptation.

5. **Challenges in Information Use:**
   - It was noted that scientists must be open to the fact that end-users will apply the information differently from how the scientists themselves would, including interpretation of uncertainty or simplification of results. This requires a more user-friendly approach to data and tools.

In summary, the workshop highlighted the complexities of integrating climate resilience into infrastructure projects, the need for better governance structures, and the importance of tailoring information for different audiences. Participants agreed that the federal government must play a central role in setting the stage for resilience efforts, while also addressing education and training needs to increase the overall impact and uptake of climate resilient practices in Canada.

2. Advocates and Civil Society

Participants highlighted several key points which emphasize the importance of enhancing knowledge translation, accessibility, communication, education, and incentives to improve the adoption of climate-resilient infrastructure guidance.

1. Knowledge Translation via Regional Partners:

- Leverage "knowledge translators/amplifiers" (such as local climate service organizations) to make guidance more tangible and relevant for decision-makers.
- Providing more contextualized information about where standards are applicable helps these intermediaries promote relevant practices.
- Summarizing technical details into key takeaways enables local partners to interpret and adapt the guidance effectively.
- Listening to local/regional partners to understand their needs and providing accessible resources (e.g., brief summaries of standards) supports better guidance rollout.

2. Accessibility and Communication:

- Technical guidance needs to be presented in clear, accessible formats (e.g., plain language, checklists) to engage broader audiences, especially those with limited technical knowledge.
- Address affordability to eliminate cost barriers, ensuring guidance is not locked behind paywalls.
- Emphasize the ancillary benefits of climate-resilient solutions, like aesthetics, to appeal to broader audiences.
- Ensure trustworthy organizations back proposed solutions to build credibility.
- Integrate professional communicators into research budgets to effectively engage key audiences.

3. Education and Outreach:

- Promote the "business case" for climate resilience measures, clarifying their value and potential cost savings to encourage uptake.
- Streamline information to prevent overload, while connecting people to relevant climate vulnerability data.
- Incorporate feedback loops to share success stories and lessons learned, allowing continuous improvement in guidance.
- Ensure ongoing education to keep professionals updated on evolving standards.

4. Incentivizing Uptake:

- Use regulatory measures and insurance-related benefits to drive adoption of climate-resilient practices.
- Promote climate risk disclosure for properties and infrastructure, potentially through tools like a "Green Button" for risk.
- Consider withholding public funding for projects in high-risk areas to incentivize safer, more resilient development.
- Embed resilience guidance into decision-making processes to ensure its integration across sectors.

In summary, the overall goal is to make guidance more accessible, actionable, and integrated into decision-making at local levels, fostering widespread adoption of climate-resilient infrastructure practices.

3. Engineers, Architects, Planners

Participants in the discussion on engineers/architects/planners highlighted several key strategies to enhance the uptake and impact of climate resilience in infrastructure. These include:

1. Education:

- Focus on high-quality, informed sources for both new professionals and continuous education. This could include creating a co-curriculum between organizations like CSCE, RAIC, CIP, CAC, OAQ, GCRTC, and OUQ.
- Include courses, workshops, and symposiums at annual conferences to increase learning opportunities.
- Target the entire industry, including contractors, and learn from the efforts of the planning community that is on track to have 70% readiness by 2027.
- Collaborate on knowledge transfer and integration through initiatives like a shared portal or coordinated knowledge mobilization efforts, ensuring accessibility through translation and prioritizing content by region, asset areas, and topics. Potentially establish an oversight committee on knowledge transfer, that could work with HICC/SCC/NRC and coordinate activities in this space.

2. Guidance Documents:

- Engage with users early in the development of guidance to ensure its relevance and usefulness.
- Seek input on the most appropriate tools and documents for various audiences, with specific guidance needed for northern regions.
- Use examples such as the Canadian Handbook for Architects or Climate Policy for Planners to inform the creation of these resources.

3. Advocacy and Early Engagement:

- Focus on educating clients of professionals, enabling them to make informed decisions on climate adaptation.
- Influence decision-makers and engage with local populations early in project development to build support for climate resilience.

4. Celebrating Excellence:

- Highlight successful projects through case studies and awards, recognizing excellence in implementing climate resilience.

5. Legislation:

- Advocate for supportive planning legislation and model codes, ensuring that climate resilience is built into housing standards and regulations across jurisdictions.
- Investigate the role of Indigenous Services Canada (ISC) and Crown Indigenous Relations and Northern Affairs Canada (CIRNAC) as partners in incentivizing climate resilience in First Nations communities.

6. Barriers:

- Address challenges such as funding, incentivizing the finance sector, and the limited resources available for non-mandated climate resilience projects.
- Focus on overcoming barriers like asset owners funding only what is mandated, and prioritizing resource allocation.

7. Examples and Metrics:

- Build on successful examples like the Low Carbon Training Project at RAIC, which has shown positive results through surveys post-training to gauge impact.
- Promote initiatives like the PIEVC (Public Infrastructure Engineering Vulnerability Committee) protocol and certified resilient projects to increase awareness and literacy on climate resilience, ensuring these programs cater to different regions and sectors.

In conclusion, the feedback emphasizes a multi-faceted approach, combining education, early engagement, targeted guidance, legislation, and celebration of successes to drive the impact and uptake of climate-resilient infrastructure in Canada.

4. Funders

Participants in the funder's discussion suggested key strategies to enhance the uptake and impact of climate resilience efforts in infrastructure. These include:

1. **Model Tenders:**
   - There is a need for example tenders that demonstrate how to incorporate climate resilience standards in infrastructure, buildings, and communities.
2. **Funding for Innovation:**
   - Support infrastructure and community resilience projects that foster innovation, and ensure that valuable knowledge generated is replicable and transferable to others.
3. **Supporting Professional Standards:**
   - Funding mechanisms should recognize the importance of professional standards and 'duty of care' in ensuring resilience is incorporated into infrastructure projects. Legal or professional practice aspects should also be acknowledged as key components for the success of updated resilience guidance.
4. **Common Definitions for Resilience:**
   - Establishing a shared understanding of resilience-related terms will help various entities, such as federal departments, consistently integrate resilience into procurement projects.
5. **Legislative Barriers:**
   - Studies should identify and address legislative barriers that hinder the integration of climate resilience, such as policies that restrict rebuilding efforts after climate-related disasters (e.g., Halifax's metal roof ban after wildfires).
6. **Merit-based Funding Challenges:**
   - Funding agencies face challenges in assessing if resilience is adequately considered. In some cases, simply asking applicants to demonstrate consideration of resilience guidance may be the most feasible approach.
7. **Integration Across Federal Agencies:**
   - A study is needed on how federal departments integrate national standards for resilience into their funding and procurement processes. Identifying responsibility for ensuring all departments meet National Adaptation Strategy targets is crucial.
8. **Application Preparation Time:**
   - Funders should ensure applicants have enough time to gather and incorporate data on climate hazards and design values (both current and future) into their applications.
9. **Post-Build Commitments:**
   - Funders should consider requiring applicants to commit to post-construction plans for maintenance and asset management practices to ensure long-term resilience in the face of climate change.
10. **Role of Standards in Asset Development:**
   - Acknowledging the role of standards across all stages of asset development, including procurement, is essential for maintaining resilient infrastructure.

This feedback underscores the importance of supporting clear, consistent practices across various interested parties and ensuring sufficient resources and time are available to integrate resilience into infrastructure development effectively.

5. Insurers

The discussion on insurers identified key strategies for improving climate resilience, focusing on the roles of different sectors and addressing barriers to action. These include:

1. Insurer's Role

- **Simplified Messaging**: Insurers emphasized the importance of using simple, clear communication to help homeowners understand how to protect their properties from flooding. They suggested using **infographics** and practical guides (like checking sump pumps or installing backwater valves) that are easy to follow and share. This messaging reaches millions of households, often included in mortgage packages or shared through banks. Such communication should be embedded within a broader strategy that includes pricing, underwriting, and building regulations. Insurers also have internal capacity to produce consumer-facing materials, suggesting that greater value may lie in focusing efforts on technical guidance to support underwriting decisions and regulatory improvements.
- **Insurance Costs and Climate Risks**: **Life and health insurers** are seeing increasing costs due to climate-related impacts, including more mental health claims and physical recovery from extreme weather events. This highlights the growing financial burden of climate change.
- **Advocacy and Education**: The **Insurance Bureau of Canada (IBC)** focuses on educating the public and advocating for stronger policies. Their "**push-pull strategy**" includes working with governments to push for better policies and helping consumers understand the risks they face.

2. Standards and Research

- **Building Resilience**: The **Institute for Catastrophic Loss Reduction (ICLR)** is involved in researching and developing standards for resilience, working with insurers, builders, and contractors. However, they face challenges such as high costs, limited contractor capacity, and slow adoption of new building codes.
- **Innovative Solutions**: **Ecohabitation**, a nonprofit, is researching solutions like "perfect basements" that are resistant to floods and developing AI tools to provide personalized resilience advice for homeowners.
- **Need for Validation**: To scale up resilient building practices, there's a need for validated checklists and training programs that ensure construction is up to standard, benefiting both builders and insurers.

