



Natural Resources
Canada

Ressources naturelles
Canada



SCIENCE AND TECHNOLOGY STRATEGY



*Creating a
Sustainable Canadian Resource Advantage
Through Science and Technology*

Canada

FOREWORD

One hundred and forty years ago, Canada's first scientific agency, the Geological Survey of Canada, published a magnificent geological map of Canada. On a scale of 1 inch to 25 miles, it conveyed the geology and geography of southeastern Canada, helping the builders of our nation design a diverse and robust economy for their day.¹

Today, the maps of Canada and the world are much different, both literally and figuratively. The key features of our world continue to evolve as powerful and pervasive social, economic and technological drivers of change make their influence felt. A map reflecting the evolving terrain of the 21st century is required, one that provides an effective guide to how Natural Resources Canada's (NRCan's) world-class science and technology (S&T) will help Canadians create a sustainable natural resource advantage in a fast-changing world.

NRCan's S&T Strategy, as presented in this document, provides such a map. It sets out how NRCan will mobilize, renew and connect our S&T endowments – our people, our ideas, our S&T management systems and our infrastructure assets – to help build a sustainable resource advantage for Canada.

The strategy builds on our S&T successes, some of which are highlighted in these pages. It will enable the department to address large and complex issues linked to resource stewardship, many of which transcend particular resource sectors. It will help us be agile and responsive in providing the best scientific knowledge and timely, evidence-based advice to inform decision making. It supports the priorities and applies the core principles of the Government of Canada's S&T Strategy, *Mobilizing S&T to Canada's Advantage*. Most importantly, this S&T Strategy will help ensure we deliver results for Canadians across many areas of social and economic endeavour linked to the sustainable development of natural resources.

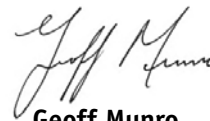
We are pleased to present and endorse NRCan's S&T Strategy, *Creating a Sustainable Canadian Resource Advantage Through Science and Technology*.



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¹Vodden, Christy (1992) *No Stone Unturned: The First 150 years of the Geological Survey of Canada* (Ottawa: Energy, Mines and Resources Canada).

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EXECUTIVE SUMMARY

Today's natural resource stewardship challenges are larger and more complex than ever before. They are being shaped by powerful drivers of societal change in Canada and globally: regional and global economic integration; intensified international competition based on knowledge and innovation; climate change and adaptation; health, safety and national security imperatives; and perhaps most significantly, by advances in science and technology (S&T). At the same time, these drivers of change are opening up opportunities for Canadians to bring new ideas and innovations to the world for building a sustainable natural resource future.

Natural Resources Canada's (NRCan's) S&T Strategy is based on a clear mission to help Canadians build a sustainable resource advantage through S&T excellence. Our S&T has always delivered a strong value proposition – NRCan S&T directly serves the public interest through the generation of reliable, credible knowledge that advances science and fosters innovation, informs public decision making and delivers tangible benefits to Canadians. This S&T Strategy renews the value proposition by setting out five S&T strategic objectives and identifying focused directions and actions for achieving them. It maps out how we will mobilize our S&T to deliver results for Canadians.

Under this S&T Strategy, NRCan will pursue five ambitious strategic objectives over the coming years. We will strive to be

- a recognized source of world-class natural resource S&T
- a champion for applying S&T for sustainable natural resource advantage

- a leader in integrating S&T with policy and program decision making
- a partner in understanding and addressing national and international natural resource issues through S&T
- a trusted and effective communicator of NRCan's S&T priorities, directions and performance

To realize NRCan's S&T Strategy, five priority areas have been identified, each supported by a clear and strong set of actions for achieving results for Canadians:

NRCan's S&T Strategic Priorities



● NRCan's S&T knowledge base

Ensuring continued excellence in scientific, technological and economic research, development and related scientific activities through performing S&T at world-class levels of excellence; integrating our S&T knowledge base to meet 21st century opportunities and challenges; connecting our S&T knowledge base nationally and internationally; and applying and sharing our S&T knowledge base for greater positive impact.

● S&T partnerships and collaboration

Developing effective collaborative arrangements that bring the full capacity of the Canadian science and innovation system to bear on the issues and challenges of today and tomorrow in the natural resources sectors. Through national and international partnerships and collaboration, NRCan will expand Canada's S&T capacity and enhance our place in the world.

● World-class S&T capacity

Supporting our S&T human resources, real property and other scientific assets through investing in our people; renewing our S&T infrastructure; and managing our S&T assets as a national resource.

● S&T governance and accountability

Meeting high standards of S&T governance and accountability by organizing ourselves for integrated S&T corporate decision making; increasing our agility and responsiveness through collective leadership; and enhancing NRCan leadership on national and international S&T priorities.

● Public and stakeholder engagement

Reaching out to and seeking the knowledge and perspectives of employees, stakeholders and other Canadians through pro-actively seeking and considering external advice; deploying new approaches and technologies for engaging NRCan employees, stakeholders and government leaders; and fostering the knowledge, interest and participation of the public in S&T and natural resource issues through active outreach to Canadians.

Implementation of the NRCan S&T Strategy will connect individual actions to broader pillars of NRCan management excellence, including people and funding capacity aligned with objectives; modern governance and accountability systems; supportive and integrative information systems; and performance management and evaluation systems geared to meeting the expectations of Canadians.

NRCan's S&T is a federal asset of enormous value and one of strategic importance in light of the increasing demand for S&T to inform decision making across many areas of public policy. It is a key lever for the department to achieve its three strategic outcomes of economic competitiveness, environmental responsibility, and safety, security and natural resource stewardship. This S&T Strategy, through its mission of S&T excellence, is a powerful and essential instrument for NRCan to improve the standard of living and quality of life of Canadians. Through significant technology development, scientific advancements and contributions to targeted and effective regulations, policies and programs, NRCan will help Canadians create a sustainable natural resource advantage.

