

# National Research Council Canada

2017–18

## **Departmental Results Report**

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The Honourable Navdeep Bains, P.C., M.P.,  
Minister of Innovation, Science and Economic  
Development

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The Honourable Kirsty Duncan, P.C., M.P.,  
Minister of Science and Sport

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## Ministers' message



**The Honourable Navdeep Bains**  
Minister of Innovation, Science and  
Economic Development



**The Honourable Kirsty Duncan**  
Minister of Science and Sport

We are pleased to present the 2017–18 Departmental Results Report for National Research Council of Canada (NRC).

Over the past year, through integrated work across the various organizations of the Innovation, Science and Economic Development Portfolio, the Government of Canada worked very hard to improve Canada's global competitiveness while creating jobs, nurturing growth and strengthening our country's middle class.

In 2017-18, the Portfolio continued to implement the Innovation and Skills Plan to promote innovation and science, including support for scientific research and the commercialization of research and ideas. The Plan also encourages Canadian small businesses to grow, scale-up, and become more productive, more innovative and more export-oriented. An important area of this work included promoting increased tourism in Canada and the creation of new opportunities in our tourism sector. The Plan's overarching aim to position Canada as an innovation leader has been the driving focus of the Portfolio's programs.

2017-18 was a transformational year for NRC as it started implementing the changes defined through its re-visioning exercise and set the stage for creating lasting impact for Canada through excellence in research and innovation. NRC integrated more fully into the Government priorities by building and working with a wide network of collaborators and clients, stimulating and facilitating business growth through innovation and international market access, advancing scientific knowledge and the next generation of technologies through which Canada is poised to become a world leader, and improving its governance and management of resources.

Through deep collaborations and inclusive partnerships, the Innovation, Science and Economic Development Portfolio organizations have embarked on a shared journey to stronger, cleaner and more inclusive economic competitiveness that benefits all Canadians. This report documents the contributions that NRC is making towards this important work.



## President's message

In August 2016, Ministers provided me with a mandate to better integrate NRC into Government priorities, including the Innovation and Skills Plan, and to improve research excellence, engagement with stakeholders, governance and management.

In response, a year of NRC [Dialogue](#)<sup>i</sup> consultations were launched across Canada, engaging our people in developing ideas and initiatives that would help us land on a lasting vision and mission for NRC.

I am pleased to highlight the significant progress we have made. Not only has the whole of NRC worked together in crafting a new, shared vision for the future, but we also made significant strides towards embedding this vision into our organizational culture:



- We saw research excellence embodied in the wide range of novel insights and advances by NRC researchers, reflected in leading scientific journals and a wide range of funded research collaborations. We also embedded research excellence into many core NRC Dialogue initiatives, including the creation of a research excellence advisory committee comprised of our most senior researchers.
- We reflected on the innovation support and services we provide to business to identify better ways of engaging with our various partners in the Canada ecosystem. In turn, we have refined IRAP's support for thousands of Canadian innovation-based small and medium-sized (SMEs), and NRC laboratories that help hundreds of Canadian firms achieve their research and technology development objectives, with the goal of ensuring that we are accessible, easy to work with, and provide the right kind of support appropriate to each firm's individual needs and goals.
- We also undertook a variety of structural initiatives, such as working closely with Canada's five developing [Innovation Supercluster Initiatives](#)<sup>x</sup>, and beginning the roll-out of several collaboration centres with Canadian universities to bring us even closer to our partners.
- We improved governance, management and accountability, reflected in our new values and corporate mission statement, the establishment of expert stakeholder advisory boards for each of our Subprograms, improved employee survey results and improved health and safety statistics, as well as a re-confirmed commitment to Health, Safety and the Environment.
- Finally, we ensured better management of our resources, including reducing our fees charged to SMEs and academic users of our technical services and facilities, the start of a three-year review of our research facilities to identify priorities for investment, and starting work on strategic plans to guide work and supporting investments in all NRC Programs and Subprograms.

To build on this work to date, Budget 2018 announced \$1.24B over five years in new initiatives - we look forward to the year ahead in this regard.

Iain Stewart  
President





## Results at a glance

NRC strives to be an agent of innovation for the Government, with over a century of experience in supporting industrial innovation, advancing scientific knowledge and technology development, and fulfilling government mandates.

In 2017-18, NRC achieved its performance objectives in alignment with the six areas for action in support of Canada's [Innovation and Skills Plan](#)<sup>ii</sup> and in the priority areas expressed in the [President's mandate from the Ministers](#)<sup>iii</sup>. These results were achieved using \$1.02B in spending authorities and 3,979.2 full-time equivalents. Highlights include the following:

**Aligned to Canada's Innovation and Skills Plan** – NRC completed a comprehensive self-assessment called the NRC Dialogue, culminating with the NRC Action Plan, 2017-2021 to ensure better alignment with the Innovation and Skills Plan and to deliver research and development (R&D) solutions of high value to Canadians. With increased funding announced in Budgets 2017 and 2018, NRC turned dialogue into action with a focus on increasing collaborative work with innovators from higher education and business; testing and validating breakthrough research ideas; and increasing the funding and advisory services to small Canadian businesses serving 2,046 SMEs and supporting 6,542 jobs through its Industrial Research Assistance Program (IRAP).

**Delivered on R&D Initiatives** – NRC led the advancement of important technologies<sup>1</sup> to build a strong economy and improve the quality of life of Canadians. Examples include:

- Developed, with the Public Health Agency of Canada (PHAC), a vaccine against the deadly *Haemophilus influenzae* (Hia) Type A infection that is especially prevalent amongst infants in the North and in indigenous communities.
- Succeeded in biomanufacturing VBI Vaccines' candidate vaccine against glioblastoma, a prolific incurable cancer of the brain, for which thousands of Canadians are diagnosed each year.
- Enabled the growth of the printable, flexible and hybrid electronics sector, advancing Canada's leadership in burgeoning technologies that are poised to be valued in billions of dollars annually.
- Brought smart sensing and big data to the rail industry and demonstrated high reliability of a new technology in a real world transit environment, working with New York City Transit Authority, KLD-LABS, Plasser American and Dayton. T. Brown – the first instance of performance-based measurements for forces at the wheel/rail interface within a North American Transit environment.
- Performed a comparative analysis for a major financial institution on more than 70 commercial buildings housing 40,000 employees to show that green buildings can

<sup>1</sup> To protect commercial interests, the present report respects constraints on disclosing proprietary work.

contribute to a more productive workforce, along with less waste, less consumption of energy, fewer harmful emissions and lower operating costs.

- Supported Siemens Canada in the development of next generation structural materials for future engine concepts through characterization and quantification of material properties at extreme temperatures.
- Supported and contributed to the launch, by a coalition of universities, of the Canadian Hydrogen Intensity Mapping experiment ([CHIME](#))<sup>iv</sup> - Canada's newest and largest radio telescope, that will enable astronomers to construct the first map of dark energy in the universe and better understand the shape, structure, and fate of the universe.
- Collaborated with Pond Technologies Inc. and St. Marys Cement to demonstrate successful capture of waste carbon dioxide using algae, resulting in investments and plans for two commercial deployment sites for large-scale algal conversion of industrial waste.
- Enhanced global epidemic detection through innovative language processing technology based on artificial intelligence and machine learning, now used by the World Health Organization and others to provide early warning to potential threats to public health.

In terms of leading scientific excellence, a 2017 evaluation of NRC's Security and Disruptive Technologies Sub-Program established that SDT researchers perform above the world average in terms of the relative impact of their published work, conduct world-leading research in specific, promising areas including attosecond (ultra-high speed science), and maintain world-class facilities such as the quantum photonics research installations.

In addition, NRC invested in maintaining and enhancing its research facilities. These include a new research facility to design, prototype and produce new advanced materials to enable ground-breaking technology platforms, as well as another facility in the final construction phase designed to test batteries for the Canadian electric vehicle and other related industries.

NRC exceeded all its targets for increasing the innovation capacity of SMEs. Its impacts were high, with 87% of 3,465 surveyed firms reporting an increase in revenue, employment or profit.

**Managed Resources Effectively** – Through NRC Dialogue, employees from across the organization presented almost 60 approved actions to enable a re-imagined and reinvigorated research organization focused on delivering research excellence, solving public policy challenges and spurring business innovation. During 2017-18, NRC progressed in implementing the first wave of these actions with progress made and 19 substantively completed. For example: NRC realigned its R&D initiatives with a focus on larger-scale outcomes, including initiatives to support the [Innovation Supercluster Initiatives](#)<sup>x</sup>, and making more efficient use of resources. It also implemented organizational changes to improve decision-making and organizational agility.

Other examples include working in collaboration with Shared Services Canada to rebuild and modernize information technologies (IT) infrastructure with enhanced security balanced with the need for open and collaborative research environments. NRC also enhanced its ability to attract and manage talent, including the introduction of a new post-doctoral fellowship and student employment programs. In addition, NRC redefined its program delivery model to strengthen governance for performance, as well as to place greater focus on research excellence through a peer review process for research proposals.

NRC began a review of its Internal Services, with a focus on optimizing the effectiveness, efficiency, and client-orientation in such areas as procurement and management of real-property, and implemented its Environmental Management System, starting with two pilot projects, and supported by a newly published Environmental Policy and Directive.

**Experimentation and GBA Plus** - NRC contributed to the Government’s commitment to innovation and experimentation in policy and program design and delivery. The organization established targeted experiments for:

- Increasing diversity, focussing initially on improving the gender balance of research personnel.
- Reducing costs of NRC's R&D and technical services for qualifying SMEs.
- Offering new services that enable clients to timestamp their transactions more accurately and with traceability to NRC’s time standard.
- Using blockchain technology with government-wide potential for making secure, unalterable records available to Canadians.
- Applying new methods for grass-roots ideation and collaboration in R&D programs and projects across NRC. One such exercise provided valuable information and networking to support technology development for next-generation protection gear for military and first responders.

### Diversity

A Gender-Based Analysis Plus (GBA+) review of NRC’s complement of 2101 researchers revealed that only 24.7% are women. Towards improving the balance, NRC engaged a third party to interview women and to identify ways to improve how NRC attracts, recruits and retains women. Implementation of the recommendations is led at the vice-president level, and is integrated into NRC’s Employment Equity Strategy.

