Enhancing Knowledge about Public Infrastructure

Perspectives in the Federal Family

Report

May 2004

RESEARCH AND ANALYSIS

INFRASTRUCTURE CANADA

Canada

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Executive Summary

This report provides an analysis of presentations made by fifteen federal departments, agencies and a Crown corporation at the December 2003 and January and March 2004 meetings of the Horizontal Research Roundtable on the State of Infrastructure (HRRSI). The presentations addressed three questions:

- What is "public infrastructure" for your organization?;

- What types of "public infrastructure" are of principal interest for your organization?; and

- What are the strategic objectives of your organization vis-à-vis "public infrastructure"?

Through an examination of the presentations and discussions, the report examines the parallels and dissimilarities between departments' perspectives, priorities, strategic objectives, and research interests related to infrastructure. There are three principal findings:

- No one definition or perspective is adequate to capture the diversity of public infrastructure within the Government of Canada, nor is one necessary. Instead, and very importantly, federal family organizations agree, unreservedly, that the essential quality of public infrastructure is that it provides collective benefits for Canada and for Canadians.

- Public infrastructure is a dynamic concept. Reflecting this, perspectives on public infrastructure in the federal family are evolving and expanding to include new categories of infrastructure, especially those related to the well-functioning of a 21st century economy and society; and

- Within the federal family, there are sub-families or clusters of organizations with shared interests and especially shared strategic objectives vis-à-vis public infrastructure. These clusters can be seen as falling along a continuum that has a focus on tangible (or physical) infrastructure at one end and a focus on intangible infrastructure at the other.

The report also provides critical intelligence about horizontal themes and corresponding priority areas for horizontal research. Six priority areas emerged from the federal family presentations and the ensuing discussions:

- Economic, social and environmental impacts;

- State of infrastructure;

- Financing mechanisms;

- Technology, innovation and transformative infrastructure;

- Governance; and

- Communities/cities

The central challenge for the HRRSI in the next phase of its collaborations is to develop more fulsome and detailed, policy-driven research action plans to guide its knowledge generation, community-building and knowledge dissemination and transfer activities in these areas.
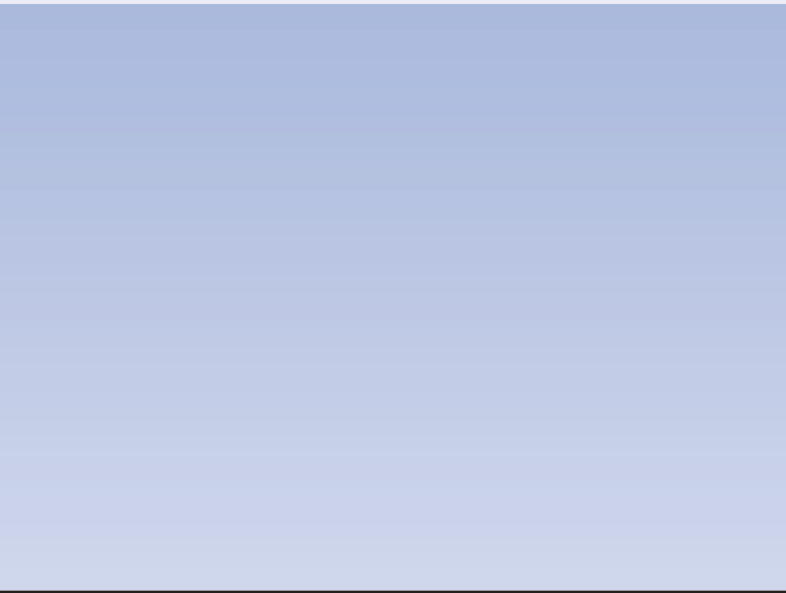
1.0 Introduction

In the 2002 Speech from the Throne, the Government of Canada made a long-term commitment to modernizing Canada's public infrastructure. It also created Infrastructure Canada (INFC) to be a focal point in the federal government for policy development, programme administration and research on public infrastructure.

The Research and Analysis Division at INFC is responsible for ensuring that a more rigorous, comprehensive, and integrated knowledge foundation is in place to support and inform policy- and decision-making. As part of this work, in the fall of 2003 Research and Analysis established the inter-departmental Horizontal Research Roundtable on the State of Infrastructure (HRRSI). The HRRSI is a new venue in the Government of Canada designed to facilitate and foster information exchange, to enhance knowledge on horizontal infrastructure issues and to strengthen the research community interested in infrastructure issues in the federal government. Through the HRRSI, more than 25 federal government departments, agencies, and a Crown corporation[1] are presently engaged in collaborative research on key horizontal issues related to public infrastructure. This research responds directly to needs identified through consultation with policy-makers across the federal family. In addition, the HRRSI is placing a priority on ensuring its research results are shared, disseminated and effectively transferred for policy purposes.

At the first meeting of the HRRSI in October 2003, members decided that its research should begin with an exploration of what "public infrastructure" means for different federal organizations. Therefore, the objectives of the December 2003 and January and March 2004 meetings were two-fold: to learn what "public infrastructure" means across the federal family; and to understand the strategic objectives being pursued by the federal government through programs, policies, research and other activities related to "public infrastructure."

This report provides an analysis of presentations made by 15 federal family organizations[2] at the December 2003, January and March 2004 meetings. Each of the presentations addressed three questions:

- What is "public infrastructure" for your organization?;

- What types of "public infrastructure" are of principal interest for your organization?; and

- What are the strategic objectives of your organization vis-à-vis "public infrastructure"?

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1   The following federal family organizations are members of the HRRSI: Agriculture and Agri-Food Canada, Atlantic Canada Opportunities Agency, Canada Economic Development for Quebec Regions, Canada Mortgage and Housing Corporation, Canadian Heritage, Environment Canada, Finance Canada, International Trade Canada, Health Canada, Indian and Northern Affairs Canada, Industry Canada, Infrastructure Canada, National Defence, National Research Council, Natural Resources Canada, Public Safety and Emergency Preparedness Canada (formerly Office of Critical Infrastructure Protection and Emergency Preparedness), Parks Canada, the Policy Research Initiative, the Privy Council Office, Public Works and Government Services Canada, Statistics Canada, Transport Canada, the Treasury Board of Canada Secretariat and Western Economic Diversification Canada. For simplicity only, the term "department" is used in a generic way for these organizations throughout the report.