Fuel of the future

NRCan has led the charge for Canada's recognition as a world leader in gas hydrate science.

For the past two decades, NRCan, working with various partners in academia, industry and other governments, has led the development of new geophysical tools and methods to characterize gas hydrate occurrences and confirm the feasibility of gas hydrate production.

Gas hydrates – ice-like solids with gas molecules trapped inside – represent a potentially immense energy resource for Canada, one that is cleaner than oil or coal. There are vast reserves of this “fuel of the future” under Canada's Arctic waters and beneath the permafrost in the Mackenzie-Beaufort region.

The United States has estimated there are enough gas hydrates beneath its Alaskan north slope to heat 100 million homes for 10 years. In Canada, the potential energy in gas hydrates in the Mackenzie-Beaufort region and the Arctic islands is estimated to be an order of magnitude greater than all Canadian conventional gas resources and could add decades to Canada's gas supply at current rates of consumption.

NRCan is laying the forward-looking, scientific foundation that will allow responsible extraction of this resource. Already, NRCan, in collaboration with Japan and the Government of the Northwest Territories, can claim a world first that has yet to be equalled – a successful sustained drilling and gas hydrate extraction test in 2008 that proved it is feasible to produce natural gas from a permafrost gas hydrate deposit.

To be ready 20 years from now, when gas hydrates may make more economic sense, NRCan will continue carrying out its leading-edge geoscience – finding and measuring the resource and ensuring the extraction will be environmentally responsible – to help maintain and enhance Canada's place in the volatile and highly competitive global energy market.

This gas hydrate work demonstrates the critical role NRCan geoscience plays in the discovery of new energy sources and the subsequent potential for the development of a sustainable economic base.



OUR MISSION OF S&T EXCELLENCE

Our science and technology (S&T) mission is to build a sustainable Canadian resource advantage through S&T excellence. We measure our S&T “excellence” in terms of relevance, impact and world-class quality. Natural Resources Canada’s knowledge and expertise are world-class and are based on a proud history of success. Our S&T leadership is a cornerstone of Canada’s strength as a natural resources powerhouse.

This S&T Strategy provides a unifying and integrative framework for carrying out this mission. It is a framework for mobilizing, renewing and connecting the department’s S&T endowments – our people, our ideas, our S&T management systems and our infrastructure assets. It will enable the department to provide the best scientific knowledge at the right time for informed decision making.

This S&T Strategy speaks to NRCan’s own people – to our highly skilled scientists, technologists and research staff; to our policy and program officials and administrative staff; and to our executive leadership. It provides us with a guide and touchstone for how NRCan’s S&T will address existing and emerging natural resource-related societal challenges based on the highest standards of scientific excellence. It highlights how S&T will be integrated with the department’s policy and program decision making and will support the Government of Canada’s S&T objectives of fostering Canadian advantages in entrepreneurship, knowledge and people.

NRCan is a results-oriented science organization with national presence, regional impact and global reach

- about 3000 staff supporting S&T activities and delivering results for Canadians
- 18 major laboratories located across the country
- approximately \$500 million in S&T spending annually
- 900 peer-reviewed publications annually
- working with, and drawing strength from, our portfolio partners, our counterparts in provincial and territorial governments, and our other stakeholders
- more than 1000 collaborations annually that generate \$300 million in additional S&T activity relevant to NRCan’s priorities

NRCan’s S&T Strategy also speaks to all Canadians, other levels of government in Canada and diverse stakeholder groups at home and abroad. It shares with them our S&T priorities and directions. It points to opportunities for working with us to build sustainable economic, environmental and social advantages for Canadians.

For more than 150 years, NRCan and its predecessor departments have built and exemplified best practices in performing and applying S&T in the public interest and for the public good. This S&T Strategy looks to the future but is connected to the past through a continuing and steadfast commitment to S&T excellence.

Approach

Before this S&T Strategy was developed, the Office of the Chief Scientist conducted a thorough examination of the challenges and opportunities for NRCan's S&T in a fast-changing world. The report of this work, *Positioning Natural Resources Canada's Science and Technology in the Innovation System*, documents the informed views and perspectives of NRCan's research community, outside experts and more than 60 stakeholder groups. Over the past two years, dedicated members of NRCan task teams, drawn from across the department and led by the Chief Scientist, have considered best practices found across the department and other leading science-based public organizations in Canada and abroad. This S&T Strategy draws on the results of all of this work.

NRCan's S&T Strategy is presented in five sections:

- a summary of the major areas of challenge and opportunity for NRCan S&T leadership
- NRCan's five strategic S&T objectives that succinctly capture and communicate what we want to achieve, then follow
- priority areas for S&T focus and key directions under each
- our expected outcomes
- critical success factors for implementing the strategy

The Government of Canada's S&T Strategy: Objectives and principles

The Government of Canada will foster three distinct Canadian S&T advantages: an Entrepreneurial Advantage, a Knowledge Advantage and a People Advantage. The Government's S&T objectives and its policy commitments will be guided by four core principles.

Promoting world-class excellence. The Government of Canada will ensure that its policies and programs inspire and assist Canadians to perform at world-class levels of scientific and technological excellence. The government will foster an environment of healthy competition to ensure that funding supports the best ideas.

Focusing on priorities. The Government of Canada will continue to play an important role in supporting basic research across a broad spectrum of science. To enhance its success, it will also be more focused and strategic – targeting more basic and applied research in areas of strength and opportunity.

Encouraging partnerships. The Government of Canada will support S&T collaborations involving the business, academic and public sectors, at home and abroad. Partnerships are essential to lever Canadian efforts into world-class successes and to accelerate the pace of discovery and commercialization in Canada. Through partnerships, the unique capabilities, interests and resources of various and varied stakeholders can be brought together to deliver better outcomes.