Together, these experiments succeeded in instilling new approaches and a culture of innovation in policy and program design and delivery. Plans were also made to launch new experiments in 2018-19 in consideration of the lessons learned from the past year.

For more information on NRC’s plans, priorities and results achieved, see the “Results: what we achieved” section of this report.



## Raison d'être, mandate and role: who we are and what we do

### Raison d'être

NRC bridges the innovation gap between early stage research and development (R&D) and commercialization, focusing on socio-economic benefits for Canada and increasing national performance in business-led R&D and innovation. A federal leader in technology development, NRC supports Canadian industry to enhance their innovation capabilities and capacity and become more productive in the development and deployment of innovative products, processes and services for markets of national priority and importance. While keeping a primary focus on business innovation support, NRC also upholds public policy mandates, and it works to advance knowledge. With a presence in every province<sup>2</sup> and [unique infrastructure](#)<sup>v</sup>, NRC combines its strong national foundation with international linkages to help grow Canada's productivity and remain globally competitive. NRC works in collaboration with industry, governments and academia to maximize Canada's overall R&D investment.

With over 2,000 scientific and technical staff, NRC recently launched [a new online directory](#) for enhanced accessibility to its research experts by clients, and facilitate collaboration with partners and stakeholders<sup>vi</sup>.

### Delivering Innovation Support

The NRC has the facilities, expertise and networks to convene strategic, large-scale national teams committed to cutting-edge innovation.

- Budget 2018



<sup>2</sup> NRC maintains a research presence in Edmonton, Penticton, Saskatoon, Vancouver, Victoria, Winnipeg, Boucherville, Chalk River, London, Mississippi Mills, Montreal (two sites), Ottawa (four sites), Saguenay, Charlottetown, Fredericton, Halifax, Ketch Harbour, Moncton, and St. John's.

## Mandate and role

Under the [National Research Council Act<sup>viii</sup>](#), NRC is responsible for:

- Undertaking, assisting or promoting scientific and industrial research in fields of importance to Canada;
- Providing vital scientific and technological services to the research and industrial communities;
- Investigating standards and methods of measurement;
- Working on the standardization and certification of scientific and technical apparatus, instruments and materials used or usable by Canadian industry;
- Operating and administering any astronomical observatories established or maintained by the Government of Canada;
- Establishing, operating and maintaining a national science library; and
- Publishing and selling or otherwise distributing such scientific and technical information as the Council deems necessary.

For more general information about NRC, see the “Supplementary information” section of this report. For more information on the department’s organizational mandate letter commitments, see the [Ministers’ mandate letters<sup>ix</sup>](#).

### NRC Vision, Mission, and Values

**Our Vision** is a better Canada and world through excellence in research and innovation.

**Our Mission** is to have an impact by advancing knowledge, applying leading-edge technologies, and working with other innovators to find creative, relevant and sustainable solutions to Canada’s current and future economic, social and environmental challenges.

**Our Values** hinge on Integrity, Excellence, Respect, and Creativity, as detailed on [our website<sup>vii</sup>](#).

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## Operating context and key risks

### Operating context

Canada experienced stronger growth in 2017 compared to previous years at 3.0% of GDP, amidst continuing global geopolitical uncertainties. Organizations were bracing for the impact of shifting trade policies and priorities of key trading partners, with anticipated disruption of their global value chains. This was accompanied by a recognized need to assess alternative strategies in order to sustain operations and remain competitive, as evidenced by companies announcing shifts to their investment decisions in 2018.

The release of the [Innovation and Skills Plan](#)<sup>ii</sup> in Budget 2017, referenced earlier, identified a number of high profile initiatives with collaboration implications for NRC, including a role to support and enable efforts around: the [Innovation Supercluster Initiatives](#)<sup>x</sup> (Digital Technology, Protein Industries, Advanced Manufacturing, Artificial Intelligence (AI)-Powered Supply Chains (SCALE.AI), and Ocean); [Innovative Solutions Canada](#)<sup>xi</sup> to help scale-up and grow Canadian SMEs through public procurement; and the [Impact Canada Fund](#)<sup>xii</sup> supporting a ‘challenge’-based approach to help focus and accelerate efforts toward solving Canada’s big challenges, targeting clean technology and smart cities as a start. These created opportunities for NRC involvement, but had to be managed along with the implementation of NRC’s Dialogue Action Plan<sup>3</sup>, while maintaining ongoing R&D initiatives and client commitments. Associated risks around capabilities to support these initiatives and removing barriers to collaboration were addressed as part of the Dialogue initiatives implemented (see risk table). NRC has been working with Canada’s Chief Science Advisor (announced in 2017-18) and will be appointing its own Departmental Science Advisor to work with other departmental science advisors towards advancing efforts to make federal science accessible and facilitating evidence-based policy making.

Internally, a Dialogue Hub was established along with a governance structure including a Steering Committee and Change Management Advisory Board to support the effective implementation of the Dialogue Action Plan and manage the risks associated with implementing the changes. The first wave of projects was launched in 2017-18 while balancing other operational commitments. Budget 2017 and 2018 funding helped advance the projects as planned, and mitigated risks around future capacity to deliver.

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<sup>3</sup> See Results in Internal Services for further details on the Dialogue Action Plan.



## Key risks

The effects of the digital transformation were increasingly evident on industry and society with developments in artificial intelligence, autonomous systems, robotics and virtual environment systems, concurrent with disruptions around biotechnologies, energy and environment, and advanced materials amongst others. Reflecting the pervasive information technology developments, the top five R&D spending organizations in 2017 were noted to be Information and Communication Technology (ICT) companies (Amazon, Google/Alphabet, Microsoft, Facebook and Intel), spending over US\$60B in R&D, with global ICT spending over \$225B predicted for 2018. Accompanying these developments were growing risks around cyber-security, privacy, regulations and standards. These considerations together with the Budget 2018 announcement for a Digital Research Infrastructure Strategy continued to drive the urgency of efforts around building strong R&D information technology (IT) capabilities needed to be a valued service provider and partner for academia and for impactful R&D collaborations. A supply ecosystem (e.g., Shared Services Canada (SSC), external service providers, locally maintained, strategic partnerships) to provide fit-for-purpose research IT platforms is being implemented to increase agility and flexibility, while balancing security needs. A three-year facility review was also initiated towards putting in place the necessary scientific infrastructure to advance key technologies of the future.

While the work around IT and scientific infrastructure help address NRC's risk identified around barriers to collaboration, further progress is noted in NRC's update to its Intellectual Properties (IP) policy to make IP more accessible to Canadian companies, in line with Canada's [Intellectual Property Strategy](#)<sup>xiii</sup>. A new IRAP experimental program and a reduced NRC fee structure also made its services more accessible to build competitiveness of Canadian companies. On the international front, NRC enabled R&D partnerships for Canadian firms through its IRAP initiatives, and established an international engagement strategy focused on key countries (U.K., Germany and Japan).

Global competition for a limited pool of scientific and technical skills available to respond to the shifting needs of the labour market and growing emphasis on digital skills were factors that impacted NRC, noted in efforts to recruit skilled talent in digital technologies. NRC's current initiatives to strengthen linkages with universities and industry, and to build greater visibility and international reputation are anticipated to help mitigate this risk in the longer term to help access the best talent to deliver on NRC's programs and for its clients.

These points are further elaborated in the table below with progress made around the key risks identified around capabilities to support the Innovation and Skills Plan, barriers to collaboration, aging scientific and reliability of IT infrastructure.



Risks <sup>4</sup>	Mitigating strategy and effectiveness	Link <sup>5</sup>
<p>1) Insufficient capabilities &amp; expertise to respond to scale and scope of Canada's Innovation and Skills Plan</p> <p><b>Likelihood:</b> Unlikely (2)</p> <p><b>Consequence:</b> Moderate (3)</p> <p><b>Assessment:</b> Medium</p> <p><b>Tolerance:</b> Moderate</p>	<ul style="list-style-type: none"> <li>• New post-doctoral program implemented to recruit and employ top talent (12 new positions, and further a call has been issued); and student employment program for future talent</li> <li>• Implemented new human resource management system to support hiring, onboarding, learning and performance management.</li> <li>• Renewed promotion criteria for research professionals that reflect research excellence, collaboration and program leadership.</li> <li>• Updated workforce plans developed for Programs and Subprograms.</li> <li>• Active participation in the Federal Science and Technology Infrastructure Initiative (FSTII) to ensure suitable supporting R&amp;D facilities, along with 3-year review of NRC facilities in process.</li> </ul> <p>Successful implementation of the above actions and others related to developing NRC talent, and building infrastructure are helping to sustain current and build future capability in delivering NRC commitments in support of Canada's Innovation and Skills Plan.</p> <p><b>Sample Measures:</b> In addition to NRC performance outlined in the DRR reflecting our support to the Innovation &amp; Skills Plan, staff engagement, as measured through the public service employee survey measured a 13% jump in employee satisfaction in NRC between 2011 and 2017, at 71% and higher than the 68% public service (PS) average. 84% of NRC employees also indicated that they like their job relative to the 80% PS average which can be expected to affect retention.</p>	<p>1. Commitments to the Innovation Skills Plan including digital economy, clean technology, agri-food, advanced manufacturing, bio-sciences, and clean resources.</p> <p><a href="#">Mandate to the Minister of Innovation, Science and Economic Development<sup>ixi</sup></a></p> <p>2. Commitments to innovation support, and engagement of key R&amp;D stakeholders.</p> <p><a href="#">Ministers' mandate to the President of NRC<sup>iii</sup></a></p>

<sup>4</sup> Risks are assessed on a 1-5 scale for likelihood and consequence.

<sup>5</sup> Links to mandate letter commitments or to government-wide and departmental priorities. In addition, all identified risks link to all three of NRC's Programs.