2   Atlantic Canada Opportunities Agency, Canada Economic Development for Quebec Regions, Canada Mortgage and Housing Corporation, Canadian Heritage, Environment Canada, Health Canada, Indian and Northern Affairs Canada, Industry Canada, Infrastructure Canada, National Defence, Natural Resources Canada, Public Safety and Emergency Preparedness Canada (formerly Office of Critical Infrastructure Protection and Emergency Preparedness), Public Works and Government Services Canada, Transport Canada, and Western Economic Diversification Canada.

The report examines the diverse perspectives that were offered on these questions. It also identifies and discusses the leading horizontal themes and related research issues that emerged, both in the presentations and the subsequent, often very lively discussions among the approximately 50 HRRSI members at each meeting.

The findings presented in the report constitute an important contribution to knowledge about infrastructure in the federal family. They will also help the HRRSI refine its priority areas for research and guide its knowledge generation, community-building and knowledge dissemination activities in the next phase of its collaborations.

It is important to note that, while some organizations such as the National Research Council and Statistics Canada are active members of the HRRSI, they did not make presentations on the three questions. This report is based only on the 15 presentations that were made; therefore it does not reflect the entirety of federal activities vis-à-vis public infrastructure.

2.0 What Does Public Infrastructure Mean in The Federal Family?

2.1. Perspectives on "Public Infrastructure" and Infrastructure of Principal Interest

This section examines how the 15 federal family organizations understand "public infrastructure" and what types of "public infrastructure" are of principal interest to them.

The difficulty of defining infrastructure was immediately apparent at the HRRSI meetings. However, one of the key conclusions from the presentations and discussions was not the difficulty of defining "public infrastructure," but rather that it is unnecessary to reach consensus on one specific definition—and, as some contended, that it is probably misguided to see this as the most desirable goal. Understanding first, that there is a diversity of departmental perspectives on infrastructure and second, that at the same time there are similarities and differences among them is often sufficient for research, policy and program purposes.

This conclusion is consistent with the fact that among external experts there is no agreement as to what constitutes infrastructure. As Vander Ploeg recently noted in his important study for the Canada West Foundation on the challenges of terminology and methodology in the area of infrastructure, "conceptions about infrastructure are changing and the list is expanding to include non-physical items that have not traditionally been thought of as infrastructure."[3]

Building on earlier literature, Vander Ploeg divides infrastructure into categories that reflect the expansion of the concept.[4] Historically, we have relied on traditional infrastructure such as highways, telecommunications, water supply and distribution, and energy utilities. These are tangible (physical) and "hard" (i.e., for Vander Ploeg, considered essential to the economy and to society). Public housing and public health infrastructure (e.g., hospitals and health clinics) are also considered to be traditional, tangible and hard. High-tech infrastructure is also tangible and hard but, as Vander Ploeg argues, it is equally non-traditional and includes the Internet, e-mail, and cellular and satellite telecommunications.

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3   Casey G. Vander Ploeg, "Municipal Infrastructure in Canada: Issues of Terminology and Methodology." Canada West Foundation, November 2003, p. 7.

4   Ibid., pp. 6-7.

"Amenities," according to Vander Ploeg, are traditional and tangible infrastructure that until recently were not considered to be part of the national infrastructure and were consequently labelled as "soft" infrastructure. This category includes public parks, museums, and other leisure, recreational, community and cultural facilities.

Finally, Vander Ploeg shows that knowledge-based infrastructure is the most recent addition to our concept of infrastructure. Like amenities, it is generally considered to be "soft"; however, it includes both tangible and intangible infrastructure. Tangible examples include educational facilities, libraries, and research facilities, and intangible examples include the national weather service, publicly available electronic databases, information and research networks, and business and university links.[5]

While Vander Ploeg's classification may be useful for analytical purposes, the distinction between "hard" and "soft" infrastructure has faded in Canada. As the HRRSI's deliberations concluded, infrastructure is a dynamic concept: it reflects the changing nature of what is essential to a society at a particular time. The infrastructure that is con- sidered to be "essential" to a society, or the investments in infrastructure that are considered to be "essential," change over time as a society evolves. Historically, Canada has invested heavily in "essential" or "hard" infrastructure. Over time, however, investments in "soft" infrastructure have become increasingly important. The presentations and discussions at the HRRSI meetings suggested, moreover, that the fundamentally dynamic nature of infrastructure (as opposed, for instance, to a firm distinction between "hard" and "soft" infra- structure) must be central to policy design and implementation to meet the infrastructure needs of Canadians in a knowledge-based economy and society, especially in the medium- to long-term.

The perspectives on public infrastructure presented by departments at the HRRSI meetings include some or all of the categories outlined by Vander Ploeg as well as one additional category— "transformative" infrastructure. Transformative infrastructure is a system of deep structural adjustments that have both a scope and depth of effect sufficient to alter virtually every aspect of the economy, society and the environment. The Internet is a well-known example of transformative infrastructure. Perhaps most importantly, the dis- cussions at the meetings demonstrated that, in this regard too, the concept of public infrastructure as it is understood in the Government of Canada is dynamic and evolving to include the more recent types of infrastructure, such as knowledge-based infrastructure and transformative infrastructure. The implications for public policy on infrastructure and related issues clearly merit further investigation.

With respect to the meaning of public infrastructure, the leading area of consensus among depart- ments at the HRRSI meetings was that what makes public infrastructure public is not a matter of ownership, but rather benefits to the public. In other words, infrastructure—whether privately or publicly owned—is "public" infrastructure because it delivers collective benefits to the public. Those benefits may warrant further discussion, since departments strive to provide Canadians with not only infrastructure, but also the benefits of that infrastructure. The water disaster in Walkerton demonstrates that physical infrastruc- ture itself is not adequate to maximize collective benefits. Although departments did not explicitly discuss how benefits fit into their concept of infrastructure, their strategic objectives often reveal the benefits that they pursue through infrastructure investments.

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5 Casey G. Vander Ploeg, "Municipal Infrastructure in Canada: Issues of Terminology and Methodology." Canada West Foundation, November 2003.