3. Communication and Education

- **Simplified Communication**: Effective communication is key. Visual tools, such as infographics and posters, are recommended to engage the public. Major retailers could help by showcasing flood-prevention products and guides.
- **Professional Training**: There is a push to train professionals, like realtors and home inspectors, in resilience measures. While training uptake has been slow, it is growing, with more than 8,000 mortgage brokers completing relevant courses.
- **Multi-Channel Outreach**: A strategy called the **"8-touchpoint" communication model** was recommended, meaning using multiple channels (posters, online tools, courses, community outreach) to ensure broad, consistent messaging.

4. Challenges and Barriers

- **Regulatory Hurdles**: One significant barrier is the slow pace of **building code updates**. Developers often argue that resilience measures are too expensive, which delays changes that could make infrastructure more climate-resistant.
- **Homeowner Knowledge Gaps**: Many homeowners are unaware of the maintenance tasks needed to protect their homes (e.g., cleaning backwater valves). This lack of knowledge presents a gap in achieving resilience.

- **Insurance Challenges**: Insurers are facing difficulties with pricing policies due to more frequent and severe events—such as **hailstorms, wildfires, flooding, severe storms, wildfire smoke, and other extreme climate events**. Some high-risk homes, such as those in floodplains, may become uninsurable, and insurers are increasingly introducing separate premiums for specific hazards like hail or sewer backups.

5. Balancing Risk and Responsibility

- **Risk Reduction**: The goal is to **"get risk out of the system"**, meaning preventing problems before they happen through resilience efforts. Even small actions, like regular maintenance or flood-proofing, can make a significant difference and help drive broader change.
- **Public Programs**: Some climate-related risks, such as uninsurable losses, will require public funding or disaster relief. As new risks emerge (e.g., hail or sewer backups), there may be a shift toward public responsibility for covering these costs.
- **Community-Level Solutions**: At the community level, **natural infrastructure** (like cisterns for water collection) and tools like **municipal flood assessments** are becoming more important for protecting against climate risks.

6. Next Steps and Priorities

- **Actionable Communication**: There is a call to move beyond awareness to tangible action. This means translating knowledge into practical steps that residents can take to make their homes more resilient.
- **Regulatory Support**: Efforts should focus on pushing for **regulatory changes** that mandate resilience measures in building codes and standards.
- **Continued Research**: Ongoing research into cost-effective resilience solutions, including the development of **AI tools** to validate and support resilience measures, is crucial.
- **Collaboration**: Finally, **collaboration** is essential. All interested parties, from insurers, governments, builders, and homeowners, must work together to move from awareness to action.

7. Key Takeaways

- **Simple, visual messaging** is critical and effective for engaging households in climate resilience.
- **Clear standards**, **validation tools**, and **regulatory alignment** are needed for effective resilience measures.
- **Insurance gaps** are growing, and without systemic change, this will worsen.
- **Collaboration** among all sectors is essential to translate knowledge into action and achieve meaningful climate resilience.

In short, the workshop underscored that moving forward requires **clear communication**, **better standards**, **collaborative action**, and a shift in how risk is managed and shared across society.

6. Asset Owners

The asset owners' discussion identified several barriers to increasing the uptake of climate resilient infrastructure guidance and proposed solutions across various topics. These include:

1. **Guidance:**
   - A significant barrier is the lack of clarity on who is responsible for implementing resilience standards, especially for municipalities. Municipalities face difficulty navigating complex layers of guidance. The solution involves creating clearer lists of responsibilities for municipalities and collaborating with trusted sources like SCC and ISO to simplify implementation. Awareness of user needs is key, and guidance should be tailored for different audiences (e.g., engineers, small municipalities). Collaboration with various interested parties (e.g., insurers, policymakers) is essential to increase adoption.

2. **Awareness:**
   - A general lack of awareness about available guidance and updates is problematic. The solution is to raise awareness by sharing and highlighting the benefits of resilience measures, providing practical tools, and distilling content for smaller municipalities. Leveraging AI to condense large volumes of guidance and creating an up-to-date national inventory could further enhance access.

3. **Cost, Capacity, and Implementation:**
   - Budgeting for resilient construction is challenging due to uncertainty about the efficiency of resilience measures over the asset lifecycle. A clearer connection between risk assessments and adaptation solutions is needed. Financial assessments should be integrated earlier in the process to aid decision-making. Municipalities with limited resources could benefit from pooling efforts or participating in communities of practice to better understand and implement resilience standards.

4. **Regulations/Requirements:**
   - Current asset management regulations, such as in Ontario, have driven progress, but there is a need for stronger regulations. Municipalities need provincial leadership to encourage resilience considerations. Moreover, integrating resilience into procurement processes, such as those in PSPC, and requiring accredited professionals for resilience-related work could strengthen implementation.

5. **Funding and Federal Government:**
   - The focus should be on improving processes rather than relying solely on federal funding. Funding for maintenance, repairs, and retrofits is critical. Additionally, resilience measures should be factored into funding and tied to different asset lifecycle stages. The Disaster Financial Assistance Arrangements (DFAA) could play a role by incentivizing preventive measures for high-risk areas, signaling a shift towards risk mitigation.

6. **Skilled Workforce:**
   - There is a need for more training on adaptation and resilience for professionals like engineers and architects, with market incentives to increase enrollment. Creating certifications for engineers to ensure minimal standards of practice across Canada could help build a more skilled workforce.

In summary, the workshop emphasized the importance of clear guidance, tailored communication, early integration of resilience measures into financial planning, stronger regulations, and a skilled workforce to improve the uptake and impact of climate-resilient infrastructure in Canada.

7. Policymakers and Regulators

Feedback with regards to policymakers and regulators provides a comprehensive outlook on how to enhance the impact of climate-resilient infrastructure guidelines and better reach various audiences. These include:

1. Who are the users and who is lacking?

- The core users of climate-resilient infrastructure guidance comprise:
  - **Engineers** and **municipal staff** (critical leaders with the ability to implement solutions)
  - **Indigenous communities** (who bring essential perspectives and knowledge)
  - **Practitioners**, **procurement staff**, and **professors** (who educate and apply these standards in practice)
  - **Funders** and **investors** (whose support is crucial for scaling solutions)
  - **All levels of government** (involved in policy and decision-making)
- However, there is a recognition that some groups are underrepresented and need to be more engaged, specifically:
  - **Indigenous voices**, whose traditional knowledge and perspectives are vital for climate resilience.
  - **Youth**, whose involvement is essential for creating long-term solutions and ensuring that future generations are well-prepared.

2. Challenges and Barriers:

- **Awareness and Accessibility of Codes and Standards**:
  - Many people don't know about or can't find the right codes and standards.
  - **Translation of information**: The technical language in standards and codes is often not adapted for different audiences, making it hard for non-experts to understand and use them effectively.
- **Tool Effectiveness**:
  - Existing tools and toolkits are not sufficient; they often don't address the **real-world challenges** faced by users.
  - Rather than developing new tools, there is a call for more **socially relevant services** that are better tailored to the needs of users.
- **Integration into Existing Processes**:
  - Climate resilience shouldn't be an **add-on**; it needs to be embedded into existing systems, policies, and practices as a **default consideration**.
  - There are challenges related to **jurisdictional barriers** and navigating different perspectives and needs from various interested parties.
- **Cost-Benefit Analysis (CBA)**:
  - It's crucial to better assess the costs and options related to climate resilience, including the costs of **not taking action**. More evidence-based economic analysis is needed to demonstrate the financial benefits of resilience.

3. Measuring Impact:

- **Quantifying Impact**: Traditional methods of measuring impact, like attributing outcomes directly to specific actions (e.g., codes and standards), are difficult to implement. There are challenges in tracking the uptake of tools and **proving causality** between actions and results.
- **Climate Economics**: Using data such as the **cost of insurable losses** or avoided costs from climate-related damage can help show the financial benefits of resilience.
- **Health and Safety**: Another critical metric is the **reduction in health issues** (such as deaths or injuries) due to improved climate resilience measures, though there's a lack of data on the actual impact and uptake of these measures.

4. Path Forward:

- **Focus on Outcomes**: It's essential to emphasize **real-world impacts** such as reduced damages, financial savings, and improved safety, rather than just the technical aspects of the guidance.
- **Reaching Varied Audiences**: Tailor messaging to **different communities** (e.g., northern communities, youth, Indigenous groups) to ensure the guidance is relevant and compelling to each group. This could involve using **storytelling** to illustrate how these standards and practices can make a tangible difference in people's lives.
- **Integration into Broader Value Systems**: Climate resilience should be woven into broader social, economic, and policy frameworks, making it a **mainstream priority** rather than a niche concern. This includes ensuring that governments, institutions, and corporations see climate resilience as part of their core objectives.
- **Promoting Champions and Influencers**: To drive wider adoption, it's important to highlight and support **champions**—individuals or organizations that are leading the charge and influencing others to follow suit.
- **Use of Technology**: Leveraging technologies like **AI** could be key to improving how people access and use complex tools like codes and standards. AI could simplify processes, provide modular and digestible answers, and help users navigate through complicated information more efficiently.