Risks <sup>4</sup>	Mitigating strategy and effectiveness <sup>6</sup>																				
<p>2) Unable to remove barriers &amp; establish common ground for successful and timely collaborations</p> <p><b>Likelihood:</b> Likely (4)</p> <p><b>Consequence:</b> Moderate (3)</p> <p><b>Assessment:</b> Medium</p> <p><b>Tolerance:</b> Low</p>	<ul style="list-style-type: none"> <li>• Brought SMEs, academia, provincial and other research organizations together to enable discussions in support of delivery on the Innovation Agenda (e.g., large scale consultations around Advanced Manufacturing, the results of which supported development of the Economic Table, Intelligent Transportation System workshops)</li> <li>• Engagement strategies developed for stakeholders and key clients: key NRC research and business leads identified to work with each Supercluster; strategic account management framework in development</li> <li>• Fee reduction for SMEs and academia</li> <li>• New guidelines for collaboration centres in development</li> <li>• Revised NRC IP policy to facilitate access and collaboration</li> <li>• International engagement strategy established</li> </ul> <p>NRC has strived to maintain and build relationships with academia, government and industry, including engagement in support of the innovation supercluster development, proposals for new collaborative programs, planned collaboration centres and international initiatives. Work continues, however, to strengthen IT and scientific infrastructure for R&amp;D to support these efforts. The slight dip noted in 2017-18 figures could potentially have been due to capacity issues and multiple change initiatives happening.</p> <p><b>Sample Measures:</b></p> <table border="1" data-bbox="505 1136 1118 1339"> <thead> <tr> <th></th> <th><u>2015-16</u></th> <th><u>2016-17</u></th> <th><u>2017-18</u></th> </tr> </thead> <tbody> <tr> <td>Total clients</td> <td>1,089</td> <td>1,117</td> <td>1,095</td> </tr> <tr> <td>New clients</td> <td>457</td> <td>465</td> <td>415</td> </tr> <tr> <td>% New clients</td> <td>42.0%</td> <td>41.6%</td> <td>37.9%</td> </tr> <tr> <td>Signed agreements</td> <td>2,721</td> <td>2,737</td> <td>2,723</td> </tr> </tbody> </table> <p>Results from NRC’s client satisfaction survey indicate that 90% of respondents were satisfied with NRC’s services (equivalent to 2016-17 at 91%) and 94% (rating 6 and higher out of 10<sup>7</sup>) would work with NRC again (a jump from 91% in 2016-17).</p> <p>From scientific and technical output perspective, external and international collaboration rate for publications have been stable at between 84-86% and 51-53% respectively over the last 4 years.</p>		<u>2015-16</u>	<u>2016-17</u>	<u>2017-18</u>	Total clients	1,089	1,117	1,095	New clients	457	465	415	% New clients	42.0%	41.6%	37.9%	Signed agreements	2,721	2,737	2,723
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<sup>6</sup> This risk links to the same commitments and priorities as Risk 1

<sup>7</sup> The response scale was from 1 to 10, where 1 means “not satisfied at all” and 10 means “completely satisfied”. Responses 6 or higher are interpreted as “satisfied”.

Risks <sup>4</sup>	Mitigating strategy and effectiveness <sup>8</sup>
<p>3) Inability to deliver leading-edge research as a result of aging scientific and unreliable IT infrastructure</p> <p><b>Likelihood:</b> Possible (3)  <b>Consequence:</b> Severe (5)  <b>Assessment:</b> High  <b>Tolerance:</b> Low</p>	<ul style="list-style-type: none"> <li>• An investment planning process and investment management committee is in place to identify and prioritize capital requirements. A review of total capital investment is in progress.</li> <li>• Worked with SSC to strengthen, modernize, and stabilize NRC's information technology resources – including cloud services now available for researchers to access through SSC, and in agreement with SSC, NRC has some ability to development and implement its own Specialized Research Environments.</li> <li>• A real property and building assessment, as well as a 3-year external review of facilities are in progress to assess: facility condition, functionality and utilization, ability to respond to present and future research facility needs, and potential for collaboration/renewal, suitability of divestiture plan. A cross-NRC working group has been established, the facility review framework developed, and an inventory of facilities drafted.</li> <li>• NRC is an active member of all emerging Federal Science and Technology Infrastructure Initiative (FSTII) projects, which provides great opportunity for NRC to renew an aging real property reality.</li> </ul> <p>Progress has been made in 2017-18, however, efforts are continuing to build the needed capabilities for future requirements.</p> <p><b>Sample Measures:</b></p> <p><b>NRC's base building Facility Condition Index<sup>9</sup></b> was 12.5% in 2008, and is currently at 13.5%. Average annual investment in base building infrastructure is approximately \$12M, which is under the \$15M to maintain at 2008 condition (and \$31M recommended by the Treasury Board Secretariat) consequently driving NRC's participation in FSTII.</p> <p><b>Total IT outages</b> (data centre, email, network, mobile phones):  75 (2015-16); 163 (2016-17); 143 (2017-18).</p>

<sup>8</sup> The risk links to the same commitments and priorities as Risk 1.

<sup>9</sup> This ratio compares the total deferred maintenance for a building to its estimated replacement value. It places a value on the capital costs that NRC would incur in the future relative to the costs to rebuild anew. The higher the ratio, the larger the capital needed to keep the building in a functioning state.



## Results: what we achieved

### Programs

#### Technology Development and Advancement (TD&A)

##### Description

This program develops and advances technologies to enhance the prosperity of Canadian industries in support of federal priorities. This includes national-scale flagship technology-development initiatives having sufficient critical mass to contribute demonstrably to national prosperity. To bring new and innovative products and processes to the marketplace, companies must advance the emerging and maturing technologies embodied in applied developments and prototypes to a level where the risk is sufficiently reduced to be acceptable from business, investment, and regulatory perspectives. The program bridges this critical technology gap through mission-oriented research and development services, and specialized technical services such as custom design and fabrication, testing, prototyping, up-scaling, and demonstration in specialized facilities.

##### Results

In 2017-18, clients expressed a commitment to deploy or commercialize 21 innovations that were developed or advanced by TD&A. The 2017-18 target was achieved even as TD&A introduced a larger proportion of longer-term research initiatives grounded in the fundamental sciences and aimed at building the technology platforms of the future.

The Program continued to advance the next generation of game-changing technologies such as “smart” textiles and flexible, wearable, hybrid electronics and supported the growth of related industries, strengthening the Canadian ecosystem.

The Program also engaged key stakeholders from the private, research, and public sectors to propose options for tackling challenges in building smart, sustainable, and integrated cities

in Canada. For its part, TD&A completed an extensive comparative analysis for a major financial institution on more than 70 commercial buildings housing 40,000 employees to ascertain whether investments in “green” buildings bring net returns to Canada. The study concluded unequivocally that green buildings can contribute to a more productive workforce in addition to known benefits that include less waste and less consumption of energy, resulting in fewer harmful emissions and lower operating costs. The results build on an earlier study released by the Program that demonstrated a positive relationship between “green” buildings and indoor air quality.

#### Partnering in Innovation

“We value the close working relationship we have always had with the NRC... (It has) laid a great foundation on which to build a strong ecosystem to support the growth of the wearables and smart textiles sector across Canada, tied into the US and into global markets.”

Peter Kallai, President and CEO,  
intelliFLEX

Additionally during the year, NRC signed a new 5-year collaborative agreement with the University of Alberta, providing a framework for sustained excellence in Nanoscience and technology, leveraging facilities, expertise, and resources from both partners to increase value and impact. In the spirit of experimentation, the NRC-University of Alberta Nanotechnology Initiative invited research proposals to improve the health of Canadians, their environment, and provide new knowledge leading to commercialization or licensing of new technologies. Following external peer-review, nine projects were approved in areas including clean energy, nano-biology and nano-electronics.

In partnership with Pond Technologies Inc. and St. Marys Cement, TD&A contributed to the government’s clean technology and business innovation objectives by co-deploying a photo-bioreactor demonstration plant at St. Marys Cement plant (Ontario) which, over two years of operation, proved the effectiveness of using algae to capture waste carbon dioxide. Buoyed by this successful demonstration in an industrial setting, Pond Technologies secured new investment allowing it to list on the Toronto Stock Exchange and to proceed with plans for two commercial deployment sites.

### Leadership in Clean Technology

TD&A reached a significant milestone that makes Canada a world leader in transforming carbon dioxide emissions into valuable products including biofuel on a commercial scale. The success further enables Canada to address greenhouse gas emissions while generating major economically- and environmentally-sustainable opportunities for Canadian companies.

[Algal Carbon Conversion<sup>xiv</sup>](#) initiative

In addition, TD&A experimented in gauging stakeholders’ existing capabilities in numerical simulation to support the development of protective materials based on nanotechnologies and other next-generation materials. The knowledge of the state of the art gained, and the networks developed, supports NRC’s ability to develop and integrate transformational materials technologies to improve the performance of protective equipment.

Other examples of technology advancements in 2017-18 include:

- The Program collaborated with PHAC to deliver artificial intelligence, machine learning, and natural language capabilities to its global outbreak detection tool, Global Public Health Intelligence Network (GPHIN). This improved its ability to scour media and other sources to identify emerging patterns in occurrences of natural disasters and epidemics. GPHIN is used by key public safety and health organizations including the World Health Organization and the North Atlantic Treaty Organization, providing early warning to potential threats to public health.
- Together with PHAC, the Program developed a vaccine against the Hia bacterial infection, which is especially prevalent in the North and amongst indigenous communities. According to Dr. Theresa Tam, Canada’s Chief Public Health Officer:

“This vaccine ... can contribute to preventing deadly infections for infants at risk of Hia in Canada. We are pleased to see the vaccine progress to the next stage...”

The vaccine has been licensed to InventVacc Biologicals Inc. as it prepared for clinical trials within 12 months.

- TD&A also bio-manufactured a glioblastoma vaccine candidate for VBI Vaccines (Ottawa), enabling the company to raise significant public investment (exceeding \$72M) and increase its workforce. Glioblastoma is an aggressive incurable cancer of the brain with which approximately 3,000 Canadians are diagnosed annually.
- With the support of Bayer Inc., TD&A developed the world’s first 3-D surgery simulator so that surgeons can practice and hone their skills to improve the success of intricate operations against CTEPH, a debilitating disease of the lung that affects several thousand Canadians annually.
- TD&A was instrumental in developing a scale-model of an indoor aircraft engine test facility that enabled Ottawa’s MDS Aero to penetrate international markets with the launch of its \$100M engine test facility in Derby, UK for Rolls-Royce.
- Together with GGI Solutions of Laval, Quebec, TD&A developed a new family of molecular inks for the Printed Electronics market for such applications as electronics, sensors, antennae, and displays. This resulted in a significant licensing agreement with a large multi-national chemical organization, contributing to the growth and stability of GGI.
- Supported Siemens Canada in the development of next generation structural materials for future engine concepts through characterization and quantification of material properties at extreme temperature.
- Brought smart sensing and big data to the rail industry and demonstrated high reliability of a new technology in a real world transit environment, working with New York City Transit Authority, KLD-LABS, Plasser American and Dayton. T. Brown – the first instance of performance-based measurements for forces at the wheel/rail interface within a North American Transit environment.
- Novel solar simulator technology, developed by TD&A and the University of Alberta, was licensed to Edmonton’s G2V Optics. Consequently, G2V shipped product to research universities and a major horticultural company, entered into an international reseller agreement with India, and secured funding to grow its workforce.