A central point of discussion at the first meeting was the inclusion and scope of "intangible" infrastructure within the concept of "public infrastructure." Departments agreed that "intangible" infrastructure such as data, protocols, and scientific research should be included, but some departments questioned where to draw the line. Including too many types of intangible infrastructure could reduce the usefulness of the concept of public infrastructure for policy, program and research purposes if it results in a concept that is boundless. This is a key finding because it is indicative of a broad understanding of infrastructure across the Government of Canada though not a consensus on the concept of infrastructure. This finding offers yet more confirmation that conceptions about infrastructure are changing and expanding to include non-physical items that have not traditionally been thought of as infrastructure within the Government of Canada.

The HRRSI meetings uncovered clusters of departments that share similar understandings of key aspects of infrastructure. The remainder of this section analyzes the perceptions presented by departments at the December 2003 and January and March 2004 HRRSI meetings and the types of infrastructure of principal interest to those departments, and groups the departments according to their similarities.

Infrastructure Canada understands public infrastructure for policy and program purposes as core physical assets instrumental to supporting the delivery of public services. INFC also recognizes the importance of examining, mainly for research purposes, a broader notion of public infrastructure, that is the key basic or underlying structures on which Canada's society and economy are built and which makes it able to work. This broader notion of public infrastructure includes intangible infrastructure and, consistent with the department's mandate for longer-term policy development, transformative infrastructure.

The HRRSI's deliberations demonstrated that there is a continuum across the federal family with respect to the emphasis placed on tangible and intangible infrastructure. Although all of the other departments at the meetings, like INFC, presented dual perspectives on infrastructure combining tangible and intangible infrastructure, some are focused mainly on physical assets while others are primarily focused on intangible infrastructure or underlying structures—and not just for research purposes. Tangible and intangible infrastructure are also linked in these various perspectives in different ways, and to varying degrees.

Environment Canada and Transport Canada are primarily focused on tangible (physical) infrastructure. For example, in its list of core infrastructure, Environment Canada (EC) includes water, wastewater and storm water infrastructure; waste and biosolids management; transportation; green spaces; and energy. The department's priority is infrastructure that helps protect the health of Canadians and the environment—"environmentally sustainable infrastructure"—such as infrastructure that helps address climate change by reducing greenhouse gas emissions (e.g., sustainable, renewable energy) and green municipal infrastructure.

Transport Canada (TC), though involved in some knowledge-based infrastructure (e.g., intelligent transportation systems), is mainly focused on physical transportation infrastructure—the long-life, capital-intensive civilian works that support the Canadian transportation system. Of principal interest to the department is the surface, air, and maritime transportation infrastructure that the department owns, regulates, finances and/or operates, or infrastructure that is a compelling public or national interest case. (e.g. privately owned infrastructure that the department feels is important to support or promote). An example of a compelling public interest case is the Pearson Airport air-rail link to downtown Toronto. The department felt that it was much needed infrastructure, but the private sector was reluctant to provide the funding necessary to get the project going. TC provided funding for the initial planning, and a privately owned consortium is completing the project.

Like Environment Canada and Transport Canada, the Canada Mortgage and Housing Corporation (CMHC) is focused on tangible infrastructure. The types of infrastructure in which CMHC is most interested overlap with the interests of Environment Canada and Transport Canada; however, CMHC is distinct in that it is primarily interested in infrastructure affecting communities and cities, including rural and northern areas. CMHC has no formal definition of public infrastructure but includes all the elements that make up our communities including physical, social, and economic infrastructure. In particular, CMHC is interested in housing and green infrastructure (e.g., sustainable community planning and development).

For both Public Works and Government Services Canada (PWGSC) and the Department of National Defence (DND) realty assets are of principal interest in terms of the public infrastructure in which they are involved. Public infrastructure for PWGSC consists of real property assets (facilities and installations required to fulfill departmental and public requirements) that the federal departments use in carrying out their mandates. These assets include mainly buildings, but also small craft ports, bridges, dams, some highways, and one dry dock. DND considers "public infrastructure" to be the framework of capability support systems including both military and civilian infrastructure(s) (e.g., realty assets, human resources, community services and support to Canadian Forces operations) that help fulfill the responsibilities of the Canadian Forces and DND. The Defence department operates many kinds of infrastructure including water and wastewater infrastructure, waste infrastructure, transportation infrastructure, energy systems, airfields, naval jetties, bulk fuel storage sites, and ammunition depots. A major part of this infrastructure support framework for the department is the (fixed) realty asset systems. The realty assets managed by the department include land (property), buildings, municipal works (water, sewers, roads, heating plants, etc.), and specialized operational works (airfields, fuel depots, ammunition storage facilities, naval jetties etc.).
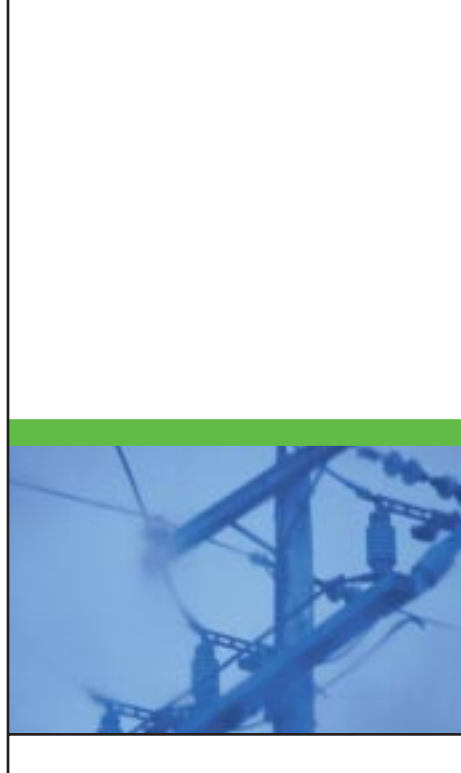
For Canadian Heritage, public infrastructure is "cultural infrastructure"—where the collective memory of the nation is preserved for future generations—and consists of tangible infrastructure such as museums, libraries, and historic sites as well as the intangible infrastructure necessary to support these physical entities such as research, databases, and cultural education. Canadian Heritage is also involved in on-line cultural infrastructure such as the Canadian Heritage Information Network and the Virtual Museum of Canada.