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Appendix F
Diverging Views, Proposed Reconciliation Actions

Common / Shared Themes

Diverging Views

- Identification of any significant differences in opinions or approaches among participants.
- Discussion of how these differences might be addressed or reconciled moving forward.

This report identifies a number of diverging views among participant groups for improving climate resilience in infrastructure. These differences are largely rooted in contrasting perspectives on priorities, implementation approaches, and the role of various actors in implementing recommendations. The following is an analysis of these differences and suggestions for moving forward for the following subjects:

1. Implementation of Climate Resilience Guidance
2. Role of the Federal Government
3. Knowledge Translation and Accessibility
4. Funding and Financial Incentives
5. Measurement and Impact Tracking
6. Regulatory and Legislative Approaches
7. Indigenous Communities Role
8. Cost of CLimate Resilience Measures

1. Implementation of Climate Resilience Guidance

- **Scientists and Researchers vs. Engineers/Architects/Planners**
  - **Divergence**: Scientists and researchers often emphasize the importance of data-driven, evidence-based approaches and focus on generating and disseminating climate data, while engineers, architects, and planners are more concerned with how this data translates into practical solutions that can be integrated into actual infrastructure projects. There is a difference in the perceived value of research outputs versus their actionable application in the field.
  - **Reconciliation**: One way to reconcile this is by establishing stronger collaboration and communication channels. Researchers could focus on making their findings actionable by working alongside engineers and architects to integrate climate resilience data directly into their practice. Collaborative tools or platforms could also be developed for continuous knowledge transfer between these groups.

2. Role of the Federal Government

- **Scientists and Researchers vs. Policymakers/Regulators**
  - **Diverging Views:**
    - **Scientists and Researchers** often push for more data-driven, long-term, and evidence-based approaches, emphasizing the importance of continued research, rigorous climate modeling, and integrated scientific studies to guide resilience efforts. They might prioritize more in-depth studies and experimental approaches, including innovative technologies for resilience.
    - **Policymakers and Regulators**, on the other hand, are focused on translating research into practical, immediate policy actions and often operate within tighter political constraints. They are more concerned with regulatory feasibility, public acceptance, and ensuring resilience measures can be enacted within short-term political cycles.
  - **Reconciliation:**
    - Scientists and policymakers can collaborate more closely through **science-policy interfaces**, where research is presented in actionable forms that align with regulatory timelines. Policymakers should rely on the expertise of researchers to build adaptive and flexible policies that can evolve based on emerging evidence.
    - Incorporating **adaptive governance** approaches allows for policies to remain flexible and responsive as more research findings become available, thus allowing space for iterative, science-backed solutions.

3. Knowledge Translation and Accessibility

- **Advocates/Civil Society vs. Insurers**
  - **Divergence**: Civil society and advocacy groups prioritize broad access to climate resilience information, focusing on clear, simplified messaging to drive public awareness and action. In contrast, insurers are primarily driven by financial viability. Their focus is on accurate risk assessments, sustainable underwriting, and policies that ensure resilience is economically feasible.
  - **Reconciliation**: Bridging this gap requires aligning communication and policy strategies to meet both public awareness goals and financial risk management needs. For instance, tools like infographics could simultaneously educate homeowners and highlight financial consequences or incentives tied to resilience measures. However, meaningful progress will

also depend on regulatory frameworks that reinforce—not compromise—the economic sustainability of insurance in the face of increasing climate risk.

- **Advocates/Civil Society vs. Engineers/Architects/Planners**
  - **Diverging Views:**
    - **Advocates/Civil Society** emphasize the human-centered, equitable aspects of climate resilience, such as community involvement, social justice, and long-term sustainability. They often stress the need for inclusive approaches that prioritize the most vulnerable groups, including marginalized and Indigenous communities.
    - **Engineers/Architects/Planners** focus more on technical solutions, the feasibility of design and infrastructure, and the efficiency of resilience measures. Their perspective may prioritize practicality and the measurable benefits of resilience measures, sometimes at the expense of a deeper social or cultural understanding.
  - **Reconciliation:**
    - To bridge these perspectives, **co-design processes** can be employed, where engineers and planners work directly with communities to ensure that resilience measures are not only technically sound but also socially equitable. This can include participatory planning processes that integrate local knowledge and ensure that solutions align with community values.
    - A more **holistic approach** that includes inclusive engagement and both technical expertise and social insights would ensure that the design and implementation of infrastructure meet the needs of both the vulnerable populations and the broader professional standards.

4. Funding and Financial Incentives

- **Funders vs. Asset Owners**
  - **Divergence**: Funders generally prioritize projects with measurable, long-term outcomes, and may be more hesitant to fund high-risk projects that lack concrete financial assessments or clear evidence of success. On the other hand, asset owners often face challenges in securing funding due to the uncertainty around the financial viability of resilience measures, especially when there's insufficient data on long-term costs and benefits.
  - **Reconciliation**: A solution could be creating joint funding mechanisms that include both financial incentives and clear metrics for evaluating success. Funders could work with asset owners to ensure that funding is tied to specific, measurable outcomes that are both cost-effective and resilient. Shared decision-making frameworks that account for both financial and resilience goals can bridge this gap.

- **Funders vs. Insurers**
  - **Diverging Views:**
    - **Funders** (e.g., governments, philanthropic organizations, development banks) are often more focused on providing financial support for broad, large-scale resilience projects and the long-term impacts of these investments. They tend to prioritize strategic, cross-sectoral solutions that might span multiple countries or regions and require significant funding.
    - **Insurers**, however, focus on risk mitigation and the financial protection of assets, often emphasizing shorter-term, more direct measures that can be quantified and incorporated into risk models. They may prioritize solutions that directly impact the insurability of assets, sometimes viewing broader resilience measures as speculative or too complex to assess in financial terms.

- **Reconciliation:**
  - Funders and insurers can work together by **aligning incentives**—funders can help support the initial investments in resilience infrastructure, while insurers can incentivize resilience measures that directly impact risk mitigation, such as offering premium reductions for climate-resilient infrastructure.
  - **Partnerships** between these two groups can drive more scalable solutions by ensuring that resilience projects are financially viable and reduce future insurance claims. For example, **shared risk pools** can be developed, where insurers and funders jointly support the implementation of resilience measures in high-risk areas.

5. Measurement and Impact Tracking

- **Scientists and Researchers vs. Policymakers/Regulators**
  - **Divergence**: Scientists and researchers struggle with measuring the long-term impact of climate resilience efforts due to the challenges of tracking data on effectiveness over time. Policymakers, however, require clear, actionable metrics to assess the success of policies and programs, which may sometimes be difficult to align with the complex and evolving nature of climate data.
  - **Reconciliation**: To address this divergence, a more dynamic system for tracking impacts could be developed that involves both continuous scientific research and policymaking. Incorporating both qualitative and quantitative data, such as case studies alongside traditional metrics, would allow for a more comprehensive understanding of climate resilience impacts. Collaborative databases and feedback mechanisms could also improve real-time monitoring of the effectiveness of resilience strategies.

6. Regulatory and Legislative Approaches

- **Engineers/Architects/Planners vs. Funders**
  - **Divergence**: Engineers, architects, and planners may see regulatory approaches as too rigid or slow to adapt to the rapidly changing climate, and are often advocating for more flexible and locally-tailored solutions. Funders, however, may prefer standardized, legally-backed frameworks to ensure that funding is directed towards projects with a higher likelihood of success and broad impact.
  - **Reconciliation**: To address this, flexible codes that vary based on risk level, or offer levels of performance (such as the energy codes) could offer solutions and allows for local adjustments. This would enable engineers and architects to implement more tailored approaches while still adhering to national standards that funders can rely on to ensure financial accountability.

- **Asset Owners vs. Policymakers/Regulators**
  - **Diverging Views:**
    - **Asset Owners** are primarily concerned with the operational and financial performance of their assets. They may be reluctant to implement resilience measures that incur upfront costs, particularly when the financial benefits are long-term or uncertain. They often prefer cost-effective, quick-to-deploy solutions.
    - **Policymakers and Regulators** tend to focus on long-term societal resilience and may push for comprehensive resilience standards and regulations that require asset owners to invest in measures that they view as necessary to protect public infrastructure, communities, and ecosystems.

- **Reconciliation:**
  - Policymakers can work with asset owners to **demonstrate the long-term financial value** of resilience through cost-benefit analyses, showing how resilience investments can reduce maintenance costs, insurance premiums, and business disruptions. Incorporating **flexible timelines and phased approaches** for implementation would also help asset owners feel less pressure and more motivated to adopt resilience strategies.
  - Additionally, **financial incentives**, such as tax credits or subsidies for resilience investments, can help asset owners make the case for upfront costs.