### “Flight Simulator” for Surgeons



Surgeon preparing for a delicate lung operation.



- A Quebec municipality leveraged NRC expertise to implement a new, highly efficient method of treating its bio-solids. The method harnesses latent energy to substantially reduce both the volume of bio-solids and disposal costs.
- Working with industries, TD&A integrated new datasets and advanced the functionality of its comprehensive database of ocean, ice, and seabed information that is critical to enabling exploration in the Beaufort Sea, an important frontier for energy exploration. The database directly supports safe and efficient oil and gas operations by increasing productivity, enabling sound engineering decisions and determining the optimal approach, equipment and schedule for offshore drilling.

To enhance its relevance, TD&A invested in developing new research facilities in pace with the emerging needs of stakeholders. For example, NRC:

- Entered the final construction phase of a new research facility for testing novel batteries for the Canadian electric vehicle and other related industries.
- Began construction for an R&D facility in Mississauga for designing, prototyping and producing new advanced materials that will enable ground-breaking technology platforms. This facility, adjacent to the Xerox Research Centre of Canada (XRCC), will support the Canadian Campus for Advanced Materials Manufacturing, a joint initiative with XRCC.
- Worked with industry, academia and Natural Resources Canada, to design and build a state-of-the-art pilot facility for simulating advanced micro-grid power generation scenarios to reduce diesel fuel consumption by electrical generators in remote communities.
- Launched its Data Analytics Centre providing data analytics, text mining, and machine learning and artificial intelligence experts to help industries and scientists exploit the full potential of their data.

The 2017 [Evaluation of the Security and Disruptive Technologies \(SDT\) Sub-program](#)<sup>xv</sup> illustrated how TD&A advances next generation of game-changing technologies. SDT catalyzes Canadian global leadership in select longer-range emerging and disruptive technologies. The evaluation concluded that SDT addresses a need for quantum photonics research and development, with potential for achieving significant impacts in ICT, defence and security as well as the energy and environment industries. It also concluded that SDT researchers perform above the world average in terms of the relative impact of their published work, conduct world-leading research in specific promising areas including attosecond (ultra-high speed science), and maintain world-class facilities such as quantum photonics research installations. NRC's executive management has committed to implementing recommendations of the evaluation

### Pioneering Science

Each year, the Royal Society of London presents just three scientists with the Royal Medal, an award that dates back to 1826 to recognize "the most important contributions to the advancement of natural knowledge." Dr. Paul Corkum of the NRC was one of those three in 2017, honoured for his major contributions to laser physics and his pioneering role in developing the field of attosecond science. He joins other scientific luminaries such as Charles Darwin and Michael Faraday.



including developing a strategy for maintaining the world-leading status of the fundamental research carried out within SDT.

Client survey results indicate that TD&A remains on track in creating a foundation for assisting businesses prosper in Canada in alignment with the Innovation and Skills Plan. Over 95% of surveyed clients<sup>10</sup> reported that the Program met expectations, compared to 90% in 2016-17. Furthermore, 86% of respondents reported that NRC had a positive impact in enabling their business results, such as faster deployment of technology to market, increased competitive advantage, and increased knowledge and ability to plan and execute R&D projects. This compares favourably to a survey result of 81% reported in 2016-17. In addition, responses to open-ended survey questions revealed a broad range of tangible NRC impacts including increased public outreach, improved operations and safety, enhanced tools and methods for daily operations, increased engagement and projects with new clients, reduced project risk, increased measurement quality, plus achievement of certification and accreditation for wider recognition and credibility in the marketplace.

To further illustrate the extent that clients value the Program, NRC received a Technology Supplier of the Year award from MACOM, a leading provider of high performance analog semiconductor solutions. The award cited excellence in custom photonics design and fabrication services for NRC's work in 2017.

As part of Dialogue efforts to ensure ongoing research excellence, NRC put in place an initiative that supports exploratory, self-directed research at the individual and small team level. It is anticipated that some of these ideas could become the full-fledged research initiatives of tomorrow.

Actual spending exceeded planned spending by \$82M while actual FTEs exceeded planned FTEs by 412. This was primarily because NRC received increased funding to sustain its operations in Budget 2017, which was accessed through the 2017-18 Supplementary Estimates (A) and not included in the 2017-18 planned values. Other factors include an increase in the technical and research services delivered in 2017-18 and one-time retroactive collective bargaining costs.

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<sup>10</sup> The 2017-18 survey represented 139 clients across all of NRC service offerings; from large scale R&D and technology development projects to short-term tests. The specific clients and initiatives surveyed vary by year.

## Results achieved

Expected results	Performance indicators	Target	Date to achieve target	2017–18 Actual results	2016–17 Actual results	2015–16 Actual results
Canadian industries commercialize advanced technologies	Technology deployment <sup>11</sup> (client commitments to exploit NRC innovations)	21	March 2018	21	25	18
	Client/stakeholder feedback <sup>12</sup> on benefits: jobs, sales, R&D	85%	March 2018	86% of 139 respondents	81% of 150 respondents	86% of 127 respondents

## Budgetary financial resources (dollars)

2017–18 Main Estimates	2017–18 Planned spending	2017–18 Total authorities available for use	2017–18 Actual spending (authorities used)	2017–18 Difference (Actual spending minus Planned spending)
278,362,056	289,847,651	455,390,994	371,661,915	81,814,264

## Human resources (full-time equivalents)

2017–18 Planned full-time equivalents	2017–18 Actual full-time equivalents	2017–18 Difference (Actual full-time equivalents minus Planned full-time equivalents)
1,831.1	2,242.9	411.8

<sup>11</sup> This is a measure of NRC's success in advancing technologies to the point of client and stakeholder readiness and commitment to exploit technologies commercially. It is counted in terms of the number of clients or stakeholders who expressed (e.g., through press releases or company public reports) a commitment, during the reporting period, to exploit innovations that have already been successfully developed or advanced by or with NRC.

<sup>12</sup> The proportion of surveyed clients and stakeholders who report an increase in jobs, sales, R&D expenditures or other positive benefits as result of services received from NRC.

## Industrial Research Assistance Program (IRAP)

### Description

The program contributes to the growth and prosperity of Canadian small and medium sized enterprises (SMEs) by stimulating innovation, adoption and/or commercialization of technology-based products, services, or processes in Canada. This is done through: 1) technical and related business advice and networking facilitated by a cross-Canada network of field professional staff; 2) cost-shared merit-based contributions; and 3) contributions supporting employment of post-secondary graduates. This program uses funding from the following transfer payments: Contributions to Firms; Contributions to Organizations; Youth Employment Program (YEP); and Canada Accelerator and Incubator Program (CAIP).

### Results

IRAP's impact remained high. On average, clients reported an annual increase between 2014 to 2016 of 25% in revenue and 13% in staffing. In all, 87% of 3,465 surveyed firms reported an increase in revenue, employment or profit. IRAP exceeded its targets in terms of number of SMEs served and the number of SME jobs supported. The peak performance values of 2015-16 and 2016-17 are commensurate with additional funding for those years as announced in their respective Government of Canada Budgets.

### Growth through Advanced Manufacturing

3D Printing (also called Additive Manufacturing) is a rapidly-developing technology with promising growth potential worldwide. With tailored advisory support from IRAP, Ontario's Burloak leveraged nearly \$15M in federal and provincial loans and grants to announce a \$104M investment in the new world-class Additive Manufacturing Technology Centre in Burlington, Ontario. This initiative is expected to create 295 jobs by 2026 and will help make Canada a world leader in the technology.

From [IRAP success stories](#)<sup>xvi</sup>.

To strengthen Canada's competitive position in global value chains (GVCs), IRAP increased its leadership in linking Canadian SMEs into GVC opportunities in targeted areas of advanced manufacturing. In the area of 3D Printing, for example, IRAP provided custom feasibility studies and prototype builds to prospective Canadian manufacturers, helping them advance their technologies in what is destined to become a multi-billion-dollar industry.

IRAP contributed to job creation in Canadian SMEs by providing internships to young people through its Youth Employment Program (YEP) and its Green component (YEP-Green). IRAP helped facilitate the transition of 2,140 highly-skilled young people to the labour market.

IRAP's Concierge Service served over 4,700 clients in 2017-18, significantly exceeding the original target of 4,000. This included providing Accelerated Growth Services (AGS) to 200 high potential firms to advance their growth and scale to become global competitors.

In fulfilling NRC's commitment to accelerate clients' growth and entry into global markets in 2017-18, IRAP provided \$10.1M to 116 Canadian SMEs along with advisory support and co-innovation partnering opportunities in Europe. Additionally, IRAP committed \$13.3M to new

multi-year international co-innovation projects to support 32 Canadian SMEs. Already, these multi-year projects are beginning to prosper. For example, Vancouver’s Arius Technologies credits IRAP for its successes in deploying its novel 3D imaging technology to reproduce masterpieces and artifacts for major galleries and museums in Europe.

### Helping Companies Grow

Resson in NB provides predictive data analytics for the agriculture sector, helping growers use their field data to make informed decisions and increase the productivity of their farms. After working with IRAP on both hardware and software products, Resson attracted \$15M in new investments and it doubled its workforce every year over the last four years.

From [IRAP success stories](#)<sup>xvi</sup>.

Through consolidation and standardization of its diverse international programs spanning Europe, Asia and South America, and through the implementation of best practices, IRAP made substantial progress in the following areas: simplified client engagement; improved IRAP international project due diligence and decision-making; and enhanced advisory services support designed to help clients with partnership development, project consortium formation, and co-innovation project development. These improvements are expected to accelerate clients' entry and growth in global markets and improve their ability to conduct business abroad.