Enhancing accountability. The Government of Canada will implement stronger governance and reporting practices to deliver and demonstrate results. Accountability is important because it puts the responsibility on those who are supported by public funds to demonstrate to taxpayers that results are being achieved.

Mobilizing Science and Technology to Canada's Advantage (Government of Canada: 2007)

1. LEADERSHIP IN A WORLD TRANSFORMED THROUGH S&T

Science and technology (S&T), wherever it is performed, is essential for achieving the department's three strategic outcomes of economic competitiveness, environmental responsibility, and safety, security and stewardship. Natural Resources Canada's (NRCan's) own S&T provides a distinctive and essential contribution to these outcomes that other components of Canada's innovation system are unable or are not well-positioned to provide in isolation. NRCan leadership will be even more important in the years ahead as the force of S&T as a driver of economic and social change continues with intensity and at a pace not seen before.



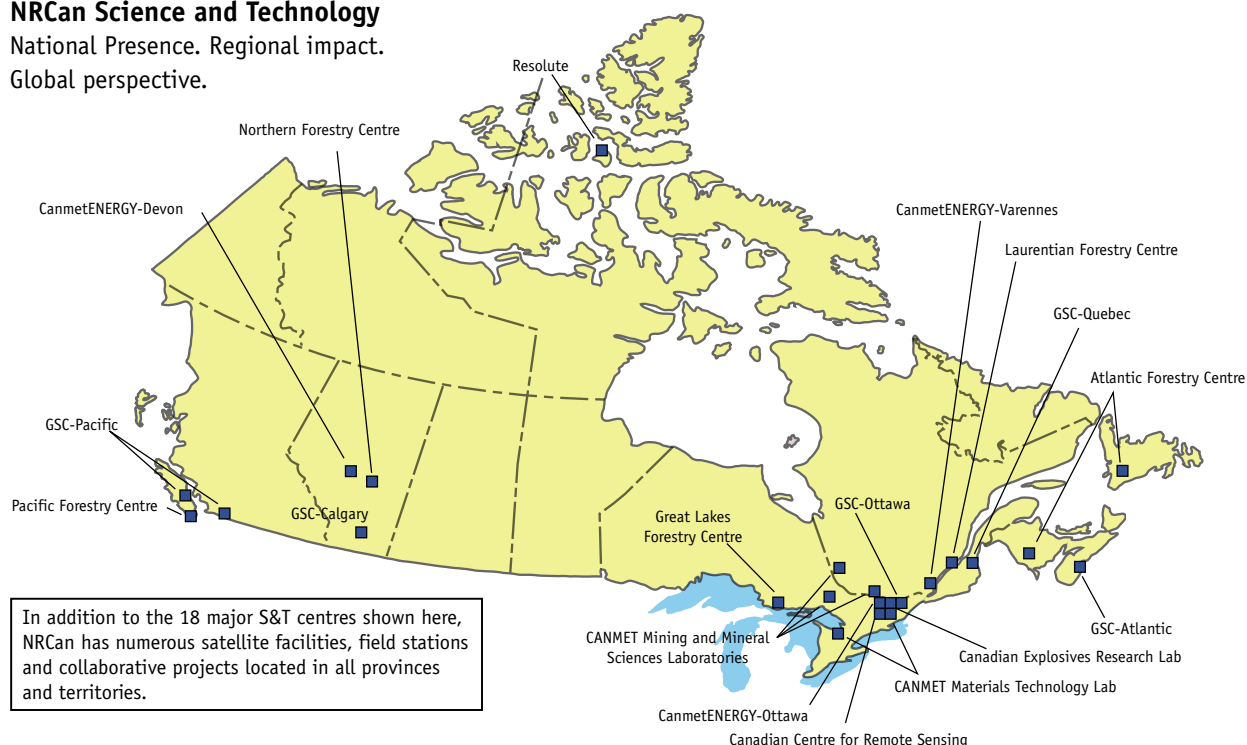
Examples of NRCan's international S&T connections

- Memorandum of understanding (MOU) with China on cooperation in upgrading and refining technologies
- Canada-China MOU on transfer of small hydro technologies
- Geoscience for Andean communities
- Provision of S&T knowledge to the UN Intergovernmental Forum on Mining & Sustainable Development
- MOU with Korea on cooperation in energy and environmental R&D and technology transfer
- Memorandum of agreement with the United States on collaborative energy R&D
- Canada-Mexico MOU on energy efficiency and alternative energy
- The Montréal Process on internationally agreed-upon criteria and indicators for the conservation and sustainable management of temperate and boreal forests

NRCan Science and Technology

National Presence. Regional impact.

Global perspective.



S&T leadership and economic competitiveness

In the 21st century, ideas and knowledge have become the principal contributors to value creation, productivity and sustainability in the natural resource sectors. This remains the case whether we sail on calm economic waters or must navigate through economic storms.

NRCan and our predecessor organizations have a long and distinguished record of providing an S&T foundation for competitiveness across the natural resource sectors. We have helped Canadian resource industries identify and develop economically viable resources. We have strengthened industry's ability to do so in a sustainable manner.



Prairie Creek Mine

Photo: Danny Wright

NRCan S&T powered by partnerships and collaboration

Carbon capture and storage

Partnering with more than 15 public and private organizations to understand the storage of carbon dioxide in geological formations with the Weyburn-Midale CO₂ Project

Synergies in manufacturing research

Establishing a national cooperative research effort on materials and manufacturing with the relocation of NRCan's CANMET Materials Technology Laboratory to the McMaster Innovation Park

Innovation in forestry research

NRCan played a leadership role in creating FPInnovations, one of the world's largest forest research institutes that brings together the private sector, governments and academia.