7. Indigenous Communities' Role

- **Indigenous Communities vs. Non-Indigenous Parties (e.g., Engineers, Funders)**
  - **Divergence**: Indigenous communities often emphasize the importance of integrating traditional knowledge and a holistic approach to climate resilience, while non-Indigenous parties may focus on technical, modern solutions and quantifiable measures of resilience. The contribution of Indigenous knowledge to formal frameworks and regulations is sometimes overlooked.
  - **Reconciliation**: Inclusion of Indigenous knowledge in formal resilience frameworks is crucial. One solution is to establish formal partnerships where Indigenous communities are involved in decision-making processes, particularly in regions where their knowledge of local ecosystems and climate risks is invaluable. Moreover, including Indigenous perspectives in the development of standards and regulatory frameworks would help to ensure that resilience measures are robust and inclusive.

8. Cost of Climate Resilience Measures

- **Asset Owners vs. Insurers**
  - **Divergence**: Asset owners often face significant challenges in justifying the upfront costs of implementing climate resilience measures, especially in light of uncertainties about the long-term benefits. Insurers, on the other hand, may push for immediate action, citing the rising costs of insurance premiums due to climate-related risks.
  - **Reconciliation**: To bridge this gap, insurers and asset owners could collaborate to offer risk-based financial incentives for resilience measures. Insurers could provide rebates or lower premiums for properties that demonstrate resilience, while asset owners could leverage these financial incentives to offset initial costs. Risk-sharing models and more flexible financing structures could also help make resilience measures more affordable.
- **Policymakers/Regulators vs. Funders**
  - **Diverging Views:**
    - **Policymakers/Regulators** typically seek to implement broad, long-term policy frameworks that ensure resilience across sectors and communities. They often look for clear mandates and enforceable measures to institutionalize climate resilience.
    - **Funders**, however, tend to be more focused on the immediate impact of their investments and may be more hesitant to commit to long-term policy goals that are not directly linked to short-term financial returns or clear outcomes.

- **Reconciliation:**
  - Policymakers and funders can work together by **creating clear, actionable funding frameworks** that align with policy goals. By ensuring that funding is directed toward projects that help implement regulatory mandates, funders can see the value in their investments while contributing to broader systemic change.
  - **Incremental funding models** that start with pilot projects or scalable initiatives could also reduce the perceived risks for funders while providing a pathway for broader policy implementation.

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Appendix G
Presentations

Housing, Infrastructure and Communities Canada

Logement, Infrastructures et Collectivités Canada

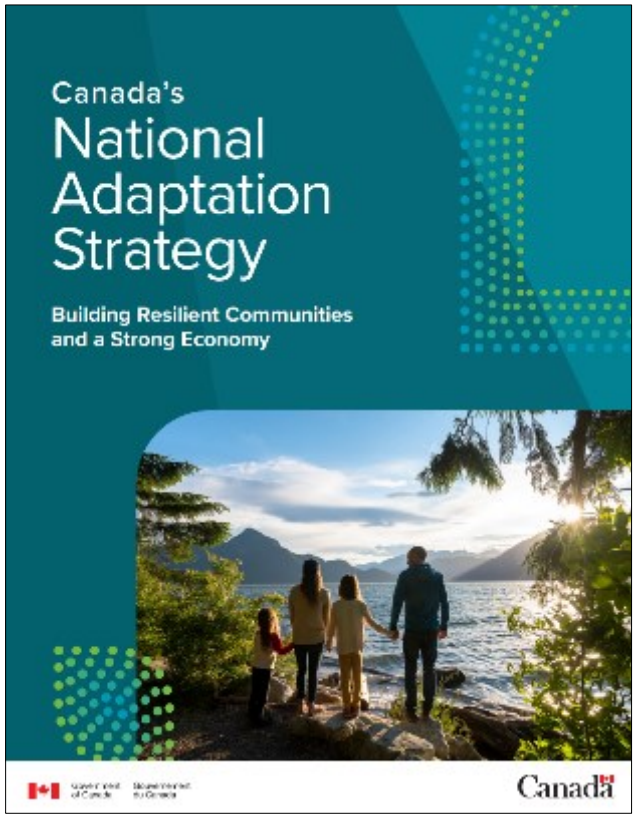
Setting the Stage for Action on Climate Resilience

4 December 2024

Erin Taylor, Director of Adaptation and Resilience
Housing, Infrastructure and Communities Canada

National Adaptation Strategy (NAS)

Objectives and targets related to guidance in the Infrastructure system



Objectives	Targets
Codes and Standards	By 2026, additional climate change resiliency considerations are incorporated into **3 Canadian Codes** (National Building Code, Canadian Highway Bridge Design Code, & Canadian Electrical Code). By 2030, **robust guidance, codes and standards** covering the top climate change risks for key public infrastructure systems are available to be adopted by all infrastructure decision-makers.
Infrastructure Decision-making	By 2030, 80% of **public and municipal organizations have factored climate change adaptation** into their decision-making processes.
Resilient Infrastructure Funding	Starting in 2024, resilience to climate change impacts is factored into all **new federal infrastructure funding programs**.

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Building the Pipeline from Fundamental Research Through to Guidance and Codes

Marianne Armstrong
Director, Climate Resilient Built Environment Initiative

NRC·CNRC

Climate Resilient Built Environment Initiative

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Canada

NRC's Climate Resilience Initiatives

Ongoing partnership with Infrastructure Canada to integrate climate-resilience into guidance, codes and standards

- Climate Resilient Buildings and Core Public Infrastructure Initiative (CRBCPI), $42.5M over 2016-2021
- Climate Resilient Built Environment Initiative (CRBE), $35M over 2021-2026
- $30M under the Government of Canada Adaptation Action Plan (GCAAP), 2023-2028 – expands scope to include Resilient Residential Retrofit

NRC Research Areas – Climate Hazards

Priority Asset Areas

Five original public infrastructure asset types (2016):
Buildings, Bridges, Roads, Water/wastewater, Rail transit





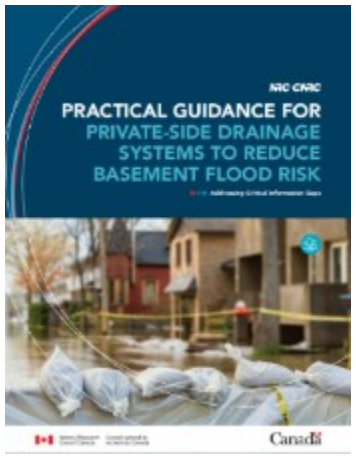
Priority Asset Areas

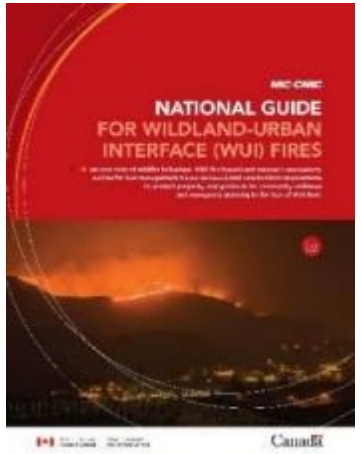
Five original public infrastructure asset types (2016):
Buildings, Bridges, Roads, Water/wastewater, Rail transit

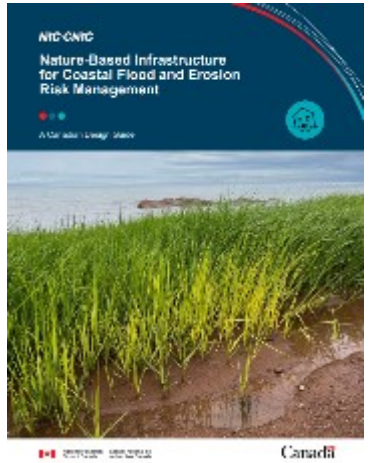
Residential Retrofit
(added in 2024)

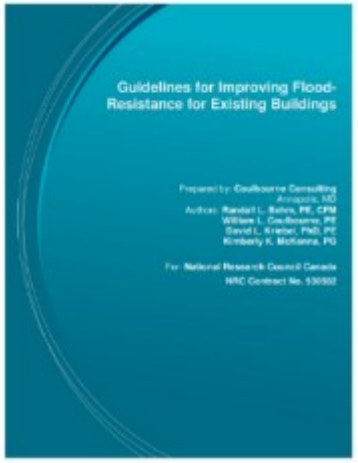
Dams
(added
in 2021)

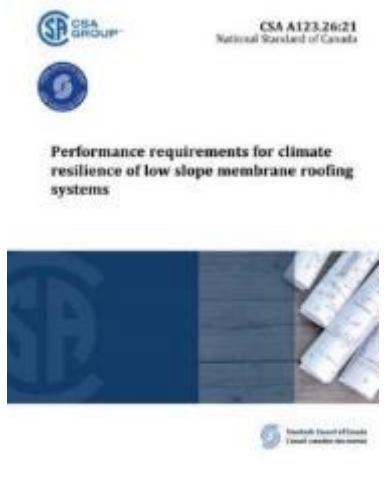
A suite of guidance documents, data and standards are now available to inform resilient construction in Canada