To fulfil NRC’s commitment to co-deliver the [Canadian International Innovation Program \(CIIP\)](#)<sup>xvii</sup> together with Global Affairs Canada (GAC), IRAP assisted 62 Canadian SMEs develop working relationships in China, India, South Korea and Brazil. In addition, IRAP assisted GAC in planning and delivering 7 outbound missions for 49 Canadian SME participants. Total CIIP funding provided in 2017-18 was \$1.3M supporting 13 Canadian SMEs.

IRAP continued to deliver the [CanExport Program](#)<sup>xviii</sup> in partnership with Global Affairs Canada (GAC) and it assisted SMEs in developing new export opportunities, particularly in high-growth priority markets and sectors. Close to 1,000 projects were approved since 2016 with SMEs across Canada in multiple sectors targeting 81 foreign markets. To date, 40% of recipients have reported that they have started to export to a new market.

IRAP partnered with other government departments to help deliver their programs to support innovative SMEs in advancing their technologies through to commercialization. For example, IRAP partnered with Innovation Science and Economic Development Canada (ISED) in delivering the [Innovative Solutions Canada](#)<sup>xi</sup> and the [Innovation Superclusters](#)<sup>x</sup> programs.

IRAP tested an experimental initiative that reduced the cost for qualifying SMEs to access NRC's R&D and technical services. By mid-November, 2017, over 100 research contracts were approved, representing \$6.7M in NRC research work. This successful program was supported by funding announced in Budget 2018 targeted for reducing the costs of NRC services. Plans were made to launch an improved version of the initiative in 2018-19.

In addition, IRAP experimented with the use of [public blockchain technology](#)<sup>xx</sup> in proactive disclosure of IRAP’s contract agreements, with a longer-term view of applying this technology to other applications at NRC and facilitating its adoption across the Government of Canada as a means of presenting secure, unalterable public records. As a first step in the experiment, IRAP began publishing information on new and amended contribution agreements on the Ethereum blockchain.

## Leadership in Data Transparency

Blockchains are essentially public registers of transactions that are secure and unalterable. IRAP’s on-going experiment with blockchain technology will assess whether it can achieve unprecedented levels of transparency and trust in its monetary contribution data, serving as a model across NRC and other public institutions.

[IRAP Blockchain Publishing Prototype](#)<sup>xix</sup>

The [evaluation of IRAP](#)<sup>xv</sup> confirmed that IRAP continues to be relevant and that it addresses the need for SME innovation support in Canada in a manner that is consistent with government priorities and the role of government. Notably, IRAP was found to have generated at least \$10B in net economic benefits from 2005-06 through 2015-16. IRAP committed to addressing the evaluation’s recommendations for improvement: developing a targeted outreach strategy; increasing operational efficiencies; and leveraging ICT tools for more efficient and effective program delivery.

The actual FTE deployment of 387 fell short of the planned deployment of 411. The difference was due to a variety of factors including several retirements and departures that offset the gains through hiring. The process for hiring IRAP industrial technology advisors is lengthy given the specific skillsets required and which are in high demand.

### Results achieved

Expected results	Performance indicators	Target	Date to achieve target	2017–18 Actual results	2016–17 Actual results	2015–16 Actual results
Innovative businesses grow in Canada	SME jobs supported (through contributions)	5,500	March 2018	6,542	12,216	10,980
	SMEs served (through funding by the <i>Contributions to Firms</i> transfer payment program)	1,500	March 2018	2,046	2,555	2,341
	SME client feedback <sup>13</sup> on growth	85%	March 2018	87%	88%	87%

<sup>13</sup> This is the percentage of surveyed IRAP clients funded through Contribution to Firms transfer payment program and who reported having experienced growth in terms of: 1) employees or; 2) revenue from goods and services or; 3) net operating profit. Data is compiled from an on-line survey completed by firms 6 months following their fiscal year end.

Budgetary financial resources (dollars)

2017–18 Main Estimates	2017–18 Planned spending	2017–18 Total authorities available for use	2017–18 Actual spending (authorities used)	2017–18 Difference (Actual spending minus Planned spending)
269,123,074	269,123,074	290,326,291	276,547,147	7,424,073

Human resources (full-time equivalents)

2017–18 Planned full-time equivalents	2017–18 Actual full-time equivalents	2017–18 Difference (Actual full-time equivalents minus Planned full-time equivalents)
411.0	387.3	( 23.7)

## Science Infrastructure and Measurement (SI&M)

### Description

This program manages national science facilities and infrastructure critical to research, development and innovation by Canadian scientific and technological communities. This includes operating and administering Canada’s astronomical observatories. It also fosters development and maintenance of Canada’s metrological infrastructure system that provides industries and researchers access to reliable measurements that are traceable to recognized national standards maintained by the program. The program helps clients make the most of this infrastructure by facilitating access to a wide range of Canadian and international user communities and by participating in networks. In addition, the program provides stewardship of the TRIUMF sub-atomic research facility. This program uses funding from the following transfer payment: TRIUMF (Canada’s National Laboratory for Particle and Nuclear Physics).

### Results

Satisfaction with SI&M’s metrology services remained high with 88% of respondents reporting eight or more on a scale of 1 to 10. The Program’s performance in astronomy is reflected by a continued high number of scientific publications of SI&M’s telescope users (778 publications compared to 611 in 2016-17). Altogether, these results indicate that the Program’s services are valued by its user community.

SI&M continued to expand and improve its services and contribute to government priorities in areas of importance to Canadians. Notable achievements include the following.

- A team co-led by NRC and Dalhousie University published in the prestigious journal *Nature*, on a cluster of galaxies observed when the universe was one-tenth its present age, calling into question our understanding of how structures form in the universe.
- The Program experimented in developing two [new Time Dissemination services<sup>xxi</sup>](#) where time signal authenticity, traceability, accuracy and security are part of technical or regulatory requirements. One of them, called Monitored NTP, is the first-of-its-kind service offered internationally that provides traceability for standard and universal network time synchronization protocol. The other, called NRC-TimeLink Remote Clock, provides very high accuracy time synchronization that is also secure, traceable, and fit for the auditing

### Leadership in Astronomy

The Honorable Kirsty Duncan, Minister of Science and of Sport inaugurated Canada’s newest and largest radio telescope: the CHIME (Canadian Hydrogen Intensity Mapping experiment) telescope. SI&M’s technology and expertise supported this initiative funded by the Canada Foundation for Innovation and led by coalition with McGill University, the University of British Columbia, and the University of Toronto. This telescope will allow scientists to create a multi-dimensional map of the universe, including dark energy, extending deep into space and time. By measuring the composition of dark energy, scientists will understand better the shape, structure and fate of the universe.

purposes of regulatory bodies. Already, a major stock exchange has entered into an agreement to deploy the service.

- NRC led the world in redefining the mass standard in terms of electrical force that counterbalances a weight. The research involved redefining a fundamental physical constant (Planck’s Constant); cited by the esteemed Nature scientific journal as one of the toughest challenges known to physics. In 2017, SI&M was deemed to have provided the world’s most accurate measurement of this constant - so accurate that it is equivalent to correctly counting all the hairs on the heads of 1100 people, to within one hair. This paves the way for redefining the world’s entire system of measurement units, called the *Système internationale d’unités* (SI), in a more accurate and practical manner that does not depend on imperfect objects such as the piece of metal housed in France that is presently the SI primary standard of mass. This achievement, together with NRC’s other successes in high precision measurements, will, for many decades to come, be the basis for expanding the range of all measurements, thus driving technical advancement. It will also enable the testing of fundamental constants and even the probing of exotic questions on dark matter and the nature of the universe.

Actual spending totalled \$123.1M in comparison to planned spending of \$200.1M. The most significant cause of decreased spending results from the \$76.1M funding reprofile from 2017-18 to 2018-19 to account for project delays beyond NRC’s control associated with Canada’s participation in the construction of the Thirty Meter Telescope.

The total spending includes a \$54.6M transfer payment to the TRIUMF facility for sub-atomic physics. Details on TRIUMF’s successes are provided in supplementary information tables available on NRC’s [website](#)<sup>xv</sup>. They include the publication of 307 manuscripts in scientific journals to advance science and Canada’s reputation on the world stage.

### Results achieved

Expected results	Performance indicators	Target	Date to achieve target	2017–18 Actual results	2016–17 Actual results	2015–16 Actual results
National science infrastructure and measurement standards services are valued by user communities	Client/user satisfaction	85%	March 2018	88%	91%	86%



## Budgetary financial resources (dollars)

2017–18 Main Estimates	2017–18 Planned spending	2017–18 Total authorities available for use	2017–18 Actual spending (authorities used)	2017–18 Difference (Actual spending minus Planned spending)
199,164,722	200,135,686	249,610,904	123,136,776	(76,998,910)

## Human resources (full-time equivalents)

2017–18 Planned full-time equivalents	2017–18 Actual full-time equivalents	2017–18 Difference (Actual full-time equivalents minus Planned full-time equivalents)
290.5	290.3	( 0.2)

Information on the NRC's lower-level programs is available in the [GC InfoBase](#).<sup>xxii</sup>

## Internal Services

### Description

Internal Services are those groups of related activities and resources that the federal government considers to be services in support of programs and/or required to meet corporate obligations of an organization. Internal Services refers to the activities and resources of the 10 distinct service categories that support Program delivery in the organization, regardless of the Internal Services delivery model in a department. The 10 service categories are: Management and Oversight Services; Communications Services; Legal Services; Human Resources Management Services; Financial Management Services; Information Management Services; Information Technology Services; Real Property Services; Materiel Services; and Acquisition Services.

### Results

Guided by the results of NRC Dialogue, NRC prepared the [NRC Action Plan, 2017-2021](#)<sup>xxiii</sup> that presented almost 60 approved actions to enable a re-imagined and reinvigorated research organization focused on delivering excellence, solving public policy challenges and spurring business innovation. The action items are scheduled to be implemented in three waves, with 19 substantively completed and first-stage NRC progress in 2017-18 including the following under internal services:

- **Competitive post-doctoral program pilot** – strengthened NRC’s ability to attract top talent from around the world in science, technology, engineering and mathematics (STEM), through the launch of a new post-doctoral fellowship program that attracted 12 promising young scientists to work alongside NRC researchers to develop ideas and technical solutions in areas of importance to Canada (e.g. building an innovative translation model designed to revitalize and preserve indigenous languages).
- **Improved talent management** – implemented a new online talent management tool for hiring, onboarding, learning and personnel performance management. The result was a more streamlined and enhanced human resources process featuring new reporting capabilities that reduces administrative requirements and provides for an organizational integrated view on performance commitments. In addition, NRC built strategic partnerships with several post-secondary institutions to enhance student recruitment.
- **Employee engagement** – A regular cycle of senior management meetings and quarterly all-management meetings was solidified and robust internal communications efforts were made to keep staff informed and engaged on NRC Dialogue implementation, including two town hall roadshows involving 22 sites, and 12 additional special-purpose meetings with other internal communities across the country, led by the President and/or other senior executives, reaching nearly 2,200 personnel.
- **Integrated strategic vision and plans** – created new [vision, mission and values](#)<sup>xxiv</sup> statements that reflect the outcomes of Dialogue and that will underpin the new five-year NRC Strategic Science and Innovation Plan.