NRCan's Geo-mapping for Energy and Minerals program

Unites federal, provincial and territorial government agencies, academia and the private sector in partnered projects in Nunavut, the Northwest Territories and Yukon. Its goal is to provide the geoscience information needed to guide investment decisions leading to the discovery and development of new energy and mineral resources.

The Pan-Canadian Mining Research and Innovation Strategy

NRCan has strongly supported the Canadian Mining Innovation Council (CMIC) in its mission to enhance the competitiveness of a responsible Canadian mining industry through excellence in research, innovation and commercialization, including through new collaboration and partnership models.

NRCan's S&T contributions to economic competitiveness

- **Strengthening the marketplace for producers and consumers:** NRCan S&T supports the development of phyto-sanitary measures and the development of codes and standards for the use of forest products in wood construction. These are vital for the effective functioning of both the domestic and international marketplace for wood and wood products.
- **Supporting the development of pre-competitive and frontier technologies:** NRCan is partnering with industry stakeholders on a range of Green Mining initiatives, including development of low-emission mining equipment and tailings management technologies. We are leading the development and deployment of technology to economically capture carbon from power generation and oil sands, as well as investigating its sequestration potential in Western Canada.
- **Disseminating more and better information to market participants on resource location and accessibility:** NRCan develops and disseminates reliable geomatics and geoscience information and services to increase Canada's economic opportunities across sectors. For example, the Targeted Geoscience Initiative focuses on innovative geological mapping in three dimensions to stimulate further private sector investment that helps sustain the reserves of base metals in vulnerable mining communities.

Canada's natural resource industries continue to rely on NRCan as a source of S&T knowledge and expertise that can help them succeed in Canadian and global markets. The department must ensure our S&T knowledge is both integrated (across sectors and across scientific and technological areas) and readily accessible by Canadian industry.

Collaboration among innovation system players is now an essential aspect of building national and international scale, scope and competitive advantage. Leading private and public sector organizations, including those in the natural resource sectors, are no longer investing in every potential area of interest. Instead, they are focusing their S&T investments in what they can do most ably and with greatest efficiency. They are collaborating and entering into partnerships with others with the strategic purpose of drawing strength from what the partners are better positioned to do.

NRCan's own approach to S&T is moving to a more collaborative and open innovation model at all levels, with increasing collaboration between individual researchers, laboratories, departments, sectors and even national innovation systems. This increasing integration is reflected in such new arrangements as the creation of the Canadian Wood Fibre Centre as part of FPIInnovations and the relocation of the Materials Technology Laboratory to McMaster Innovation Park.

NRCan has more than 1000 collaborative arrangements in S&T with external partners. These take different forms (e.g., co-location, in-kind support and cost-sharing) to meet a variety of needs. They cover a wide range of innovation system players, including companies, universities and colleges, provincial and territorial governments, and other federal departments.

Many of NRCan's collaborative arrangements have international reach, involving other countries, international S&T organizations and multinational companies. Moreover, S&T developed in collaboration with Canadian companies is often deployed globally through their international investments and operations.

Going forward, we must ensure that we have the right S&T partnerships in the right areas and with the right governance arrangements – in essence, collaboration and partnerships, but with strategic focus and purpose.

High-quality regulatory regimes (supported by robust systems for standards and measurement) protect and advance the public interest in health, safety and security, the quality of the environment and the social well-being of Canadians. They also matter to the economic well-being of Canadians by promoting a fair and competitive market economy that encourages entrepreneurship, investment and innovation.

NRCan's S&T helps ensure a more predictable and accountable regulatory system – one that fosters entrepreneurial advantage while also supporting positive environmental, health and safety outcomes. For example, both safety and performance standards are being developed for a hydrogen fuelling infrastructure to remove barriers to the introduction of fuel-cell vehicles into our transportation system. Similarly, NRCan S&T is critical for developing codes and standards for the use of forest products in wood construction. Developing standards leads to improved market access for forest products, the development of new and expanded markets, and informed decision making by industry regulators, both in Canada and abroad.

International regulatory cooperation is a Government of Canada priority and an essential means to achieving better economic outcomes for Canadians. NRCan's S&T is being called upon to ensure that international regulatory cooperation initiatives, including those in areas of great environmental challenge, deliver the greatest overall economic and social benefit for Canadians.

S&T leadership and environmental responsibility

Public expectations for finding long-term solutions to environmental issues – many of which are directly or indirectly linked to natural resource management and use – are high and continue to grow. In this context, NRCan has a strong and continuing track record of success in conducting and directing our S&T to support environmental responsibility at home and abroad, including:

- the planning and responsible environmental management of resource extraction operations and eventual decommissioning of any mineral or energy-related development that results from exploration activity
- developing clean energy technologies, including technologies for clean coal, for wind and other renewables, for building energy efficiency and for reducing the environmental impact of major resource developments
- developing new and sustainable mining technologies and advancing materials research in such areas as lightweight materials for automobiles to reduce energy requirements
- national S&T leadership in sustainable forest management, including the development and implementation of a coordinated and risk-based approach to combatting forest pests
- underpinning stronger and more effective energy efficiency standards

NRCan recognizes that all of the large environmental issues, including climate change and adaptation to climate change, require solutions drawn from multiple areas of science and technology.

The present conduct and form of NRCan's own S&T reflect the value our researchers attach to cross-sectoral and multidisciplinary approaches. The challenge for the future is expanding this approach in the transfer of knowledge and application of solutions. This challenge is yet a further reason why NRCan is moving to greater engagement with industry and academia through new collaborative and partnership arrangements.

For NRCan's S&T to contribute to positive environmental outcomes, especially in a sustainable development context as called for in the NRCan Strategic Framework, we must take a long-term view – not just one or two years out, but 10, 20 or even 100 years into the future. With effective foresight, our S&T can inform decision making on new research priorities and resource allocation.