Canadian Heritage's presentation at the HRRSI meeting focused on a particular program within the department, Cultural Spaces Canada (CSC). For this program, public infrastructure consists of gathering places for artists and the community. Examples include theatres, museums, cultural centres, art galleries, and other places where artists and the community can gather and where Canadian voices are heard and stories told. The infrastructure of principal interest to Cultural Spaces Canada is meeting spaces that provide for cultural participation and expression and that connect Canadians through active citizenship and participation in cultural activities.

Western Economic Diversification (WD), Atlantic Canada Opportunities Agency (ACOA), Canada Economic Development for Quebec Regions (CED-Q), and the Department of Indian and Northern Affairs Canada (INAC) focus on infrastructure for specific populations and regions. All four departments are particularly interested in infrastructure as a means of fostering economic development. WD is concerned with tangible and intangible infrastructure that will contribute to economic development in Western Canada including highways, high-tech infrastructure, knowledge-based infrastructure such as educational research facilities, and health infrastructure. ACOA is most concerned with infrastructure that promotes economic development in Atlantic Canada. The agency seeks infrastructure investments that will increase earning income and employment. The region has increasing requirements (and a focus) for public infrastructure in the areas of high-speed Internet services (e-learning, telehealth) and transportation (air, highway, and marine transportation). Other areas of interest to ACOA include water and wastewater infrastructure, solid waste management, energy, and culture and tourism. ACOA's interests in infrastructure are also related to innovation—better access to markets, investment and ideas results in the creation of new products and services. CED-Q has three main foci related to infrastructure in Quebec: infrastructure with an economic, urban or regional impact (including knowledge-based infrastructure); green infrastructure (such as water and wastewater infrastructure); and local transportation infrastructure. Its interest in these areas of infrastructure is tied to its mandate to promote the economic development of regions of Quebec, enhance employment and prosperity, and pay special attention to those regions experiencing slow growth and inadequate employment.

For INAC, public infrastructure is the infrastructure necessary to First Nations and Northern communities such as water and wastewater, schools and teacherages (teacher residences), roads, bridges, electrification systems, community buildings, fire protection and housing. INAC has a dual mandate including Indian and Inuit Affairs, and Northern Affairs. The department is interested in infrastructure that is "economic" (for non-residential, commercial purposes and that help these communities to develop) or that helps First Nations become self-reliant communities. Northern Affairs, which has a regional development role in the three territories including industrial and research sites far beyond the communities, adds interests in transportation, communications and energy networks, in infrastructure design innovations to deal with climate and remoteness, and in scientific infrastructure such as laboratories.

Industry Canada (IC), Health Canada (HC), and Natural Resources Canada (NRCan) divide their concept of infrastructure into two or more types. For Industry Canada, public infrastructure consists of "core infrastructure" and "technological infrastructure". "Core infrastructure" consists of large physical assets and involves both public and private economic and social overhead capital. This includes machinery and equipment, engineering construction, buildings, facilities, and the services sector. "Technological infrastructure" includes both tangible and intangible infrastructure such as telecommunications, research programs in enabling technologies, research and development networks, and broadband access. IC is principally interested in transformative infrastructure, and infrastructure that supports technological change and new processes, and that drives productivity and innovation.

Health Canada also divides public infrastructure into "core" and "technological" with core infrastructure being the basic framework for a community or state. According to Health Canada's understanding, core infrastructure can be divided into "core (health) infrastructure", which consists of fixed capital assets used by the public for a common and central need and designed to promote health, and "core support infrastructure," which is more general and consists of the environmental conditions necessary for sustaining health and the health and environment management systems needed to protect health (e.g., emergency planning and preparedness). Clearly, this type of infrastructure overlaps with the infrastructure roles of other departments, and consists of the many facets of infrastructure that relate to health. For example, Health Canada includes power generators, safe and reliable water systems, and human resources within its list of core support infrastructure. In contrast, "technological infrastructure" is more narrowly conceived and includes telehealth applications and health information systems.

Public infrastructure for NRCan includes two main categories: physical infrastructure, and knowledge infrastructure. Physical infrastructure includes engineering construction (e.g., transportation systems, buildings, etc.), machinery and equipment, the physical environment (land, water, forests, etc.),[6] and NRCan facilities, laboratories, lands, and capital assets to support delivery of public and institutional infrastructure. Scientific and technological knowledge infrastructure includes data, protocols, maps, science and technology, impact assessments, monitoring and reporting systems etc. Knowledge infrastructure includes information necessary to make balanced decisions regarding natural resources. Infrastructure of

principal interest to NRCan is knowledge infrastructure regarding the impacts of infrastructure, mitigation methods, and decision-making. Due to NRCan's emphasis on knowledge infrastructure, the department recognizes the importance of human resources (i.e., people in the context of skills and knowledge) as a component of knowledge infrastructure.

Within the new federal portfolio of Public Safety and Emergency Preparedness Canada (PSEPC),[7] the branch dealing with Critical Infrastructure Protection and Emergency Preparedness (CIPEP) plays a unique role with respect to infrastructure. Its mandate is to provide national leadership for protecting Canada's critical infrastructure and to be the government's primary agent for ensuring national civil emergency preparedness for all types of emergencies. Therefore, the public infrastructure that is of interest to CIPEP (PSEPC) is "national critical infrastructure (NCI)," which is the physical and information technology facilities, networks, and assets, which if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of Canadians and the effective functioning of governments in Canada. NCI is seen as a subset of public infrastructure *writ large*. PSEPC includes ten sectors of infrastructure within the parameters of national critical infrastructure: energy and utilities, communications and information technology, finance (e.g., banking, securities, investments), health care, food (e.g., food safety, food distribution), water, transportation, safety (e.g. emergency services), government, and manufacturing. From

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6   NRCan did not include the physical environment as a component of infrastructure in its presentation at the January 2004 HRRSI meeting, but added it to its revised presentation deck in April 2004.