- **Organizational changes** – implemented structural changes designed to improve decision-making and organizational agility; e.g., NRC transferred responsibility for investment planning governance to the Chief Financial Officer to better align with overall financial resource management. An external review of NRC’s investment planning management framework was undertaken to ensure efficient and effective processes are in place to deliver investment projects. NRC began to implement key improvements arising from this review.
- **Business processes** – a client advisory board was established to review NRC’s business processes (such as procurement, travel, security) and to recommend more rationalized service delivery that optimizes use of resources while better aligning with NRC’s business needs and research requirements.
- **New R&D program model** – progressed in developing a new model for strong governance of research initiatives, including a peer review process to ensure research excellence and relevance, combined with a new approach to R&D initiatives that builds capacity via both disruptive technologies and foundational work. All existing research initiatives were reviewed for right-sizing and re-alignment to make more efficient use of resources and ensure alignment with the Innovation and Skills Plan. This resulted in fewer research initiatives, from 37 to 26 focussed on larger-scale outcomes and including initiatives to support the Superclusters and to create new challenge programs. To help ensure success, NRC appointed Technical Leads to work with each of the five Supercluster consortia to develop specific NRC research initiatives that align further with the selected areas.
- **Governance** – To improve decision-making and organizational agility, NRC launched reviews of key decision-making practices, processes and protocols as well as committee structures. When completed, by 2019, this will identify ways to ensure clarity and consistency in governance practices, as well as better communication and integration of decisions, including those related to investments, human resources and programs.
- **Financial management and oversight** – NRC improved rigour to financial practices and oversight by: establishing a financial management committee to manage and prioritize financial pressures on an ongoing basis; holding regular senior management discussions on the organization’s finances; and setting expenditure and revenue targets in executive performance agreements.
- **Research IT platform modernization** – in consultation with SSC, began a three-year investment of \$20M for high performance computing and storage space, including cloud-based solutions, for improved IT agility and reliability for NRC’s research community.
- **NRC buildings and facilities** – began assessments of i) NRC’s real property and buildings, and ii) research facilities. The former assessment focused on the utilization, physical performance and functionality of the asset, and will be integrated with the Federal Science and Technology Infrastructure Initiative (FSTII) activities. The latter initiative will ensure that new facilities are deployed optimally, maintained properly, and managed effectively to support research excellence and commercialization.

- Occupational Safety, Health and Environmental Stewardship** – created a new branch focussed on promoting employee awareness and strong workplace practices, and as a result, the number of workplace safety incidents has decreased. To review and improve its processes for environmental stewardship, NRC completed the development phase of its Environmental Management System (EMS), including approving an updated environmental policy statement and establishing regular reporting to senior management. NRC initiated the EMS implementation phase while managing ongoing compliance obligations. This included the launch of two pilot EMS projects, one of which focussed on waste water at multiple sites. To protect people and the environment from the risks associated with NRC’s contaminated sites, NRC completed year two of the four year Contaminated Sites Work Program. Environmental management actions such as remediation, assessment and site characterization. Risk assessments led to closure of four contaminated site files in 2017-18 without risk to the environment.

#### Budgetary financial resources (dollars)

2017–18 Main Estimates	2017–18 Planned spending	2017–18 Total authorities available for use	2017–18 Actual spending (authorities used)	2017–18 Difference (Actual spending minus Planned spending)
253,702,382	253,702,382	291,514,701	245,177,599	(8,524,783)

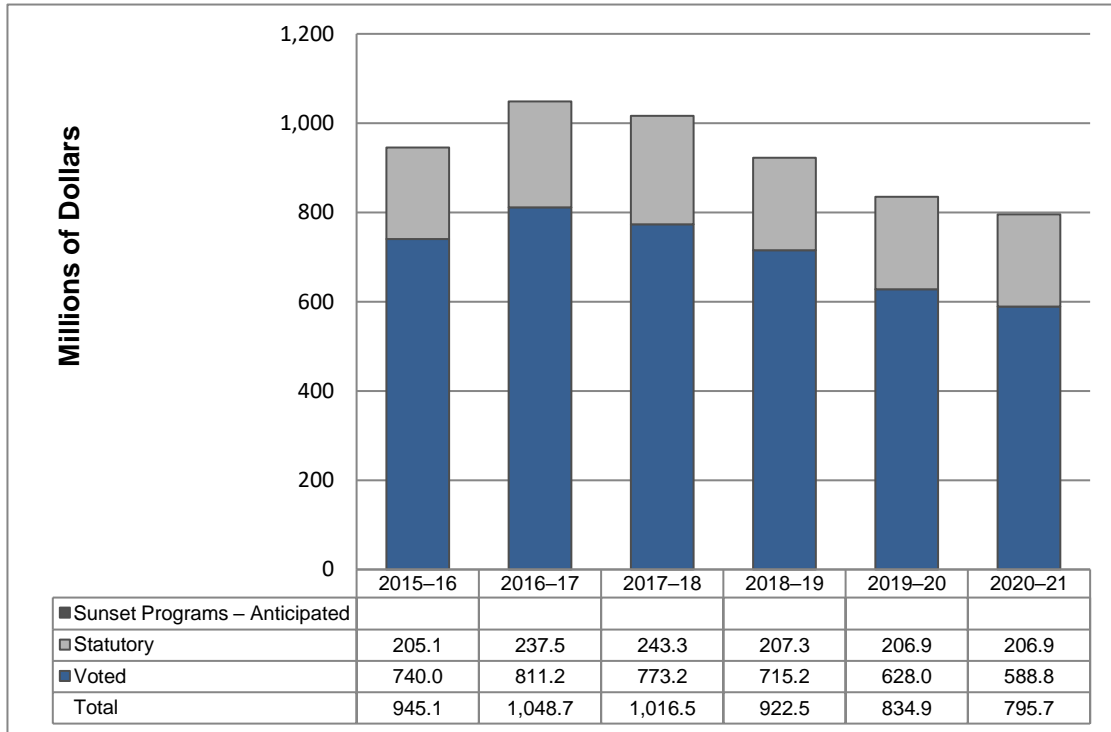
#### Human resources (full-time equivalents)

2017–18 Planned	2017–18 Actual	2017–18 Difference (actual minus planned)
1,005.3	1,058.7	53.4

## Analysis of trends in spending and human resources

### Actual expenditures

Departmental spending trend graph



## Budgetary performance summary for Programs and Internal Services (dollars)

Programs and Internal Services	2017–18 Main Estimates	2017–18 Planned spending	2018–19 Planned spending	2019–20 Planned spending	2017–18 Total authorities available for use	2017–18 Actual spending (authorities used)	2016–17 Actual spending (authorities used)	2015–16 Actual spending (authorities used)
TD&A	278,362,056	289,847,651	283,483,638	283,502,488	455,390,994	371,661,915	352,212,039	326,830,511
IRAP	269,123,074	269,123,074	262,028,318	244,936,528	290,326,291	276,547,147	322,990,061	288,919,078
SI&M	199,164,722	200,135,686	157,755,761	128,743,382	249,610,904	123,136,776	125,604,143	116,379,686
<b>Subtotal</b>	<b>746,649,852</b>	<b>759,106,411</b>	<b>703,267,717</b>	<b>657,182,398</b>	<b>995,328,189</b>	<b>771,345,838</b>	<b>800,806,243</b>	<b>732,129,275</b>
Internal Services	253,702,382	253,702,382	233,818,243	192,342,099	291,514,701	245,177,599	247,934,222	212,948,320
<b>Total</b>	<b>1,000,352,234</b>	<b>1,012,808,793</b>	<b>937,085,960</b>	<b>849,524,497</b>	<b>1,286,842,890</b>	<b>1,016,523,437</b>	<b>1,048,740,465</b>	<b>945,077,595</b>

NRC's actual spending trend over the last three years has been relatively consistent with spending of \$1,017M in 2017-18. This represents a decrease of \$32M from the \$1,049M spent in 2016-17. This decrease is largely associated with temporary funding provided by the Federal Budget, offset by increased activities funded through statutory authorities and one-time costs associated with retroactive collective bargaining negotiations. Specifically, in 2016-17 IRAP received a one-year funding allocation of \$50M from Budget 2016 to help small and medium-sized companies innovate and grow. The reduced funding for IRAP contributions to firms in 2017-18 was partially offset by a variance of \$8M to support the Youth Employment Strategy. In addition, NRC spent \$8M more in 2017-18 from its statutory revenue authorities as a result of increased activities with both private and public entities as well as \$16M in collective bargaining costs, following the ratification of 8 agreements in the last quarter of 2017-18, which were offset by a decrease in capital investment of \$16M due to the 2016-17 refocus of investment plan activities. The following variance explanations provide additional details between 2017-18 plans to actuals and year-over-year results.

Actual spending of \$1,017M in 2017-18 in comparison to planned spending of \$1,013M represents an overall increase of \$4M (0.36%). The variance from 2017-18 plans is attributable to expenditure increases of \$61M in operating and \$23M in statutory spending, offset by decreases of \$59M in grants and contributions and \$21M in capital expenditures. The most significant cause of increased spending in operating results from the funding to sustain operations at NRC announced in Budget 2017. This funding was accessed through the 2017-18 Supplementary Estimates (A) and was not included in the 2017-18 Planned Spending. This funding has been renewed on permanent basis through Budget 2018. The increase of \$23M in statutory revenue spending results from additional technical and research services delivered in 2017-18 and \$16M in one-time retroactive collective bargaining costs. The decrease of \$59M in

grants and contributions resulted from a \$76M funding reprofile from 2017-18 to 2018-19 to account for project delays associated with Canada's participation in the construction of the Thirty Meter Telescope, offset by an increase of \$18M for the Youth Employment Strategy Program. The decrease of \$21M in capital expenditures is mainly attributable to a \$17M funding reprofile to 2019-20 and 2020-21 for the Advanced Manufacturing project (a 2014 Federal Infrastructure Initiative project).