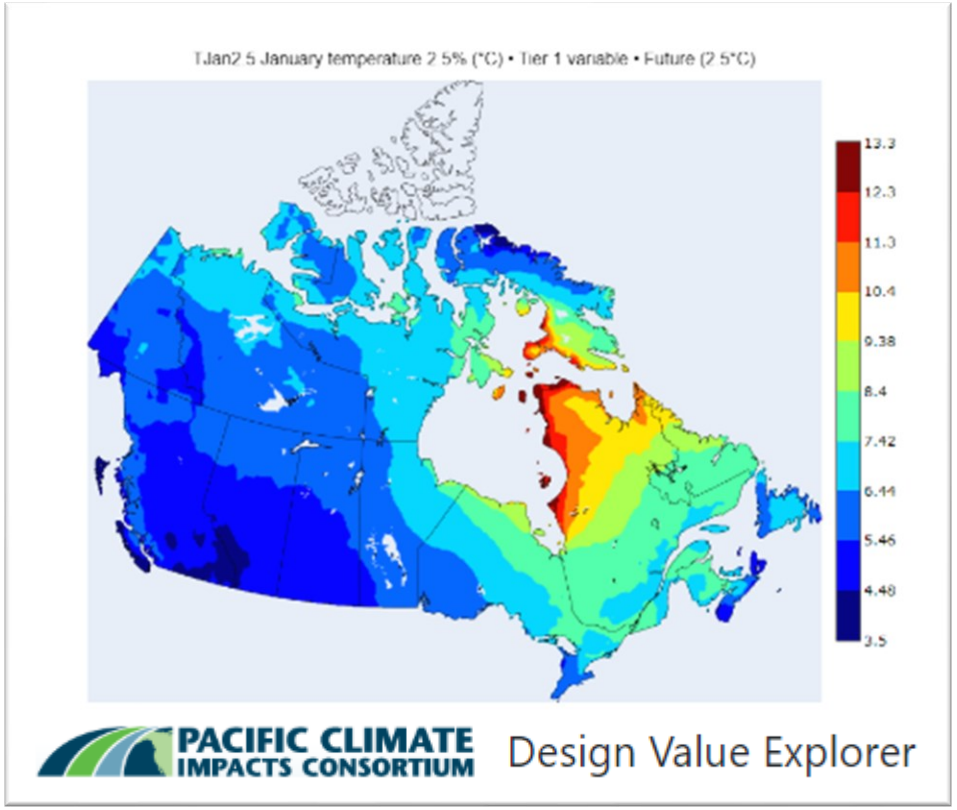












CRBCPI (2016-2021)

CRBE (2021-2026)
CRBE-NAS (2023-2028)

AND BEYOND

Foundational Science

Scientists, Academics

- Future climatic loads for the design of B&CPI
- Performance of materials and systems in a changing climate
- Life Cycle Assessment for infrastructure
- Monitoring and detection methods

Guidance

Committees

- Proposed code changes for the resilient design of new Infrastructure
- Guidance documents for the retrofit of existing B&CPI
- Science-based design solutions
- Tailored asset-specific guidance

Tools

Industry, Professionals

- Updated codes, standards and specifications
- New standards
- Technologies to improve climate resilience
- Decision support tools (Design, risk asst., asset mgmt.)

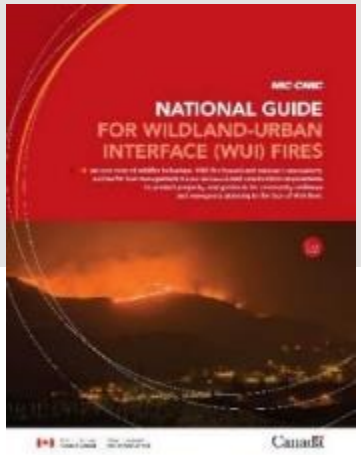
Uptake & Implementation

Users, Owners, Associations

- **Education materials and courses**
- **Resiliency certification for materials and systems**
- **De-risking of tools and technology through pilot projects**
- **Integrated national guidance**
- **Integration into policy**

ENABLING RESILIENCE

Path to Impact:
Wildland-Urban Interface (WUI) Design



Technical Committee Established (2017)

WUI Guide Publication (June 2021)

WUI Standard Publication (2026)

R&D Gap Analysis (2016)

Literature review and Seed document development (2017)

Guide Development, supporting research (2018-2020)

Targeted review (2020)

Impact Assessment (ICLR, May 2021)

Uptake by PacifiCan, Checklists, technical sheets, presentations to stakeholders

Workshops on Standard scope (2022)

RFP for Standard development (June 2024) Smoke Research (2023-2026)

Builder workshops & feedback (TBD)

Codes Policy Discussions (2024-2025)

Research

Tools & Guidance

Deployment & Regulation

Monitor & Evaluate

Enabling Climate Resilience in the National Model Codes

ENABLING CLIMATE RESILIENCE IN THE NEXT EDITION OF THE **CANADIAN HIGHWAY BRIDGE DESIGN CODE**

Challenges

- Limited uptake of resilience measures and guidance
- Implementation in code/regulation, policy, practice, or project level varies greatly and lacks integration
- Prioritizing adaptation actions is essential, as limited funding necessitates tools to support informed decision-making and investment.
- Industry is navigating a rapidly evolving regulatory landscape, where resilience is just one of several objectives (GHG mitigation, affordability).

Potential Areas of Focus

- Support Uptake by Policy and Regulation
- Support Industry Innovation
- Enable Deployment of Guidance and Technologies by Municipalities and Asset Owners
- Increase Expertise of Trades and Professionals and their Ability to Apply Adaptation Solutions
- Support Emergency Preparedness and Response

Key Takeaways

- It takes time to get from research to application
- There are multiple pathways to achieving impact
- We can only achieve impacts if there is awareness and use of knowledge
- We each have a role to play

THANK YOU

Marianne Armstrong
Director, Climate Resilient Built Environment Initiative
Marianne.Armstrong@nrc-crnc.gc.ca

Standards to Support Resilience in Infrastructure Program (SSRIP)

Standards Council of Canada
Open a world of possibilities.

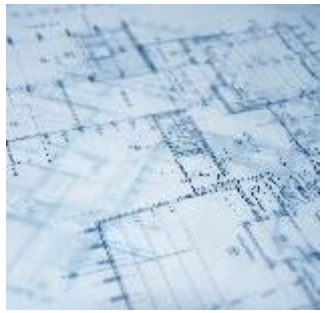
Conseil canadien des normes
Un monde de possibilités à votre portée.

Canada

Why Standards? What is the Benefit?

Agreed upon by consensus

Easy to incorporate into program/policy (requirements, guidance)



Become a requirement when incorporated in codes/regulations

Updated on a regular cycle

The need for standards and guidance for climate resilience

- Much of today's buildings and infrastructure are designed, built, and operated according to standards that were written with a stable climate in mind.
- But as the climate changes, older standards are no longer enough to keep Canadians safe.
- To address this gap, since 2016 SCC's **Standards to Support Resilience in Infrastructure Program** has led the development of standards and related guidance to help communities, businesses, builders, and infrastructure operators adapt.

SSRIP and the National Adaptation Strategy

The National Adaptation Strategy (NAS) explicitly includes the standards and codes:

> *Technical standards…have been updated or developed to embed climate change in all decisions to locate, plan, design, manage, adapt, operate, and maintain infrastructure systems across their lifecycle.*
>
> *By 2030, robust guidance, codes and standards covering the top climate change risks for key public infrastructure systems are available to be adopted by all infrastructure decision-makers.*

BENEFICIARIES

- ✓**Canadians** will enjoy safer communities and climate resilient infrastructure for decades
- ✓**Engineers, planners, architects, and asset owners** will have best practices and guidance
- ✓**Departments** to partner with SCC and advance adaptation through standardization

What we plan to achieve (2021-2028)

Overarching objective: **Deliver up to 86 standardization projects**

Northern-specific infrastructure	**Strengthening assets against extreme weather events**	**Integrating risk management**
Nature-based solutions	**Low-carbon resilient building materials**	**Climate-resilient transportation infrastructure**