7   The Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) presented to the HRRSI on December 10, 2003. Two days later, on December 12, 2003, the government announced the new department, Public Safety and Emergency Preparedness Canada (PSEPC), under which OCIPEP became the branch of CIPEP.

an emergency management perspective CIPEP (PSEPC) has an interest in promoting the mitigative benefits of certain types of infrastructure, such as the Red River Floodway, which can be used to protect communities from natural disasters, and in promoting disaster resistant structures. Further, CIPEP has an interest in ensuring that Canada's critical and built infrastructure is developed to standards that take into account the hazards and risks they may face. By doing so, and by building in resiliency, the infrastructure is able to minimize or withstand the effects of disasters and emergencies in order to maintain operational effectiveness over time.

Federal perspectives of infrastructure continue to evolve over time to include new forms of infrastructure, and the conceptions and areas of principal interest to federal departments reflect this evolution. While most departments are focused on tangible, hard infrastructure, some departments have begun to include intangible, knowledge-based, or transformative infrastructure in their perspectives. As a result, federal departments demonstrate a wide diversity of interests related to public infrastructure.

2.2 Strategic Objectives Vis-à-vis Public Infrastructure

The Government of Canada does not invest in public infrastructure for the sake of infrastructure itself, but also to achieve the instrumental benefits (e.g., social, economic and environmental) that derive from such investments. Federal departments invest in infrastructure to further their strategic objectives; therefore, their strategic directions vis-à-vis infrastructure are mandate-driven and reflect their respective roles and responsibilities.

Some departments that have similar understandings of public infrastructure or similar interests have different strategic objectives. For example, Industry Canada (IC), Health Canada (HC), and Natural Resources Canada (NRCan) all have similar ways of defining public infrastructure, yet IC's strategic objectives relate to economic development, HC's relate to social (health) outcomes, and NRCan's strategic objectives relate to federal resource policies and science and technology that support the sustainable development and competitiveness of the energy, forest, mining, and related sectors. Examining the strategic objectives of departments helps to illuminate the research interests of departments and the themes that traverse the Government of Canada, which will assist with establishing key priorities areas for research. This section analyzes the presenting departments' answers to the third question—"What are the strategic objectives of your organization vis-à-vis public infrastructure?"

To ensure that investments in infrastructure leverage maximum public benefits, INFC has adopted a policy leveraging framework for infrastructure, following consultation with federal departments. Using a policy leveraging framework means that funding decisions are based on a recognition of support for infrastructure as well as support for policy, funding, regulatory or legislative changes that serve to enhance the primary and auxiliary benefits of the infrastructure being funded. For example, a program that funds transportation and also requires that all funded projects reduce urban air pollution or encourages municipalities to undertake associated pollution reduction measures, results in benefits to the environment as well as providing infrastructure. The policy leveraging is a lens through which funding decisions are made for INFC programs such as the Canada Strategic Infrastructure Fund (CSIF) and the Municipal Rural Infrastructure Fund (MRIF). It is also a tool that can assist INFC and other federal departments in maximizing total benefits to Canadians from federal activities in areas related to but beyond infrastructure, for instance adapting to climate change or facilitating Aboriginal employment.

Infrastructure Canada's mandate—to manage and lead federal participation in the development and implementation of a long-term strategy to meet Canada's modern infrastructure needs—is inherently connected with other departments' strategic objectives regarding infrastructure. A few other departments have infrastructure-related strategic objectives that are relatively broad and are linked to the activities and interests of other departments. For example, PSEPC's strategic objective vis-à-vis infrastructure—to help assure the continuation of essential services and the continued viability of national critical infrastructure—complements the interests and responsibilities of many departments. Also, Transport Canada's strategic objectives for infrastructure are far reaching and include integrated transportation systems, efficient trade and passenger corridors, and urban transportation

needs such as climate change policies from both supply and demand perspectives. These objectives relate to Environment Canada's interest in sustainable urban transportation and the reduction of harmful environmental impacts of all transportation, and the concerns of ACOA and INAC regarding transportation.

DND and PWGSC—in contrast to INFC, PSEPC, and TC—have strategic objectives that are more mandate-specific and related less closely to other departments. Both departments are in the process of reducing inventory while facing a maintenance and repair backlog for aging infrastructure, especially realty assets. DND's strategic objectives are to reduce its inventory and increase levels of investment in the realty that it retains. DND faces significant funding challenges because of the construction backlog, maintenance and repair backlog, and age backlog of its assets. Similarly, PWGSC has been in the process of devolving much of its asset base over the past few years. The department uses alternative service delivery (ASD) arrangements to maintain

much of its building stock. PWGSC's traditional infrastructure asset base is shifting away from its original assets (e.g. bridges, highways, dams etc.) and becoming more buildings centred. PWGSC is striving to do more with fewer resources and older facilities, in a secure and safe manner while being environmentally and socially responsible; therefore, like DND, the department faces issues related to budgetary constraints, the age of its assets and the changing requirements for its buildings while also trying to contribute to urban renewal, and address environmental and climate change concerns.

Social outcomes are the cornerstone of the infrastructure activities of Canadian Heritage (Cultural Spaces Canada), Health Canada, and CMHC. These departments' strategic objectives relate to the improvement or development of physical and technological infrastructure in order to achieve social outcomes. Cultural Spaces Canada's strategic objectives primarily relate to buildings—improve access to performing arts, visual arts, media arts and to museum collections and heritage displays; and contribute to improved physical conditions for artistic creativity and innovation—but the overall goals are to foster cultural expression and to connect Canadians. These social objectives are accomplished through funding improvement, renovation, and creation of arts and heritage facilities. Health Canada's strategic objectives vis-à-vis infrastructure are to improve Canada's health infostructure, improve First Nations' and Inuit access to health services, create more secure work conditions and accommodations, and improve health and environment management systems, in order to achieve a healthier population by promoting health and preventing illness. In addition to its economic and environmental goals, CMHC is focused on improving housing infrastructure in order to achieve social goals such as improving housing choice and affordability, reducing homelessness, and improving living conditions for households with distinct needs. According to CMHC, housing can help address the root causes of poverty when linked with education and training.