Overall, year over year fluctuations within NRC's actual spending largely results from transfer payment programs and capital infrastructure.

## Actual human resources

Human resources summary for Programs and Internal Services  
(full-time equivalents)

Programs and Internal Services	2015-16 Actual	2016-17 Actual	2017-18 Planned	2017-18 Actual	2018-19 Planned	2019-20 Planned
TD&A	2,055.4	2,186.6	1,831.1	2,242.9	1,874.7	1,850.1
IRAP	356.0	369.4	411.0	387.3	409.0	409.0
SI&M	277.2	291.0	290.5	290.3	294.8	294.8
<b>Subtotal</b>	2,688.6	2,847.0	2,532.6	2,920.5	2,578.5	2,553.9
Internal Services	980.0	1,023.3	1,005.3	1,058.7	1,005.3	1,005.3
<b>Total</b>	3,668.6	3,870.3	3,537.9	3,979.2	3,583.8	3,559.2

The increase of 441.3 in actual FTE in 2017-18 (3,979.2) over planned (3,537.9) is attributable mainly to FTEs associated with the funding to sustain operations at the NRC (estimated at 400 FTEs) announced in Budget 2017. This funding was accessed through the 2017-18 Supplementary Estimates (A) and was not included in the 2017-18 Planned FTEs.

Actual FTE in 2017-18 (3,979.2) increased in comparison to 2016-17 (3,870.3) and 2015-16 (3,668.8). The increase is mainly attributable to growth to support program delivery across NRC.

## Expenditures by vote

For information on NRC's organizational voted and statutory expenditures, consult the [Public Accounts of Canada 2017-2018](#).<sup>xxv</sup>

## Government of Canada spending and activities

Information on the alignment of NRC's spending with the Government of Canada's spending and activities is available in the [GC InfoBase](#).<sup>xxii</sup>

## Financial statements and financial statements highlights

### Financial statements

NRC's audited consolidated financial statements for the year ended March 31, 2018, are available on [NRC's website<sup>xv</sup>](#).

### Financial statements highlights

Condensed Consolidated Statement of Operations (audited) for the year ended March 31, 2018 (dollars)

Financial information	2017–18 Planned results	2017–18 Actual results	2016–17 Actual results	Difference (2017–18 Actual results minus 2017–18 Planned results)	Difference (2017–18 Actual results minus 2016–17 Actual results)
Total expenses	986,310,000	1,045,440,000	1,064,791,000	59,130,000	(19,351,000)
Total revenues	187,313,000	221,352,000	202,479,000	34,039,000	18,873,000
Net cost of operations before government funding and transfers	798,997,000	824,088,000	862,312,000	25,091,000	(38,224,000)

NRC incurred total expenses of \$1,045M in 2017-18, a decrease from the \$1,065M of 2016-17. NRC's major expense components are salaries and employee benefits (\$467M) and grants and contributions (\$281M), representing 72% of total expenses. The \$19M decrease is primarily due to a decrease in grants and contributions of \$49M, an increase in salary and benefits of \$18M mainly due to retroactive pay and an increase of \$9M in professional services. Most of the other expense categories appearing in the financial statements were stable in comparison to 2016-17. The planned expenses, as reported in NRC's Future Oriented Financial Statements in the 2017-2018 Report on Plans and Priorities (RPP), were \$986M. The variance between

#### Expenses by Type (2017-18)

Type	Percent of total expenses
Salaries and employee benefits	45
Grants and contributions	27
Professional and special services	9
Utilities, materials and supplies	8
Amortization	5
Other	6

#### Revenues by Type (2017-18)

Type	Percent of total Revenues
Technical Services	51
Research Services	30
Intellectual property, royalties and fees	6
Grants and Contributions	5
Rentals	3
Sales of goods and information products	3
Other	2



planned and actual results of \$59M is primarily due to an increase in professional and special services of \$25M, an increase in grants and contributions of \$21M and an increase in utilities, materials and supplies of \$8M.

NRC generates revenue which can be reinvested in operations. NRC earned total revenues of \$221M in 2017-18, an increase from \$202M in 2016-17. NRC's major revenue components were Research Services (\$67M) and Technical Services (\$113M), representing 81% of revenues. The planned revenue, as reported in NRC's Future Oriented Financial Statements in the 2017-18 Departmental Plan was \$187M. The total variance of \$34M is largely attributed to Technical Services (\$26M higher than the planned results), Research Services (\$9M higher than the planned results), Grants and Contributions (\$4M lower than the planned results) and finally to an increase of \$3M due to Intellectual Property, Royalties and Fees and Other Revenues.

Condensed Consolidated Statement of Financial Position (audited) as at March 31, 2018 (dollars)

Financial Information	2017–18	2016–17	Difference (2017–18 minus 2016–17)
Total net financial assets	363,419,000	356,715,000	6,704,000
Total liabilities	297,146,000	302,286,000	(5,140,000)
Departmental net financial assets	66,273,000	54,429,000	11,844,000
Total non-financial assets	654,245,000	614,721,000	39,524,000
Departmental net financial position	720,518,000	669,150,000	51,368,000

NRC's consolidated net financial assets totalled \$363M as at March 31, 2018, an increase of \$6M from the March 31, 2017 balance of \$357M. The balance is made up of the Due from the Consolidated Revenue Fund (CRF), accounts receivable, inventory for resale and cash and investments. The increase is primarily due to an \$8M increase of the Due from the CRF.

#### Net Financial Assets as at March 31, 2018

Type	Percent of total net financial assets
Due from the Consolidated Revenue Fund	83
Accounts receivable and advances	12
Inventory for resale	2
Cash and investments	3

NRC’s consolidated liabilities consist of accounts payable and accrued liabilities, vacation and compensatory leave, lease inducements, deferred revenue and employee future benefits. The balance as at March 31, 2018 of \$297M represents a \$5M decrease from the March 31, 2017 balance of \$302M. The decrease is primarily due to a \$4M decrease in accounts payable and accrued liabilities payable to external parties.

**Liabilities as at March 31, 2018**

Type	Percent of total liabilities
Accounts payable and accrued liabilities	67
Vacation pay and compensatory leave	10
Lease inducements	10
Deferred revenue	3
Employee future benefits	10

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## Supplementary information

### Corporate information

#### **Organizational Profile**

**Appropriate ministers:**

The Honourable Navdeep Bains, P.C., M.P., Minister of Innovation, Science and Economic Development;

The Honourable Kirsty Duncan, P.C., M.P., Minister of Science and Sport

**Institutional head:** Mr. Iain Stewart, President

**Ministerial portfolio:** Innovation, Science and Economic Development

**Enabling instrument:** [National Research Council Act](#)<sup>viii</sup>, R.S.C. 1985, c. N-15

**Year of incorporation / commencement:** 1916

**Other:** NRC is a departmental corporation of the Government of Canada, reporting to Parliament through the Minister of Innovation, Science and Economic Development in collaboration with the Minister of Science and Minister of Small Business and Tourism. NRC works in partnership with members of the Innovation, Science and Economic Development Portfolio to leverage complementary resources to promote science and integrated innovation, to exploit synergies in key areas of science and technology, to promote the growth of small and medium-sized enterprises and to contribute to Canadian economic growth. NRC's Council provides independent strategic direction and advice to the NRC President and it reviews organizational performance. The President provides leadership and strategic management and is responsible for the achievement of NRC's long-range goals and plans in alignment with government priorities as reflected in his [Mandate letter](#)<sup>iii</sup>. Each of NRC's Vice Presidents is responsible for a number of areas composed of research sub-programs, initiatives, centres, the Industrial Research Assistance Program, and/or a corporate branch. Vice Presidents and NRC managers are responsible for executing plans and priorities to ensure successful achievement of objectives.

## Reporting framework

NRC's Strategic Outcomes and Program Alignment Architecture of record for 2016–17 are shown below.

**1. Strategic Outcome:** Canadian businesses prosper from innovative technologies

**1.1 Program:** Technology Development and Advancement

**1.1.1 Sub-Program:** Aerospace

**1.1.2 Sub-Program:** Automotive and Surface Transportation

**1.1.3 Sub-Program:** Ocean, Coastal and River Engineering

**1.1.4 Sub-Program:** Energy, Mining and Environment

**1.1.5 Sub-Program:** Construction

**1.1.6 Sub-Program:** Aquatic and Crop Resource Development

**1.1.7 Sub-Program:** Medical Devices

**1.1.8 Sub-Program:** Human Health Therapeutics

**1.1.9 Sub-Program:** Information and Communications Technologies

**1.1.10 Sub-Program:** Security and Disruptive Technologies

**1.2 Program:** Industrial Research Assistance Program (IRAP)

**2. Strategic Outcome:** R&D Infrastructure for an innovative and knowledge-based economy

**2.1 Program:** Science Infrastructure and Measurement

**2.1.1 Sub-Program:** National Science Infrastructure

**2.1.2 Sub-Program:** Measurement Science and Standards

### Internal Services

## Supporting information on lower-level programs

Supporting information on lower-level programs is available on [GC InfoBase<sup>xxii</sup>](#).

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## Supplementary information tables

The following supplementary information tables are available on NRC's [website](#)<sup>xv</sup>.

- ▶ Departmental Sustainable Development Strategy
- ▶ Details on transfer payment programs of \$5M or more
- ▶ Evaluations
- ▶ Fees
- ▶ Horizontal initiatives
- ▶ Internal audits
- ▶ Response to parliamentary committees and external audits

## Federal tax expenditures

The tax system can be used to achieve public policy objectives through the application of special measures such as low tax rates, exemptions, deductions, deferrals and credits. The Department of Finance Canada publishes cost estimates and projections for these measures each year in the [Report on Federal Tax Expenditures](#)<sup>xxvi</sup>. This report also provides detailed background information on tax expenditures, including descriptions, objectives, historical information and references to related federal spending programs. The tax measures presented in this report are the responsibility of the Minister of Finance.