Northern-specific Infrastructure

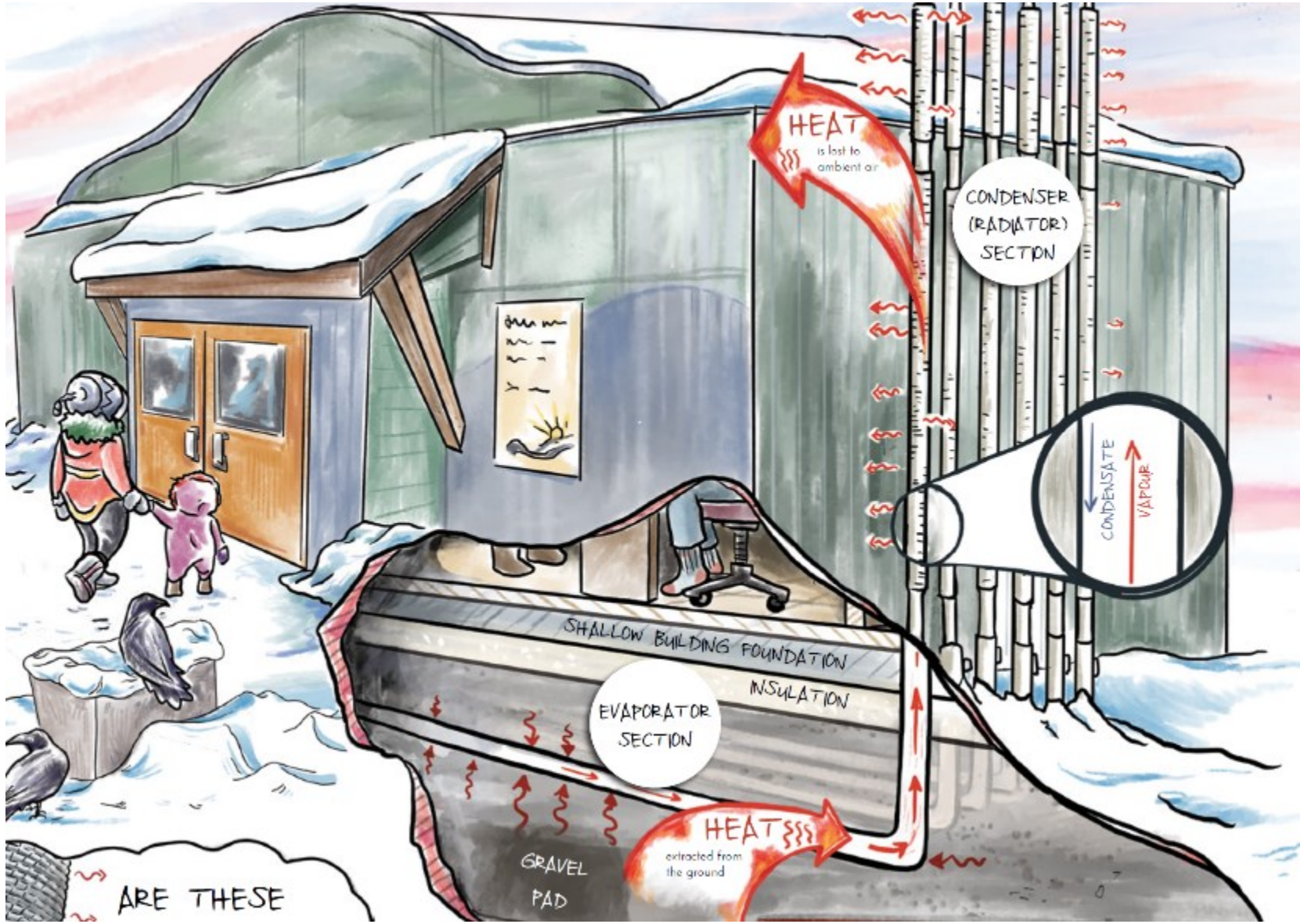
By-the-North and for-the-North standards to support communities facing rapid permafrost thaw and other regional issues. Priorities and work driven by a Northern Advisory Committee.

Current initiatives

- Asset management with climate change in mind for permafrost zones
- Mould guidelines for northern communities
- Community roadway management in permafrost zones
- Water and wastewater distribution systems

Spotlight on NISI

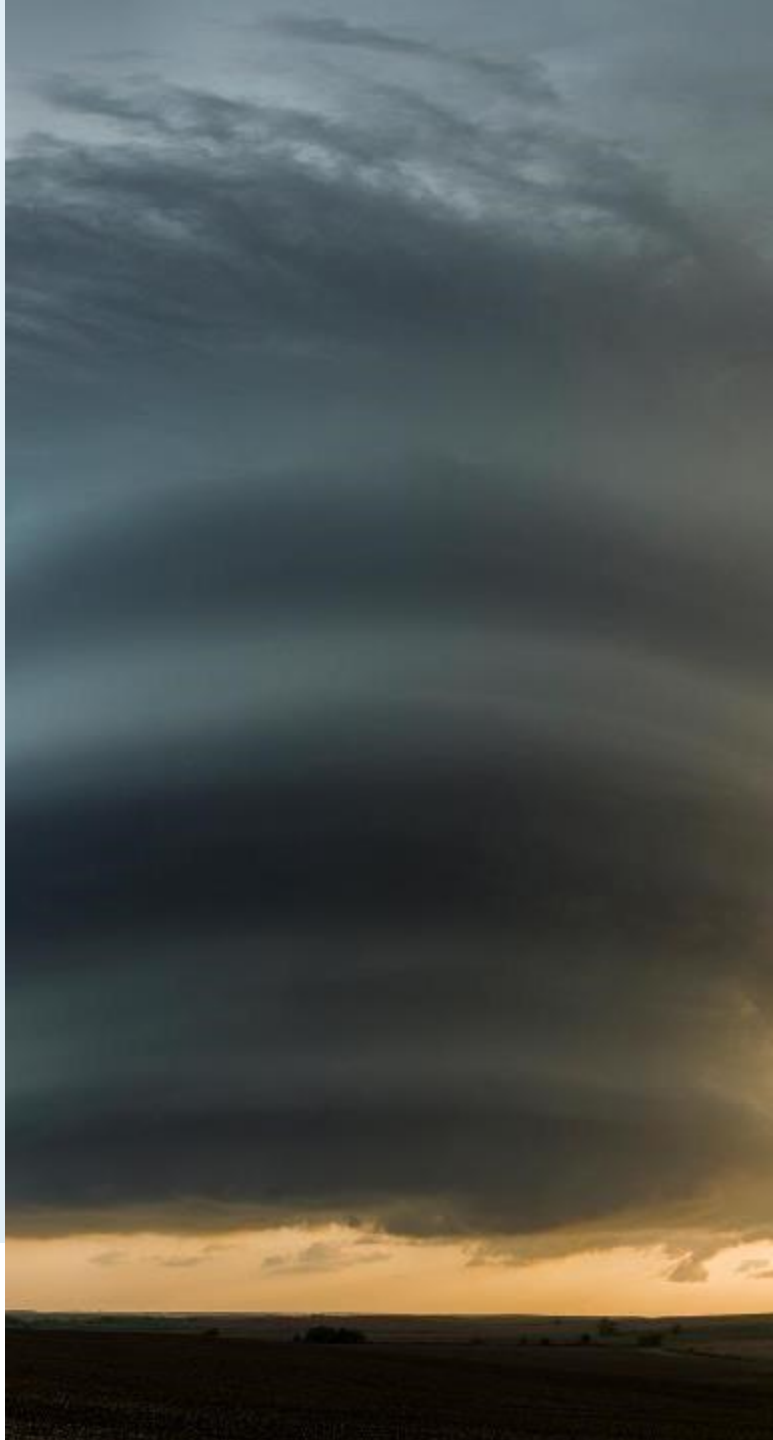
- CSA S500:21 Thermosyphon foundations for buildings in permafrost regions
- CSA S501:21 Moderating the effects of permafrost degradation on existing building foundations
- CSA S503:20 Community drainage system planning, design, and maintenance in northern communities
- CSA W203:19 Planning, design, operation, and maintenance of wastewater treatment in northern communities using lagoon and wetland systems
- BNQ 9701-500 Risk-based approach for community planning in northern region
- CSA PLUS 4011:19 Technical guide: Infrastructure in permafrost: A guideline for climate change adaptation
- CSA Plus 4011.1:19 Technical Guide: Design and construction considerations for foundations in permafrost regions
- CSA R111 Solid waste sites in northern communities: From design to closure
- CSA S502:21 Managing changing snow load risks for buildings in Canada's North
- CSA W205:19 Erosion and sedimentation management for northern community infrastructure
- CSA S504:19 Fire resilient planning for northern communities
- CSA S505:20 Techniques for considering high winds and snow drifting and their impact on northern infrastructure
- BNQ 2501-500 Geotechnical Site Investigations for Building Foundations in Permafrost Zones


HEAT
is lost to
ambient air
CONDENSER
(RADIATOR)
SECTION
CONDENSATE
VAPOUR
SHALLOW BUILDING FOUNDATION
INSULATION
EVAPORATOR
SECTION
HEAT
extracted from
the ground
GRAVEL
PAD
ARE THESE

Strengthening assets against extreme weather events

With a focus on new tools to de-risk critical community infrastructure

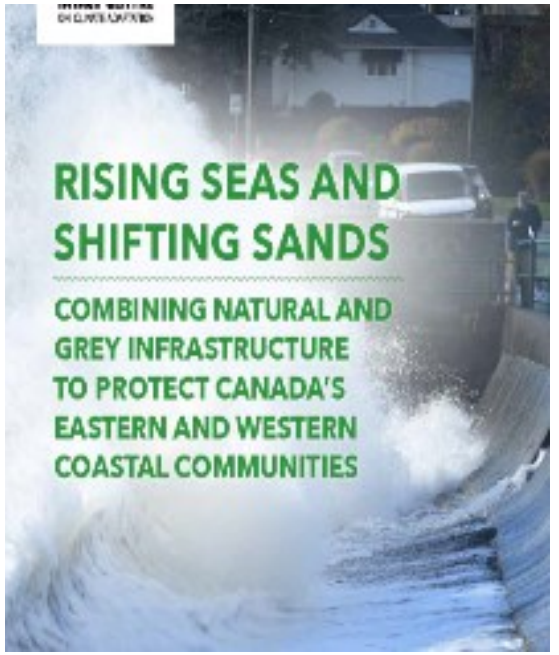
- Addressing **heat-related risks** for infrastructure relevant to vulnerable populations (e.g., long-term care homes)
- **High-winds and storm protection** for utilities (electricity, gas, communications) networks
- Solutions for mitigation of **flooding** (urban, coastal and riverine) for community infrastructure



Flooding

This report describes how Canada can scale up the use of **nature-based solutions**, in tandem with **grey infrastructure**, **to protect communities** along the East and West coastlines.