Technology road mapping

- The purpose of technology roadmaps (TRMs) is to chart a course for technology development and deployment by consulting all key stakeholders (businesses, users, governments, etc.).
- NRCan has been instrumental in the development of several TRMs, including clean coal and carbon capture and storage, wind energy and electric vehicles.
- These roadmaps outlined a consensus among stakeholders of what needs to be done on all fronts (technology development, regulations, incentives, information dissemination) to ensure that technologies reach the market.

NRCan's S&T foresight capacity is already proving its worth. NRCan has worked with other federal government departments, provincial and territorial governments and their agencies, industry and academic partners to develop a number of technology roadmaps. These roadmaps identify and prioritize the environmental technologies needed to support strategic research and development (R&D), marketing and investment decisions.

NRCan must now build on the experience and knowledge gained in technology road mapping to develop and embrace new processes and analytical tools that can assist in planning for the future.

Our S&T foresight capacity must systematically integrate evidence from across S&T, economic, social and environmental areas to identify scenarios for the future that help decision-makers anticipate change, rather than constantly chase events. Our foresight must provide a source of guidance for the allocation of research resources.

S&T leadership and safety, security and stewardship

Taking care of Canada's natural resource endowment for present and future generations is a stewardship responsibility shared by all. As previously described, NRCan's S&T is an essential means to better enable Canadians and their governments to exercise this responsibility across economic and environmental dimensions. NRCan's S&T is equally important with respect to resource stewardship for better social outcomes, including the safety and security of citizens and the communities in which they live.

NRCan is increasingly called upon to help address a growing number of safety and security challenges. Our S&T is both conducted and delivered as part of integrated solution sets involving many players. Current examples include:

- NRCan's geomatics S&T contributes to responses to natural disasters both in Canada and abroad, to emergency management including satellite monitoring of seasonal flooding, to search and rescue and to many other national security applications. In addition, Canada's public health officials rely on NRCan's geomatics capacity to support population health surveillance and health emergency response.
- NRCan's materials research and seismic expertise underpin various vulnerability assessments for critical infrastructure, including pipelines and dams, thereby helping to make sure that workers and the public are safe and secure.
- The Government of Canada's Northern Strategy aims to strengthen Canada's sovereignty, advance economic and social development, promote environmental sustainability and improve governance in the North. NRCan's S&T helps support this strategy. For example, NRCan and

Fisheries and Oceans Canada (DFO) have been conducting Arctic surveys over the past three years to acquire the scientific data required to substantiate Canada's submission to the United Nations Commission on the Limits of the Continental Shelf, as provided for by the UN Convention on the Law of the Sea (UNCLOS).

Risk assessment and adaptation to a changing climate

"Making decisions regarding adaptation requires dealing with uncertainty. There are uncertainties inherent in projections of future climate, the impacts of these changes and future socioeconomic conditions (which strongly affect adaptive capacity). Risk management provides a means for dealing with these uncertainties in a manner routinely used for non-climatic factors. It offers a practical and credible approach that is well understood by decision-makers for defining measures to achieve acceptable levels of societal risk, and is currently used in many professional fields."

Impacts to Adaptation: Canada in a Changing Climate (NRCan: 2007)

Risk assessment, based on the most current and reliable scientific evidence, is one of the best ways to evaluate natural resource threats and hazards. For example, NRCan has developed a series of projects to address hazards assessment, vulnerability, risk assessment methods and geohazard awareness, through the engagement of many user groups. These projects provide a legacy of databases, methods and tools for those involved in the mitigation of, and preparedness for, natural disasters.

S&T is an essential input to well-functioning risk management systems. Conversely, risk assessment and risk management processes themselves must work effectively to ensure that S&T resources are directed to appropriate targets for research and analysis. NRCan has considerable experience and success in ensuring our S&T both informs and is responsive to risk management processes.

S&T governance

NRCan's S&T contribution to the stewardship of Canada's natural resources, across economic, social and environmental dimensions, is enabled by an S&T governance regime that has strong corporate S&T leadership, management and oversight, and encourages individual initiative and good ideas.

"Science and policy functions exist in the public service to provide advice to governments. To do this in the best manner possible, it is of paramount importance that science and policy work together in an integrated fashion. Progress has been made by building bridges and interfaces to better link these communities. But the present and emerging challenges are unlike those of the past – they require a fundamentally new approach, one of common purpose and integration."

Report on the 2002 Roundtable on Science and Public Policy: Canadian Centre for Management Development

NRCan is moving to an integrated and horizontal approach to the management of S&T. By implication, this means shifting from a primarily sector-focused approach to a framework that encourages collective leadership, innovative collaboration and knowledge sharing across the department and with stakeholders in pursuit of common goals.

A continuous two-way flow of information between our scientists, policy and program officials, and executive leadership must be maintained and strengthened. This is the essence of science and policy integration.

NRCan's sectors are making strong progress in all of these areas, including integrating their S&T with their own policy development and decision-making processes. With this S&T Strategy, NRCan will take the next step forward by drawing on the best practices in S&T governance found in each sector (and other leading science-based organizations) and applying them across the department as a whole.

NRCan's S&T governance system must continue to effectively translate financial resources to S&T purposes and outcomes. It must be pragmatic and recognize that real budgetary constraints exist. NRCan is working to strengthen our management systems for maximizing the leverage of the available resources and ensuring that they are targeted to priority S&T areas, while at the same time maintaining a certain degree of higher risk efforts that foster greater learning, innovation and ultimately results. NRCan continues to place a premium on accountability – placing the responsibility with those who are supported by public funds to demonstrate to taxpayers that results are being achieved.