## Organizational contact information

National Research Council Canada

NRC Communications

1200 Montreal Road, Bldg. M-58

Ottawa, Ontario, Canada K1A 0R6

Phone: (613) 993-9101 or toll-free 1-877-NRC-CNRC (1-877-672-2672)

Fax: (613) 952-9907

TTY number: (613) 949-3042

E-mail: [info@nrc-cnrc.gc.ca](mailto:info@nrc-cnrc.gc.ca)



## Appendix: definitions

### **appropriation (crédit)**

Any authority of Parliament to pay money out of the Consolidated Revenue Fund.

### **budgetary expenditures (dépenses budgétaires)**

Operating and capital expenditures; transfer payments to other levels of government, organizations or individuals; and payments to Crown corporations.

### **Departmental Plan (plan ministériel)**

A report on the plans and expected performance of an appropriated department over a three-year period. Departmental Plans are tabled in Parliament each spring.

### **Departmental Results Report (rapport sur les résultats ministériels)**

A report on an appropriated department's actual accomplishments against the plans, priorities and expected results set out in the corresponding Departmental Plan.

### **evaluation (évaluation)**

In the Government of Canada, the systematic and neutral collection and analysis of evidence to judge merit, worth or value. Evaluation informs decision making, improvements, innovation and accountability. Evaluations typically focus on programs, policies and priorities and examine questions related to relevance, effectiveness and efficiency. Depending on user needs, however, evaluations can also examine other units, themes and issues, including alternatives to existing interventions. Evaluations generally employ social science research methods.

### **experimentation (expérimentation)**

Activities that seek to explore, test and compare the effects and impacts of policies, interventions and approaches, to inform evidence-based decision-making, by learning what works and what does not.

### **full-time equivalent (équivalent temps plein)**

A measure of the extent to which an employee represents a full person-year charge against a departmental budget. Full-time equivalents are calculated as a ratio of assigned hours of work to scheduled hours of work. Scheduled hours of work are set out in collective agreements.

### **gender-based analysis plus (GBA+) (analyse comparative entre les sexes plus [ACS+])**

An analytical approach used to assess how diverse groups of women, men and gender-diverse people may experience policies, programs and initiatives. The “plus” in GBA+ acknowledges that the gender-based analysis goes beyond biological (sex) and socio-cultural (gender) differences. We all have multiple identity factors that intersect to make us who we are; GBA+ considers many other identity factors, such as race, ethnicity, religion, age, and mental or

physical disability. Examples of GBA+ processes include using data disaggregated by sex, gender and other intersecting identity factors in performance analysis, and identifying any impacts of the program on diverse groups of people, with a view to adjusting these initiatives to make them more inclusive.

**government-wide priorities (priorités pangouvernementales)**

For the purpose of the 2017–18 Departmental Results Report, those high-level themes outlining the government’s agenda in the 2015 Speech from the Throne, namely: Growth for the Middle Class; Open and Transparent Government; A Clean Environment and a Strong Economy; Diversity is Canada’s Strength; and Security and Opportunity.

**horizontal initiative (initiative horizontale)**

An initiative where two or more departments are given funding to pursue a shared outcome, often linked to a government priority.

**Management, Resources and Results Structure (structure de gestion, des ressources et des résultats)**

A comprehensive framework that consists of an organization’s inventory of programs, resources, results, performance indicators and governance information. Programs and results are depicted in their hierarchical relationship to each other and to the Strategic Outcome(s) to which they contribute. The Management, Resources and Results Structure is developed from the Program Alignment Architecture.

**non-budgetary expenditures (dépenses non budgétaires)**

Net outlays and receipts related to loans, investments and advances, which change the composition of the financial assets of the Government of Canada.

**performance (rendement)**

What an organization did with its resources to achieve its results, how well those results compare to what the organization intended to achieve, and how well lessons learned have been identified.

**performance indicator (indicateur de rendement)**

A qualitative or quantitative means of measuring an output or outcome, with the intention of gauging the performance of an organization, program, policy or initiative respecting expected results.

**performance reporting (production de rapports sur le rendement)**

The process of communicating evidence-based performance information. Performance reporting supports decision making, accountability and transparency.



**plan (plan)**

The articulation of strategic choices, which provides information on how an organization intends to achieve its priorities and associated results. Generally a plan will explain the logic behind the strategies chosen and tend to focus on actions that lead up to the expected result.

**planned spending (dépenses prévues)**

For Departmental Plans and Departmental Results Reports, planned spending refers to those amounts that receive Treasury Board approval by February 1. Therefore, planned spending may include amounts incremental to planned expenditures presented in the Main Estimates.

A department is expected to be aware of the authorities that it has sought and received. The determination of planned spending is a departmental responsibility, and departments must be able to defend the expenditure and accrual numbers presented in their Departmental Plans and Departmental Results Reports.

**priority (priorité)**

A plan or project that an organization has chosen to focus and report on during the planning period. Priorities represent the things that are most important or what must be done first to support the achievement of the desired Strategic Outcome(s) or Departmental Results.

**program (programme)**

A group of related resource inputs and activities that are managed to meet specific needs and to achieve intended results and that are treated as a budgetary unit.

**Program Alignment Architecture (architecture d'alignement des programmes)**

A structured inventory of an organization's programs depicting the hierarchical relationship between programs and the Strategic Outcome(s) to which they contribute.

**result (résultat)**

An external consequence attributed, in part, to an organization, policy, program or initiative. Results are not within the control of a single organization, policy, program or initiative; instead they are within the area of the organization's influence.

**statutory expenditures (dépenses législatives)**

Expenditures that Parliament has approved through legislation other than appropriation acts. The legislation sets out the purpose of the expenditures and the terms and conditions under which they may be made.

**Strategic Outcome (résultat stratégique)**

A long-term and enduring benefit to Canadians that is linked to the organization's mandate, vision and core functions.

**sunset program (programme temporisé)**

A time-limited program that does not have an ongoing funding and policy authority. When the program is set to expire, a decision must be made whether to continue the program. In the case of a renewal, the decision specifies the scope, funding level and duration.

**target (cible)**

A measurable performance or success level that an organization, program or initiative plans to achieve within a specified time period. Targets can be either quantitative or qualitative.

**voted expenditures (dépenses votées)**

Expenditures that Parliament approves annually through an Appropriation Act. The Vote wording becomes the governing conditions under which these expenditures may be made.

## Endnotes

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- i NRC Dialogue, [https://www.nrc-cnrc.gc.ca/eng/about/corporate\\_overview/year\\_at\\_glance\\_2016.html](https://www.nrc-cnrc.gc.ca/eng/about/corporate_overview/year_at_glance_2016.html)
- ii Innovation and Skills Plan, <https://www.ic.gc.ca/eic/site/062.nsf/eng/home>
- iii Mandate letter to NRC President, [http://www.nrc-cnrc.gc.ca/eng/about/corporate\\_overview/mandate.html](http://www.nrc-cnrc.gc.ca/eng/about/corporate_overview/mandate.html)
- iv CHIME telescope, internal reference to the [SI&M Results](#) section of the present report
- v NRC research facilities, [www.nrc-cnrc.gc.ca/eng/solutions/facilities/index.html](http://www.nrc-cnrc.gc.ca/eng/solutions/facilities/index.html)
- vi NRC online directory to research experts, <https://www.nrc-cnrc.gc.ca/eng/contact/index.html>.
- vii About NRC, <https://www.nrc-cnrc.gc.ca/eng/about/index.html>
- viii National Research Council Act, <http://laws-lois.justice.gc.ca/eng/acts/N-15/index.html>
- ix Mandate letters to the Ministers, <http://pm.gc.ca/eng/mandate-letters>
- x Innovation Superclusters Initiative, <https://www.ic.gc.ca/eic/site/093.nsf/eng/00003.html#toc-01.01>
- xi Innovative Solutions Canada, <http://www.ic.gc.ca/eic/site/101.nsf/eng/home>
- xii Impact Canada Fund, <https://www.canada.ca/en/innovation-hub/topics/impact-canada-initiative.html>
- xiii Canada's Intellectual Property Strategy, <https://www.ic.gc.ca/eic/site/108.nsf/eng/home>
- xiv NRC Algal Carbon Conversion, [https://www.nrc-cnrc.gc.ca/eng/solutions/collaborative/algal\\_index.html](https://www.nrc-cnrc.gc.ca/eng/solutions/collaborative/algal_index.html)
- xv NRC Reporting, [https://www.nrc-cnrc.gc.ca/eng/about/planning\\_reporting/index.html](https://www.nrc-cnrc.gc.ca/eng/about/planning_reporting/index.html)
- xvi IRAP success stories, <http://www.nrc-cnrc.gc.ca/eng/irap/success/2017/index.html>
- xvii CIIP, <http://tradecommissioner.gc.ca/funding-financement/ciip-pcii/index.aspx?lang=eng>
- xviii CanExport, [http://international.gc.ca/trade-commerce/funding-financement/canexport/about-appropos.aspx?lang=eng&\\_ga=2.23117438.535481023.1530157384-453158284.1529001209](http://international.gc.ca/trade-commerce/funding-financement/canexport/about-appropos.aspx?lang=eng&_ga=2.23117438.535481023.1530157384-453158284.1529001209)
- xix IRAP Blockchain Publishing Prototype, <https://nrc-cnrc.explorecatena.com>
- xx Blockchain technology, <https://www.nrc-cnrc.gc.ca/eng/stories/2018/blockchains.html>
- xxi NRC time services, [https://www.nrc-cnrc.gc.ca/eng/solutions/advisory/calibration/time\\_frequency.html](https://www.nrc-cnrc.gc.ca/eng/solutions/advisory/calibration/time_frequency.html)
- xxii TBS InfoBase, <https://www.tbs-sct.gc.ca/ems-sgd/edb-bdd/index-eng.html#start>
- xxiii NRC Dialogue Action Plan, [https://www.nrc-cnrc.gc.ca/eng/achievements/employees/2017/employees\\_working\\_together.html](https://www.nrc-cnrc.gc.ca/eng/achievements/employees/2017/employees_working_together.html)
- xxiv NRC Mission, Vision, and Values, internal link to the [Mandate and Role](#) section of the present report

xxv Public Accounts of Canada, <http://www.tpsgc-pwgsc.gc.ca/recgen/cpc-pac/index-eng.html>

xxvi Report on Federal Tax Expenditures, <http://www.fin.gc.ca/purl/taxexp-eng.asp>