The infrastructure-related strategic objectives of Environment Canada and Natural Resources Canada (NRCan) are closely connected. Environment Canada's strategic objectives are to manage the demand and use of scarce resources; reduce the use of toxic and other harmful substances; improve transportation and energy sustainability; protect priority ecosystems and species at risk; and develop, obtain and manage new environmental technologies. NRCan has two main strategic objectives. The first is to ensure that Canadians have knowledge and information about Canada's landmass, energy and natural resources to aid in decision-making, respond to natural and man-made hazards, and advance sustainable development. The second is to ensure that Canadians derive sustainable social and economic benefits and mitigate environmental impacts from the development and use of energy and natural resources. In terms of infrastructure, these objectives relate to building national knowledge infrastructure about Canada's geography and geology, including data on its natural resources; developing methods and technologies to improve the nation's physical infrastructure (e.g., energy efficient buildings) and reduce infrastructure impacts and failures (e.g., how to increase resistance of buildings to explosions); and contributing to infrastructure decision-making through its scientific and technology activities leading to improved knowledge, data, regulations, and standards (e.g., assessing the impacts of climate change).

IC, WD, ACOA, CED-Q, and INAC all have strategic objectives related to economic development. Industry Canada's strategic objective is to improve Canada's innovation performance and make Canada the most connected country in the world. WD's strategic objectives are to help meet the needs of Western Canadians, promote sustainable communities, and foster innovation. ACOA seeks to improve understanding of the link between infrastructure and economic development, and the means of optimizing infrastructure investments. More specifically, ACOA's interest in infrastructure extends to understanding regional economic challenges and how infrastructure specifically can help meet those challenges (i.e. how to improve Atlantic Canada business access to global markets and investment through better transportation links). In Quebec, CED-Q's objective is to improve the environment for economic development, and facilitate the development and renewal of rural and urban infrastructures. INAC is focused on infrastructure as an economic development enabler. Other areas of interest to INAC include alternative capital financing such as public-private partnerships (P3s), climate change impacts, connectivity, and First Nations' capacity for infrastructure operation and management.

Through their presentations at the HRRSI meetings, participating federal departments described their understanding of infrastructure, their interests and their strategic objectives related to infrastructure. Together with the resultant discussions, the presentations point to several horizontal themes.

3.0 Horizontal Themes

One of the key findings of the HRRSI process thus far is the horizontal themes that the meetings have uncovered. Four themes were discussed most frequently and by the greatest number of presenting organizations:

- the social, environmental and economic impacts of infrastructure (including climate change and water infrastructure);

- technology, innovation and transformative infrastructure;

- governance; and

- communities/cities.

This section outlines these themes and shows the linkages among them and the research interests of the departments as they relate to public infrastructure.

Social, Environmental and Economic Impacts of Infrastructure

It is generally acknowledged that much more is known about the economic benefits and impacts of public infrastructure than the social and environmental impacts. Some federal departments have expressly studied the economic impacts of infrastructure. Others however, such as WD, ACOA, INAC, CED-Q, IC, and TC are in agreement based on their presentations to the HRRSI that key questions remain. ACOA explained the need for a better understanding of which types of infrastructure facilitate economic development, what synergies and complementarities exist in incremental infrastructure investments, and how investments can be optimized. INAC also discussed the importance of infrastructure for economic development and the need to be able to determine which types of infrastructure are most critical in fostering economic development.

Environment Canada (EC) and Natural Resources Canada (NRCan) are involved in evaluating the environmental impacts of infrastructure. EC's main objective vis-à-vis infrastructure is to improve its environmental sustainability (e.g., improved transportation and energy sustainability etc.). NRCan is also concerned with infrastructure as it relates to sustainable development and the competitiveness of natural resource sectors, infrastructure impacts on natural systems (e.g., air, land and water), and the impact of natural hazards on infrastructure.

TC and IC are concerned with the social, environmental and economic impacts of infrastructure. TC is interested in evaluating the impacts of transportation infrastructure in order to alleviate congestion, facilitate trade, reduce GHG emissions, and improve air quality. For example, it is conducting studies on congestion measurement, the welfare cost of reducing GHGs in the passenger and freight sectors, and the promotion of short sea shipping. IC is involved in evaluating the economic, social and environmental impacts of infrastructure for its work on community development, broadband deployment, future work on the social economy, and other areas.

While many departments are concerned with the economic or environmental impacts of infrastructure, Health Canada, Canadian Heritage, and CMHC are particularly concerned with the social impacts of infrastructure. Health Canada is concerned with the impact of infrastructure on health care, Canadian Heritage is interested in supporting infrastructure that promotes cultural expression, and CMHC uses infrastructure to address housing affordability and social problems such as homelessness. There is a need for a better understanding of the social impacts of infrastructure.

Two specific areas of concern regarding the impacts of infrastructure include climate change, and water and wastewater infrastructure. Due to the complexity of these issues and the breadth of their impacts, these two areas merit special attention; therefore, the next two subsections deal with departments' interests in infrastructure impacts related specifically to these two areas.

Climate Change

Several departments discussed the need for research on infrastructure that will help to mitigate climate change (e.g., infrastructure that will reduce greenhouse gas emissions). For example, PWGSC mentioned the need to address climate change concerns, and WD is interested in infrastructure related to climate change and energy efficiency. Raising awareness of the impact of the Kyoto Protocol implementation on regional development is a priority for CED-Q. EC is looking at infrastructure that helps address climate change by reducing greenhouse gas (GHG) emissions (e.g., sustainable, renewable energy), and CMHC is working to reduce residential GHG emissions at the building and community scale. Industry Canada expressed an interest in infrastructure that moves toward the economy of the future, and used a hydrogen fuel economy as an example. TC is also dealing with climate change and requires research on topics such as transportation modelling, the implementation of transportation demand management and active transportation measures, municipal modelling, and evaluating public vehicle technologies.

The aforementioned departments are mainly concerned with climate change mitigation, whereas INAC, PSEPC, and NRCan are already dealing with both climate change adaptation and climate change mitigation. These departments are interested in research expertise on infrastructure that will adapt to the effects of climate change. For example, the effects of climate change in the North are already significant. The melting of permafrost has devastating effects on housing and roads in the North. Consequently, INAC's research priorities include climate change impacts on future and existing infrastructure and the impact on infrastructure costing.