Greening the mining process

Imagine a mining industry where the A-to-Z operation – design, extraction, processing, closure and rehabilitation – is green.

That's the aim of NRCan's Green Mining Initiative (GMI). GMI has been created to help the Canadian mining industry compete economically while addressing mining's environmental issues.

GMI is a holistic approach founded on NRCan's innovative research methods and focuses on four main areas – footprint reduction, waste management innovation, ecosystem risk management, and mine closure and rehabilitation.

GMI envisions approaches that, among other things, would minimize amounts of waste rock. That would mean less rock to bring to the surface and subsequently fewer tailings – the "sands" left after the ore has been extracted – to treat and handle for the long term.

To that end, NRCan researchers are working on ways to use heat to replace explosives as a tool. Experiments indicate this method could break the ore into sand-like pieces and leave much more waste rock in place rather than, as with explosives, breaking up huge amounts of rock, bringing it to the surface and treating it to extract the ore.

Another project under the same initiative will add municipal bio-solid waste or pulp and paper waste on top of tailing sites and then grow canola, corn or soy to produce bio-fuel. The project neatly disposes of various wastes, grows a valuable bio-fuel crop and uses wasteland rather than valuable agricultural land to do it.

Early results indicate this new bio-fuel is as clean as any other. Estimates state that the Sudbury region alone has the potential to produce 1 million litres of bio-fuel annually using this new method. That amount could fuel about 800 compact cars for a year.

2. OUR S&T OBJECTIVES

Natural Resources Canada's (NRCan's) science and technology (S&T) strategic objectives must resonate with the values and expectations both of NRCan's own people and all Canadians.

The objectives must:

- seamlessly mesh with the departmental mandate and the principles laid out in both NRCan's Strategic Framework and the federal government's S&T framework, *Mobilizing Science and Technology to Canada's Advantage*
- succinctly capture and communicate what it is we want to achieve by reflecting the pillars of our S&T Mission of Excellence, which are relevance, impact and world-class quality
- be long-lasting – responding to both the priorities and circumstances of today while taking the best possible account of future uncertainties, challenges and opportunities

NRCan's five S&T strategic objectives meet these criteria.

A recognized source of world-class natural resource S&T

To be a recognized source of world-class S&T for the natural resource sectors – one marked by the highest standards of scientific integrity and quality; relevance and responsiveness to current and emerging natural resource challenges; and a willingness to share and apply our S&T for maximum impact and the economic, social and environmental advantage of Canadians.

A champion for applying S&T for sustainable natural resource advantage

To champion the application of S&T to achieve the department's vision of improving the quality of life

of Canadians by creating a sustainable resource advantage. Our S&T will be aligned with our strategic outcomes and support the government-wide S&T strategy to focus on priority areas – especially in natural resources and energy.

A leader in integrating S&T with policy and program decision making

To be a leader and a model practitioner – for both the federal government and for other science-based public institutions – in integrating S&T with policy and program decision making. NRCan will manage S&T across the department in a transparent manner that recognizes and respects the importance of scientific integrity while building an effective and symbiotic relationship among our scientific, policy and program communities.

A partner in understanding and addressing national and international natural resource issues through S&T

To infuse a global mindset in how we approach S&T and innovation. We can share our distinctive S&T knowledge and capabilities with Canada and the world. We will build new national and international S&T partnerships and collaborations that bring S&T ideas and knowledge into the department to help us deliver our mandate.

A trusted and effective communicator of NRCan's S&T priorities, directions and performance

To be a trusted and effective communicator, engaging in dialogue with the public and stakeholders. NRCan will reach out to citizens and stakeholders, listening to their views and responding to their needs. We will effectively communicate NRCan's S&T priorities, directions and performance. We will work to foster an S&T culture of excellence in Canada and help ensure that public debate on natural resource issues is informed by the best available scientific evidence and insight.

A sunny solution to heating homes

The thrust of much of NRCan's S&T could be termed anticipatory problem solving – looking to the future; seeing the challenges that will arise in 10, 20, 30 years or more; and taking innovative, pre-emptive steps now to address them.

That is certainly the case with the Drake Landing Solar Community. Conceived by NRCan in partnership with government organizations and industry, the 52 single-family house subdivision located in Okotoks, Alberta, is expected to see 90 percent of its home heating and 60 percent of its hot water needs met by solar energy by the fifth year of its operation.

Before the full solar potential can be realized, there is a ramp-up period while the ground and the storage tanks are heated. The solar fraction has increased from 55 percent in year one to approximately 75 percent at present and is on track to reach 90 percent in year five. Each home will also produce five tonnes fewer greenhouse gas emissions per year than a conventional Canadian home.

The community is heated by a system that captures and stores solar energy underground during the summer and disperses it to each home to meet heating needs in the winter.

Underlying the concept for Drake Landing is the realization that in Canada, especially in the residential sector, the vast majority of energy used is for space heating, which is based on fossil fuel use. This NRCan-driven undertaking could revolutionize how communities' homes are heated during the winter months.

In the not-too-distant future, when fossil fuel supplies are running out and supply and demand have driven their cost upward, renewable energy – solar energy – will become a necessity.

NRCan, through such forward-looking projects as this, is ensuring that Canada is prepared for that day.



3. PRIORITY AREAS AND KEY DIRECTIONS

Natural Resources Canada's (NRCan's) S&T Strategy identifies five priority areas, each supported by a clear and strong set of science and technology (S&T) directions and supporting actions for achieving results for Canadians. As with the nature of scientific progress itself, the individual actions will be open to review, continually tested and subject to revision as evidence emerges from our S&T, policy and program activities of what works and what does not.