The report catalogues these approaches and provides recommendations to scale up the use of these solutions in Canada.



Ongoing work :

- Technical sheet for basement flood protection- Climate Resilience Guidelines for Canadian Homes
- A new NSC on **airborne LiDAR data acquisition** for flood mapping purposes
- A new NSC to advance the **Federal Geomatics Guidelines for Flood Mapping**

Extreme Heat

In 2023, SCC partnered with Health Canada to advance the development of technical guidance.

Current Initiatives

-Scoring framework for extreme heat in Canadian cities

-Technical guidance on urban heat island mapping (health-health vulnerability, surface and air temperature)

-New NSC on vegetated roofing systems

Integrating risk management

Current Initiatives:

- Adopt two international standards into the Canadian system to reflect national information and needs:
  - **ISO 14090:2019 Adaptation to climate change** — Principles, requirements and guidelines
  - **ISO 14091:2021 Adaptation to climate change** — Guidelines on vulnerability, impacts and risk assessment
- Plain-language technical application guides for the transportation sector and for asset managers

Nature-based Solutions

Focused on green and natural infrastructure:

Current Initiatives

- Updating of bioretention system NSCs
- NSC for watershed-based management of erosion and flooding
- Erosion, water quality and sediment control for agriculture

Future Initiatives

- Management of natural assets
- NSC for eco-responsible parking lots
- NSCs for coastal design
- NSC for wetlands enhancement and restoration

Low-carbon Resilient Building Materials

- SCC seeks to identify opportunities to support a resilient and low-carbon construction industry through new standardization strategies and areas of collaboration with key stakeholders
- New materials for low and embodied carbon across sectors with particular focus on exploring performance-based designs and accelerating the shift toward performance-based approaches.

Climate Resilient Transportation Infrastructure

Climate resilient transportation infrastructure to protect supply chains and de-risk major infrastructure investments in the coming years, including new standards and technical specifications focused on:

- Flooding and coastal erosion adaptation for roads
- Planning and design of sustainable multimodal urban transportation infrastructure
- Geotechnical investigations for horizontal/linear infrastructure in permafrost regions
- Standards for the interpretation and use of climate modelling for roads
- Extreme weather resilience for public transit systems, including passenger rail systems

Tools currently available

Flood 

- CSA W204:19 Flood resilient design of new residential communities
- CSA W210:21 Prioritizing flood resiliency in existing residential communities
- BNQ 3682-320 Mitigation of risks of inflow and infiltration in new sewer networks

Heat 

- Thermally comfortable playgrounds: A review of literature and survey of experts

Wind 

- CSA S520:22 – Design and construction of low-rise residential and small buildings to resist high wind

Raising awareness

- Training sessions on:
  - ISO 14091 *Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment* and ISO 14092 *Adaptation to climate change — Requirements and guidance on adaptation planning for local governments and communities*
  - NISI standards
- Webinars and conference presentations
- Implementation guides (upcoming)

How Can We Support Your Work?

- Do you have guidance that you feel could/should be standardized?
- Do you want to learn more about standards and the standardization system?

Reach out to us at gillian.koh@scc.ca

Break

15 minutes

Remaining Gaps and Priority Areas for Research, Guidance and Standards

Canada

CRBE and SSRIP: Current Status

- Developed a foundational understanding of climate resilience for infrastructure, encompassing design data, climatic loads, deterioration, and strengthening technologies.
- Developed a suite of standards, tools and guidance for major asset areas including: buildings, bridges, water/wastewater, urban transit, and roads
- Advanced understanding and guidance in new areas: permafrost zones, dams, nature-based solutions, low-carbon resilience, and residential resilience
- Enabled significant updates to three National Codes
- Established and mobilized a network of over 300 experts and stakeholders
- Established global leadership in climate resilience research and standardization

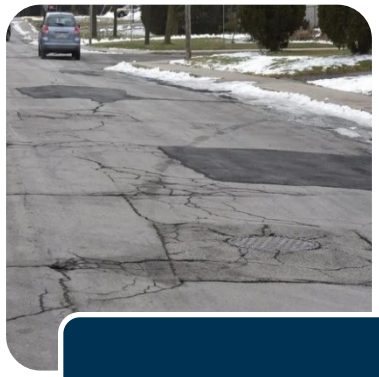
NRC's Latest Activities and Focus Areas

CCMC EVALUATION

Evaluation of Resilient Materials

Resilient Residential Retrofit

Informing Resilient Building Codes

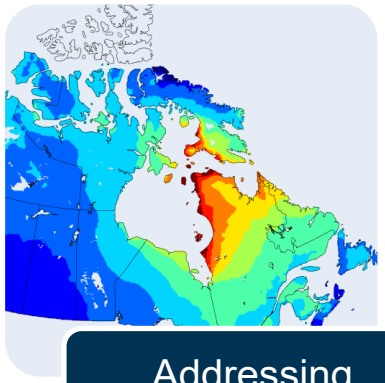


Tools for Asset Management

River Ice and Flooding

Flood Barriers

Accelerating Uptake of Nature-Based Solutions



Addressing Remaining Climate Data Gaps

SCC: Significant progress, but more to do

Example: 2023 Assessment for Coastal Erosion

- Coastal projects options appraisal ***SCC advancing***
- Coastal nature-based solutions ***SCC advancing***
- Coastal erosion risk assessment
- Design of coastal structures (including maintenance and monitoring)
- Climate resilience of ports and other marine infrastructure
- Coastal and riverine monitoring
- Dynamic revetment/cobble berm
- Removal of river training structures at outlets
- Tracking sediment and channel geometry for infrastructure protection
- Numerical modelling of nature-based solutions
- Riparian corridors and buffers
- Coastline/river/floodplain restoration
- Reforestation – cross-slope, riparian, upland

Breakout group discussions

Objective:

Identify infrastructure climate change adaptation needs and gaps (e.g., standards, guidance, research and tools)

Table topics:

- Coastal flooding
- Urban flooding
- Extreme heat
- Permafrost thaw
- High winds
- Wildfire
- Decarbonization
- Data
- Emergency management

Breakout group discussions

Objective: Identify infrastructure climate change adaptation needs and gaps (e.g., standards, guidance, research and tools)

Round 1:

1. Introduce yourselves by name and organization
2. 5-minute independent work time. Write down all your thoughts on the post it-notes and add to the flip chart paper
3. Take a few minutes to group together similar/overlapping ideas
4. Open discussion

Round 2:

1. Introduce yourselves by name and organization
2. Review the ideas that came through Round 1
3. 5-minute independent work time. Add all your thoughts on the post-it notes and add to the flip chart
4. Arrange/group similar ideas
5. Open discussion

Lunch break

45 minutes

Housing, Infrastructure and Communities Canada

Logement, Infrastructures et Collectivités Canada

Driving Uptake and Impact of Resilient Infrastructure Guidance

4 December 2024

Chad Nelson, chad.nelson@infc.gc.ca
Housing, Infrastructure and Communities Canada

Outline

- Context for Driving Uptake
- Spotlight on Federal Action
- Challenges
- Many Opportunities and Solutions
- Roles and breakout session

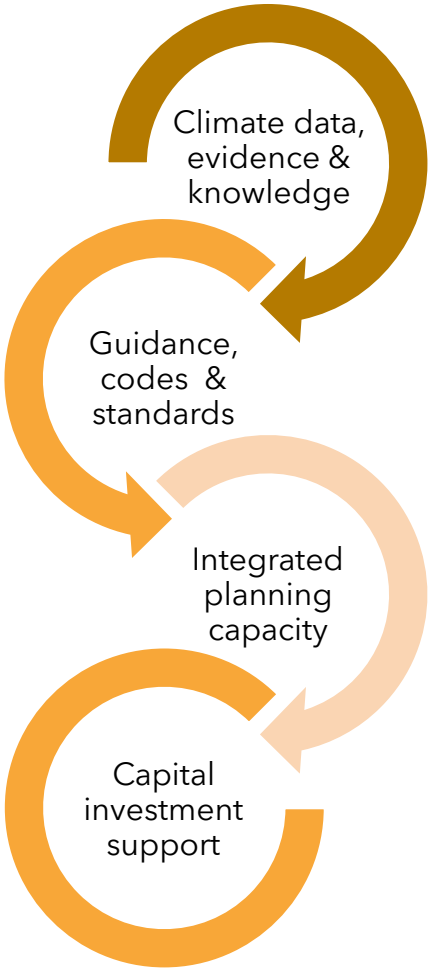
Where and How to Drive the Most Uptake and Results?