Supporting climate change adaptation and impact research is also of interest to PSEPC, which works to ensure Canada's critical infrastructure is resilient to all hazards, including increasing climate variability and extremes. This refers to physical infrastructures such as coastal roads and railways which may become more vulnerable to storm surges and also to more diffuse infrastructures such as the health sector, which is expected to face increasing pressures to respond to a climate-linked spread of certain vector-born diseases such as West Nile virus (spread by mosquitoes) and Lyme disease (spread by ticks). PSEPC's interest reaches to the development of infrastructure that relates to the management of the possible effects of climate change, e.g., floodways or coastal protection structures, in order to reduce or eliminate the effects of disasters.

NRCan includes both climate change mitigation (e.g., reducing GHG emissions of infrastructure), and climate change adaptation (e.g., making adjustments to enhance the viability of infrastructure and reduce its vulnerability to climate change) among its research priorities. For example, its research activities and interests include the economics of carbon credits, possible off-sets from fast-growing plantations, the impacts of climate change on infrastructure such as urban drainage systems and northern pipeline route selection; adaptation strategies aimed at increasing resilience; and reducing the vulnerability of infrastructure by encouraging the incorporation/consideration of climate change into regulations, standards and decision-making regarding infrastructure design and maintenance.

Water and Wastewater Infrastructure

The presentations confirm that water is an extremely important area of infrastructure in Canada and touches on the mandates or responsibilities of many departments. Thirteen of the fifteen presenting departments at the meetings and one non-presenting agency (National Research Council) mentioned or participated in discussions regarding water infrastructure. Clearly, this area of infrastructure is a key concern across departments.

Included in CED-Q's strategic objectives is the facilitation of the development and renewal of rural and urban infrastructure including drinking water and wastewater. EC recommends the implementation of water demand management practices, and PSEPC has an interest in the vulnerability of water and waste water systems both in terms of water control and treatment. CMHC has worked to encourage the development and use of alternatives to conventional water infrastructure especially in remote locations. CMHC has found that creating self-contained portable infrastructure can be cheaper than bringing in conventional infrastructure in remote areas and can reduce the demand for resources while taking advantage of available infrastructure. The water sources for CMHC's portable housing are mainly rain and recycled water (greywater). Greywater is a common area of research among departments, as is sewage infrastructure. EC, DND, PWGSC, NRCan, CMHC, and the National Research Council (NRC) all expressed an interest or an involvement in greywater or sewage infrastructure research.

Technology, Innovation and Transformative Infrastructure

Many departments mentioned that their research interests relate to technological infrastructure, technological tools for infrastructure, or transformative infrastructure. A few departments specifically categorize some types of infrastructure as "technological infrastructure." In addition, technological tools are increasingly used for infrastructure delivery and management. INFC and IC both mentioned the need for "transformative infrastructure."

PSEPC emphasizes the increasing interconnectedness of our infrastructures, and particularly the pervasive use of information technology in controlling and managing infrastructure, as being a major factor in the evolution of our infrastructure now and in the future. Technological systems as infrastructure present new and emerging challenges in terms of risks, vulnerabilities and protection both for the systems themselves as well as for the interdependencies they create (e.g., computer-controlled electrical power grids).

For Industry Canada and NRCan, "technological infrastructure" includes infrastructure such as telecommunications, research programs in enabling technologies, and broadband access, and for Health Canada it includes telehealth applications and health information systems. CMHC uses innovation and new technologies in housing design. In these examples, technologies are the actual infrastructure. In contrast, technological tools such as information technology are increasingly used for infrastructure delivery and management. For example, modern asset management—a systematic process of maintaining, upgrading, and operating physical assets cost-effectively—is conducted with the use of powerful computer systems that can create the

necessary analytical tools and techniques. Asset management is a lifecycle management method for infrastructure because it takes into consideration expenditures from construction through maintenance during the entire life of an asset. Departments such as PWGSC and DND are interested in technology for infrastructure lifecycle management and share research interests in new and improved realty asset performance measures (asset lifecycle management) and predictive modelling for realty asset operations.

Many departments use a variety of technological tools for infrastructure: NRCan's geomatics, geoscience and other technical expertise is essential for sound infrastructure planning, management and decision-making; PSEPC's research includes geospatial risk modelling in critical infrastructure protection and emergency management, and cyber infrastructure assurance; and Transport Canada uses information technology to manage transportation infrastructure. For example, intelligent transportation systems (ITS) are integrated applications of information processing, communications and sensor technologies for transportation infrastructure and operations. Canada is a world leader in ITS technologies. Examples include road weather information systems (RWIS), transit automatic vehicle location and smart cars.

Both INFC and NRCan emphasize the importance of transformative infrastructure. Technology and innovation contribute to the development of transformative infrastructure. INFC asked, "What are the required infrastructures for the future while recognizing that funds are limited?" NRCan asked if infrastructure is in place to take Canadians to the economy of the future.

Governance

Several questions surround the issue of infrastructure governance: What are the best models for infrastructure delivery? How should federal departments and other levels of government work together to deliver infrastructure? What can we learn from the delivery of infrastructure by regional agencies that have regional-federal relationships? How should infrastructure projects be managed and operated after construction? Should local communities be more involved in infrastructure planning, maintenance or operation? How? What are federal responsibilities for the assurance of critical infrastructure not directly within its control?

Canadian Heritage, INAC, PWGSC, PSEPC, and TC discussed governance issues. In terms of infrastructure planning and delivery, Cultural Spaces Canada works directly with non-profit organizations and municipalities, well-rooted in communities. Also, rather than having regional envelopes, funding decisions are made by consensus. The regions provide recommendations and a national committee reviews each project. Using numerous factors, this committee weighs them against what has been invested in that particular region, what artistic disciplines and genres they are serving, and also gives special value for targetted groups such as youth, official language minorities, Aboriginal communities and culturally diverse communities.

INAC's research priorities include First Nations' capacity for infrastructure operation and maintenance and the viability of alternative capital financing such as public-private partnerships. For infrastructure projects, in the majority of cases, First Nations establish the contracts and the government provides funding. Upon completion of construction, the First Nations are responsible for operations and maintenance. First Nation communities are engaged in planning their infrastructure and submit their needs to the department. Departmental regional capital plans reflect those infrastructure needs, ranked in accordance with the national priorities of the Long-Term Capital Plan of the department.