S&T KNOWLEDGE BASE

Ensuring excellent scientific, technological and economic research and development and related scientific activities

Key directions

Performing S&T at world-class levels of excellence

- conduct and support leading-edge S&T that meets world-class standards of excellence as measured by peer review and other means
- ensure appropriate multidisciplinary links across the natural and social sciences and engineering

Integrating our S&T knowledge base to meet 21st-century opportunities and challenges

- create an NRCan enterprise knowledge management system
- examine the requirements for an NRCan-wide advanced foresight capacity to guide our

investments, based on existing departmental practices

Connecting our S&T knowledge base nationally and internationally

- identify and collaborate with other national and global centres of natural resource knowledge
- address gaps in Canada's natural resource S&T capacity
- extend and enhance the recognition of NRCan's connections and contributions to national and international S&T-based priorities

Applying and sharing our S&T knowledge base for greater positive impact

- through new media, enhance dissemination of and access to natural resource S&T within the scientific community and by decision-makers
- benchmark NRCan as a trusted centre of knowledge within the broader innovation system (e.g., through laboratory assessments, bibliometrics and other leading-edge means)
- develop mechanisms to ensure the delivery of accurate and timely knowledge and advice, to enable informed decision making
- accelerate the application and commercialization of NRCan knowledge and innovations

S&T PARTNERSHIPS AND COLLABORATION

Developing effective collaborative S&T arrangements

Key directions

Creating enabling conditions for open innovation

- streamline and strengthen partnership agreements, funding mechanisms and departmental support for multiyear collaborative S&T arrangements
- intensify collaborative S&T relationships within NRCan and with external partners to address horizontal S&T issues

- increase networking with external partners to leverage resources and expertise

Building Canadian S&T scale and focus through national and international partnerships

- foster regional innovation clusters, such as building on the transfer of the CANMET Materials Technology Laboratory to McMaster Innovation Park in Hamilton, Ontario
- capture opportunities to create world-class institutes with external collaborators
- collaborate with our major trading partners on issues of mutual interest

WORLD-CLASS S&T CAPACITY

Supporting human resources, real property and other scientific assets

Key directions

Investing in our people

- maintain a stimulating research environment that can attract, retain and support the best and the brightest in the S&T community
- accelerate implementation of S&T human resources renewal initiatives, such as On-Campus and Mid-Career Recruitment strategies, within a framework for the recruitment and retention of S&T professionals
- support skills development to meet new opportunities and challenges with programs such as Leaders on the Move and Leading Scientific Teams
- support effective knowledge transfer through succession management, mentoring, coaching, collaborative technologies, Emeritus Scientists, etc.

Renewing our S&T infrastructure

- renew our S&T infrastructure and engage in opportunities to increase funding to maintain and repair scientific facilities and related real property

Managing our S&T assets as a national resource

- ensure compliance with government-wide asset management systems and processes
- strategically invest in scientific equipment to conduct state-of-the-art S&T
- share our S&T assets with other government departments, universities, colleges, industry and other stakeholders

S&T GOVERNANCE AND ACCOUNTABILITY

Meeting high standards of S&T governance and accountability through integrated and aligned decision making

Key directions

Organizing for integrated corporate decision making

- share, enhance and develop tools to enable integrated, transparent, evidence-based decision making
- enhance NRCan's structures and approaches in support of the integration of science, policy and programs and a focused, balanced and cost-effective S&T portfolio

Explosives

NRCan is this country's centre of expertise for non-military applications of explosives.

Explosives are part of NRCan's safety and security mandate. The department regulates and authorizes all explosive products in Canada – fireworks as well as the industrial explosives necessary to extract ore, build roads, drill wells, fuel rockets, etc. The *Explosives Regulations* ensure Canada has an efficient explosives industry that operates within certain rules of safety.

The Regulations recognize there must be control of explosives and of access to them, along with appropriate measures to strengthen the security of Canadians and of infrastructure that might be exposed to explosives.

The Regulations are underpinned by NRCan research that includes testing explosives at the CANMET Canadian Explosives Research Laboratory. The laboratory is the only one in Canada dealing with commercial explosives and one of a handful in the world. It aims to reduce the risk to Canadians from explosions, whether accidental or deliberate.

The security side of the department's mandate has taken on added importance in the post-9/11 world. There has been an increased focus on improvised explosives and on developing new regulations for some chemicals that have legitimate uses but can also be used to make explosives for criminal purposes.

Working to ensure the safety and security of Canadians has also meant forming new and/or stronger partnerships – working cooperatively with Defence Research and Development Canada, the Canadian Security Intelligence Service, the Royal Canadian Mounted Police and friendly foreign governments, such as the United States and the United Kingdom.

The department also evaluates the blast resistance of strategic installations and key buildings, such as Canadian embassies.



Increasing our agility and responsiveness through collective leadership

- establish departmental S&T priorities at a corporate level through an integrated, transparent and evidence-based process
- strengthen collective decision making related to S&T delivery mechanisms
- apply a corporate lens, process and department-wide standards to S&T resource allocation
- enhance S&T performance assessment processes to support corporate decision making

Enhancing NRCan leadership on national and international S&T priorities

- play a leadership role in developing and implementing federal S&T policies and programs
- support delivery of horizontal S&T priorities as an active member of the federal S&T community
- prioritize NRCan presence in key international fora

PUBLIC AND STAKEHOLDER ENGAGEMENT

Reaching out to and seeking the knowledge and perspectives of employees, stakeholders and other Canadians

Proactively seeking and considering external advice

- rejuvenate NRCan's formal S&T advisory structure to increase stakeholder engagement in our S&T priority setting
- seek advice from and improve engagement with the Science, Technology and Innovation Council and the Council of Canadian Academies

Deploying new approaches and technologies for engaging NRCan employees, stakeholders and decision-makers

- expand the use of new media and tools (e.g., NRCan Wiki, podcasts, video vignettes, "wired" meeting places) to communicate *with* (not merely to) employees, stakeholders and decision-makers