What are the **priorities** and **how to best foster user adoption?**

- For **different climate hazards**
- For **different types** of infrastructure **assets and sectors**
- Across various **stages of asset development** (policy setting and funding, siting, planning, design, procurement, operation and maintenance, and rehabilitation)
- For **different scales** – from the single asset up to the **community-scale**

While systematically considering projected **investment levels**, social **and economic well-being**, against **climate risk**.

A Value Chain Approach to Building Resilience



HICC supports resilient infrastructure and communities by taking a 'value chain approach,' that moves knowledge to action through a strategic sequence of investments.

- **Resilience value chain**: A model that demonstrates key areas of work, and the relationship between them, to accelerate implementation of solutions.
- **Informed investor approach**: Encouraging infrastructure investors to make informed decisions.

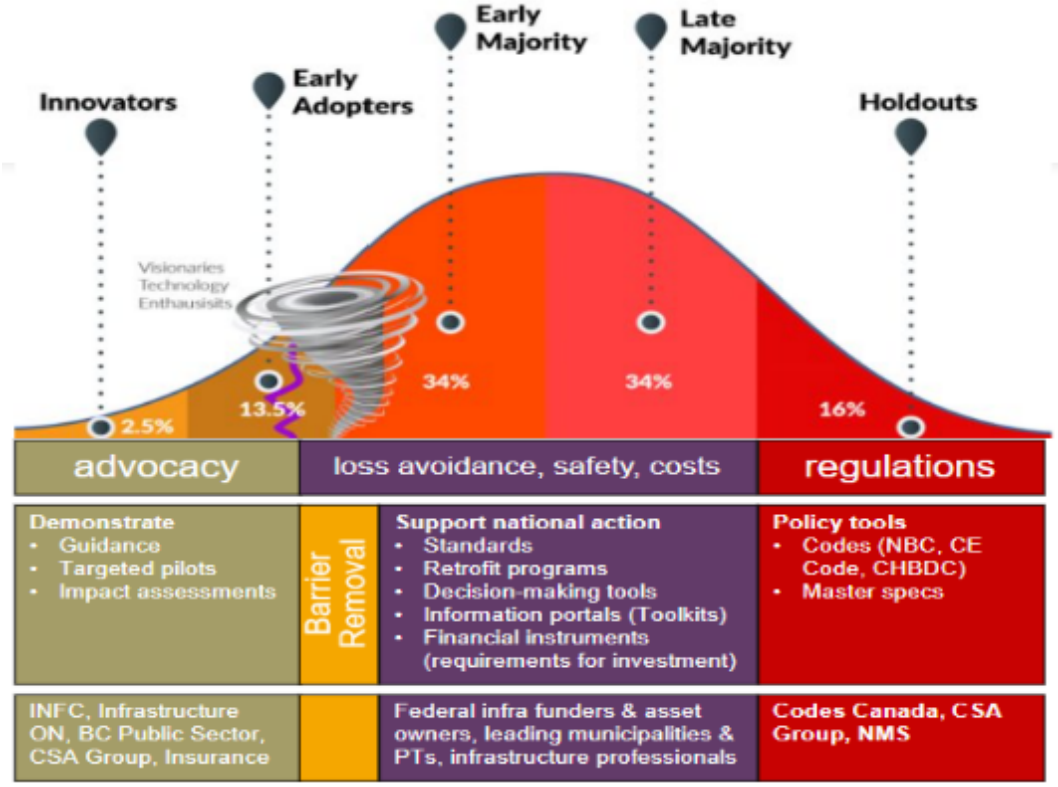
Housing, Infrastructure and Communities Canada

Spotlight: HICC's Approach to Uptake

- Generating and sharing knowledge
  - E.g., guidance development
- Integrating adaptation into federal policy and planning
  - E.g., resilience requirements
- Building adaptive capacity
  - E.g., Climate Toolkit and Helpdesk, multi-stakeholder discussions

Challenges

- **Costs:** inadequate economic analysis that overstates costs compared to direct and indirect benefits
- **Resistance:** to change and novel approaches
- **Accessibility:** "turnkey" standards, guidelines and tools can increase ease of use and adoptions
- **Others:** …



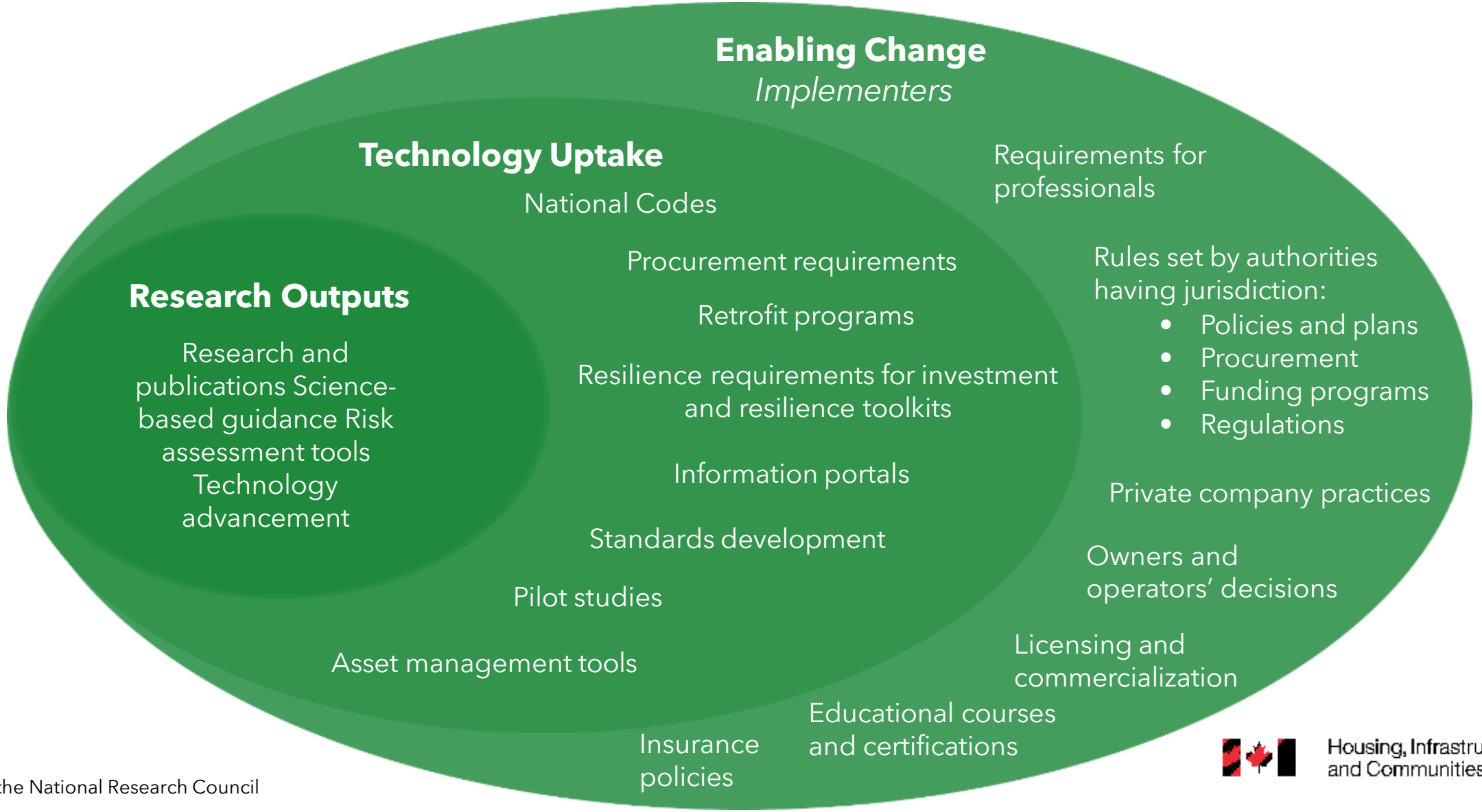
Recipe for Success

Model for Managing Complex Change

Vision	Skills	Incentives	Resources	Action Plan	=	Success
Vision	Skills	Incentives	Resources	Missing	=	False Starts
Vision	Skills	Incentives	Missing	Action Plan	=	Frustration
Vision	Skills	Missing	Resources	Action Plan	=	Resistance
Vision	Missing	Incentives	Resources	Action Plan	=	Anxiety
Missing	Skills	Incentives	Resources	Action Plan	=	Confusion

Adapted from Knoster, T. (1991) Presentation in TASH Conference. Washington, D.C. Adapted by Knoster from Enterprise Group, Ltd.

Many Opportunities and Solutions



Adapted from the National Research Council

Housing, Infrastructure and Communities Canada

Breakout Groups: Understanding Roles

1. Scientists and researchers
2. Civil Society
3. Engineers, architects and planners
4. Funders
5. Insurers
6. Asset owners and managers
7. Policy makers and regulators