PWGSC uses alternate service providers (ASPs) to manage many of its buildings. Proposed modifications to the ASP agreements will increase the spending threshold for those ASPs, which means that the ASPs could spend more before coming to PWGSC for permission. In other words, this type of governance arrangement may lessen the department's control over the quality of the buildings unless detailed performance standards are part of the service delivery arrangements.

PSPEC is concerned with governance structures suitable for guiding critical infrastructure assurance within each level of government and among other private and public sector stakeholders. There is an expectation among stakeholders that the federal government will provide some leadership and propose a structure to address the gap in direction and coordination at the national level.

Governance is also an issue and research priority for Transport Canada. For example, the department is exploring new governance and investment regimes for roads and public transit with provinces and territories. It is also conducting studies on the effective governance of transportation infrastructure investment in Canada; international urban transportation policy frameworks, strategies and governance models; and full cost accounting for transportation.

INAC, Industry Canada, and PWGSC mentioned that the use of public-private partnerships (P3s) is a research priority. According to PWGSC, initial upfront capital needs necessitate an increase in the use of P3s. The department is looking at P3s to provide some information technology infrastructure. Lease-to-purchase was the most common type of P3 that the department used in the 1960s, and operations and management is more common now.

Communities/Cities

Cities and communities are essential to Canada's future. In the 2004 Speech from the Throne, the federal government committed to a "New Deal" for Canada's municipalities, a deal that, among other things, will target "the infrastructure needed to support quality of life and sustainable growth" in Canadian cities.[8] The PCO Cities Secretariat supports the Prime Minister, the Parliamentary Secretary with special emphasis on cities, and the Prime Minister's Advisory Committee on Cities and Communities. In addition to providing policy advice on the New Deal, the Cities Secretariat coordinates horizontal policy development and communications.

The PCO Cities Secretariat has a strategic interest in infrastructure because it is a core element of sustainable cities and communities—from a cultural, social, environmental and economic perspective.[9] In this context, the Cities Secretariat's interests include developing a sustainable communities lens on government activities; enabling horizontal cooperation to achieve strategic outcomes; understanding options for the New Deal; encouraging community capacity, such as long-term planning; and facilitating agreements and partnerships that contribute to sustainable communities.

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8   "Speech from the Throne to Open the Third Session of the Thirty-Seventh Parliament of Canada." February 2, 2004.
9   The PCO Cities Secretariat is a member of the HRRSI.

The HRRSI process confirmed the breadth and extent of federal family organizations' interests in the cities and communities theme. Numerous departments are interested in research related to municipal infrastructure and urban development. For example, in addition to its work on housing, CMHC is interested in promoting housing and transportation that can help prevent sprawl, and the implementation of smart growth approaches and urban re-development. CED-Q is interested in local transportation, municipal infrastructures, and urbanization. Through federal programs such as the Municipal Rural Infrastructure Fund (MRIF), INFC will support local infrastructure needs in smaller and rural communities. ACOA expressed interest in the economic impacts of transportation infrastructure on connecting communities and promoting economic growth. Strategic directions in infrastructure investments for Transport Canada include urban transportation needs (e.g., public transit and demand management). PSEPC has a clear interest in municipal infrastructure from a public safety and security point of view, to ensure Canadians are protected and live with reduced risks.

4.0 Conclusion

This report analyzes the results of the December 2003 and January and March 2004 HRRSI meetings where 15 federal family organizations presented and discussed their perspectives on, and principal interests in, public infrastructure, and the strategic objectives and research interests of their organizations concerning public infra-structure.

The HRRSI meetings were themselves an impor-tant research exercise and point to a number of findings:

- No one definition is adequate to capture the diversity of public infrastructure, nor is one necessary, within the Government of Canada. Instead, and very importantly, federal family organizations agree, unreservedly, on the essential qualities of "public" infrastructure. It is infrastructure that provides collective benefits for Canada and for Canadians regardless of where they live and work;

- Public infrastructure is a dynamic concept. Reflecting this, perspectives on public infra-structure in the federal family are evolving and expanding to include new categories of infrastructure, especially those related to the well-functioning of a 21st century economy and society; and

- Within the federal family, there are sub-families or clusters of organizations with shared interests and especially shared strategic objectives vis-à-vis public infrastructure. These clusters can be seen as falling along a continuum that has a focus on tangible (or physical) infrastruc-ture at one end and a focus on intangible infrastructure at the other.

The report also provides critical intelligence about horizontal themes and corresponding priority areas for horizontal research. It is clear from the results of the first phase of the HRRSI's activities that the following six areas demand targeted, collaborative research attention:

- Economic, social and environmental impacts;

- State of infrastructure;

- Financing mechanisms;

- Technology, innovation and transformative infrastructure;

- Governance; and

- Communities/cities

The report identifies specific research questions in each of these areas; it also provides strong hints about potential opportunities for collaboration among all of the organizations participating in the Roundtable. This will be of invaluable assistance to the HRRSI as it develops more fulsome and detailed, policy-driven research action plans to guide the next phase of its research collaborations.

APPENDIX A:
List of Acronyms

ACOA	Atlantic Canada Opportunities Agency
ASD	alternate service delivery
ASP	alternative service provider
CED-Q	Canada Economic Development for Quebec Regions
CH	Canadian Heritage
CIPEP	Critical Infrastructure Protection and Emergency Preparedness
CMHC	Canada Mortgage and Housing Corporation
CSC	Cultural Spaces Canada
DND	Department of National Defence
EC	Environment Canada
GHG	greenhouse gas
HC	Health Canada
HRRSI	Horizontal Research Roundtable on the State of Infrastructure
IC	Industry Canada
INAC	Indian and Northern Affairs Canada
INFC	Infrastructure Canada
ITS	intelligent transportation systems
MRIF	Municipal Rural Infrastructure Fund
NCI	National Critical Infrastructure
NRC	National Research Council
NRCan	Natural Resources Canada
OCIPEP	Office of Critical Infrastructure Protection and Emergency Preparedness
P3s	public-private partnerships
PCO	Privy Council Office
PSEPC	Public Safety and Emergency Preparedness Canada
PWGSC	Public Works and Government Services Canada
TC	Transport Canada
WD	Western Economic Diversification Canada

Acknowledgements

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