Key directions

Fostering the knowledge, interest and participation of Canadians in S&T and natural resource issues

- develop an NRCan S&T outreach and communications strategy to guide our public engagement, including with youth, on S&T and natural resource issues

4. EXPECTED OUTCOMES FOR CANADIANS

This S&T Strategy identifies several priorities, directions and specific actions, but what is strategically important is their combined effect in contributing to NRCan's strategic outcomes, Government of Canada priorities and results for Canadians. From this perspective, this S&T Strategy will deliver a strong value proposition in terms of the following outcomes:

- an integrated, relevant and applied S&T knowledge base on natural resources that is accessible to those best positioned to draw new economic and social value from it
- opportunities opened up and taken up for building new S&T collaborative arrangements, partnerships and networks among national and international innovation system players
- a world-class S&T that protects and advances the public interest in health, safety and security, the quality of the environment, and the social and economic well-being of Canadians
- an S&T governance and accountability system that promotes the integration of S&T, policy and program decision making at all levels and is geared to fully meet the demands and expectations of Canadians
- a modern public service employer serving the public interest through the knowledge, experience and professionalism of its workforce today while attracting and developing a talented workforce for tomorrow
- a science-based organization that speaks with a confident, unified and trusted voice on natural resource issues, based on its well-founded reputation for S&T leadership and excellence



Fighting fire – with S&T

The Canadian Forest Fire Danger Rating System – developed by NRCan – is arguably the best in the world.

Although it is a national system, designed to protect people and property and to facilitate the efficient and economical deployment of wildfire-fighting resources across Canada, it is – or adaptations of it are – used in countries around the world, including the United States.

NRCan researchers have been studying forest fires for almost 100 years. Their research has led to – and continues to develop – leading-edge tools and technologies that accurately predict, evaluate, monitor and report on forest fire activity and/or its probability.

A continuing effort to advance and refine that capacity is a key to combatting the projected increased fire activity in many parts of the country that will likely result from climate change.

Although fire is a vital ecological process that influences the landscape and rejuvenates forests by generating new growth, it can also pose a serious threat to public safety and the forest resource.

In recent years, governments in Canada – federal, provincial and territorial – have spent close to \$1 billion a year collectively to fight forest fires.

Making NRCan's knowledge available to forest managers and citizens so that risks can be identified, understood and addressed helps ensure public safety while also seeing that public funds are used effectively.

Canada's fire danger rating system is also a cornerstone of the Global Early Warning System for Wildland Fire now being developed under United Nations auspices. Relying heavily on Canadian leadership, technology and expertise, the global system will provide, as does Canada's, current and forecasted fire danger information.

The "forecasted" information allows fire and land managers to plan and implement fire management strategies in advance, while "current" information allows for prioritized deployment of fire suppression resources.



When you feel the earth move . . .

The safety and security of Canadians is paramount to NRCan.

The department has a commitment to help minimize loss of life and damage to communities and infrastructure from earthquakes, volcanoes, tsunamis, landslides and geomagnetic storms and to enhance disaster response preparedness. NRCan is the Canadian organization responsible for undertaking assessments of these geological hazards, based on its leading-edge, sound science.

The department provides expertise and information that help shape an assortment of policies and decisions. In terms of earthquakes, contributions range from input toward the seismic provisions in the *National Building Code of Canada* to information on designing critical infrastructure, such as an oil pipeline or a nuclear power plant, or locating emergency response buildings.

Southwestern British Columbia and the corridors along the St. Lawrence and Ottawa rivers in Ontario and Quebec are heavily populated and face the threat of large earthquakes. Using NRCan's science-based expertise to plan and build helps diminish the vulnerability of Canadians in these areas.

Across the country, in cities where there are significant earthquake risks – Québec, Montréal, Ottawa, Vancouver and Victoria – specialized maps are drafted by NRCan and its partners. Relevant to large buildings and infrastructure projects, they show areas of higher hazard to help guide planning.

In British Columbia, NRCan provided BC Hydro with key earthquake hazard information for a multimillion-dollar assessment of hydroelectric dam safety. NRCan also assisted the Province in a program to retrofit schools to make them safer in the event of a quake.

Nationwide, NRCan plays a fundamental role in helping Canadians build and live safely.



5. THE WAY FORWARD

Linking to broader pillars of NRCan management excellence

Each element of Natural Resources Canada's (NRCan's) S&T Strategy is important, but the whole is greater than the sum of the individual parts. Successful implementation of the strategy requires broad recognition and understanding of the strong interdependencies among the different elements.

Implementation will also require leveraging the power of each key direction by linking its implementation to broader pillars of NRCan management excellence:

- people and funding capacity aligned with objectives
- modern governance and accountability systems
- supportive and integrative information systems
- performance management and evaluation systems geared to meeting the expectations of Canadians



Assessment, benchmarking and reporting results

Ultimately, the effectiveness of the strategy is measured in its implementation and the continual improvement and learning that flows from monitoring progress and reporting results. Ongoing assessment of our progress is required not only to meet the transparency requirements of accountability to government and citizens but also to meet the need to continually adapt in a changing world.

NRCan will take a leadership role in addressing the analytical challenges in assessing, benchmarking and reporting results from our investments in S&T. We will draw on the very best practices from other organizations and develop our own techniques as required. We will adopt an evidence-based approach to rigorously consider the relevance, quality and impact our S&T. The results will inform our S&T decision making and priority setting and also enable us to better convey to Canadians the impact and effectiveness of our S&T.

Summary

Today's natural resource stewardship challenges are larger and more complex than ever before. At the same time, the drivers of change are opening up opportunities for Canadians to bring new ideas and innovations to the world for building a sustainable future. Guided by this strategy, NRCan will help build Canada's sustainable resource advantage through the excellence of our science and technology.