

# National Research Council Canada

2019–20

## **Departmental Results Report**

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

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Departmental Results Report 2019–20  
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## Minister's message

It is my pleasure to present the 2019–20 Departmental Results Report for the National Research Council of Canada (NRC). As the organization continues to mobilize industry and the research community to confront the COVID-19 pandemic, the various organizations in the Innovation, Science and Economic Development Portfolio have coordinated their efforts to position Canada as a global innovation leader and shape an inclusive economy for all Canadians.

When Canada faces its greatest challenges, the NRC draws on its broad, multi-disciplinary expertise and capacity in science, technology and innovation to step-up and fulfill both immediate and long-term national needs. Last year, the NRC responded to climate change as a long term challenge and when the COVID-19 pandemic hit Canada and the rest of the world with force, the organization pivoted rapidly to respond. The NRC mobilized to protect the health of Canadians and its workforce, and support clients, collaborators and Canadian businesses to ensure essential services continued, so that our country could put its best foot forward amidst a global crisis.

In the first year of implementation of the NRC 5-Year Strategic Plan, efforts focused on clean energy solutions for a more sustainable economy, innovation in digital technologies and artificial intelligence, research advances in healthcare, biologics and food safety, advanced support to Canadian businesses, and enhanced collaboration with industry, academia and other government departments.

These are just a few examples of NRC's work on behalf of Canadians regardless of their background, region or generation. I invite you to read this report to learn more about how we are working hard to enhance the NRC's role in Canada's innovation landscape, reinforce research strengths, and better position the organization for collaboration with government, industry and academia.

The Honourable Navdeep Bains  
Minister of Innovation, Science and Industry  
[Mandate Letter](#)<sup>i</sup>





## President's message

The long-term mandates of the NRC include the advancement of knowledge, supporting business innovation and industrial research, and supporting the Government of Canada with public policy objectives and societal needs. In 2019–20, the NRC released a five-year strategic plan “From Dialogue to Action, Excellence to Impact”, reflecting the completion of an internal stock-taking renewal exercise, known as NRC Dialogue, and our shift toward a new agenda. This Departmental Results Report uses the structure and priorities of the NRC Strategic Plan to report to parliament on our results for the 2019–20 fiscal year.

While the greater part of last year occurred prior to the onset of the COVID-19 pandemic, in March 2020, the NRC pivoted rapidly to support Canada's response to the crisis. In a matter of days, the vast majority of our workforce was successfully transitioned to working remotely. We immediately began upgrading our Royalmount bio-manufacturing facility to expand vaccine production capacity; we signed a collaborative agreement with North American biopharmaceutical company, VBI, to test and develop vaccine candidates; we launched the Innovative Solutions Canada COVID-19 Challenge Program to bring together government and the private sector to address the most pressing needs of frontline health care providers; we established a Pandemic Response Challenge Program to expedite R&D needs in areas such as digital health, rapid detection and diagnosis, and therapeutics and vaccine development; and we received \$250M to launch the Innovation Assistance Program to deliver wage subsidy assistance to innovative, early-stage companies.

The scope and scale of the NRC's efforts supporting the fight against COVID-19 have steadily grown and advanced since those first few weeks, and will be the primary focus of our 2020–21 Departmental Results Report. With that in mind, we have focused the 2019–20 report on pre-COVID-19 results achieved, guided by the NRC Strategic Plan. With the aim of achieving a better Canada and world through excellence in research and innovation, in our first year of implementation, we delivered results in our five areas of strategic focus as follows:

**Enabling a more sustainable economy** – Through collaborative work with other government departments (OGDs) and increased efforts in research related to clean energy and the environment, natural resources, buildings and infrastructure, and transportation, we contributed significantly to help transition Canada to a more sustainable economy and a cleaner future.

**Supporting a healthier future** – From cell and gene therapies, to safe and efficient food production, we played an essential role in advancing research and development (R&D) to protect the health and safety of Canadians.

**Innovating the everyday** – Our leading-edge research in artificial intelligence and digital innovation enabled smart solutions for the transportation and manufacturing sectors; language processing software, quantum sensing and quantum networks for the communications sector; and nanoscience for the forestry, energy and biology sectors.



**Creating Canadian wealth through innovation** – In support of the federal government's vision for Canada to be a global leader in innovation, anchored by Canada's Innovation and Skills Plan, we continued our efforts to be a driver of economic growth by increasing support to Canadian small- and medium-sized enterprises (SMEs) through the National Research Council of Canada Industrial Research and Assistance Program (NRC IRAP). In addition, we enhanced relations with global partners by opening offices in Japan and Germany.

**Understanding our world** – To push the frontiers of knowledge, we made advancements in the fields of astronomy and astrophysics through partnerships with world-class observatories, explored innovative applications for integrating drones into Canada's airspace, and established contributions for collaborative projects to enable fast, reliable internet across Canada.

In addition to these successes, the NRC also achieved significant results in research excellence and business support, including:

- Generating over 1,000 peer-reviewed publications, with an average of 50 publications per 100 NRC scientists, engineers and technicians.
- Filing over 370 patent applications, with 1,822 active patents maintained.
- Working with more than 950 R&D clients, generating over \$183M in revenue, with 49 percent coming from industry clients.
- Having 92 percent of R&D clients indicate that working with the NRC resulted in positive benefits, such as increased R&D capacity, sales or jobs.
- Providing NRC IRAP funding to more than 3,300 Canadian SMEs, and advisory services to 4,732 companies.
- Achieving revenue growth of 31 percent and employee growth of 20 percent for NRC IRAP-funded clients (from 2016 to 2018).

These accomplishments are due to our dedicated employees who embody pride, passion and professionalism in all they do. Whether working in research labs, assisting NRC IRAP clients, or providing support services, each member of the NRC's workforce plays an important and essential role in delivering the research, innovation, and results that propel Canada forward.

We are working hard to respond to the global pandemic and putting the health and safety of Canadians and our clients first. In 2020–21 and beyond, we will continue to pursue our strategic goals, and fulfill our commitments to research excellence, innovative ideas, outstanding business support and workforce development.

Mr. Iain Stewart  
President  
National Research Council Canada  
[Mandate Letter from the Ministers<sup>ii</sup>](#)

## Results at a glance and operating context

What funds were used? (2019–20 Actual spending)	Who was involved? (2019–20 Actual full-time equivalents)
\$1,214,601,865	4,109.4

The NRC advances scientific knowledge, supports business innovation and provides technological solutions to public policy challenges by undertaking, assisting and promoting scientific and industrial research in fields of importance to Canada. Last year, the Government of Canada appointed Dr. Douglas Muzyka as the new Chair of the NRC Council, and six Council members were appointed to provide strategic advice to the NRC President and review the organization’s performance. This was timely with the launch of the NRC’s new five-year Strategic Plan. Last year, the NRC significantly expanded the spectrum of its collaborations with academia, OGDs, industry, SMEs and organizations abroad. In addition, the NRC continued to streamline and improve its business processes in an effort to be a high performing organization.

### Scientific and technological knowledge advances

The NRC made great strides towards achieving its targets in advancing scientific and technological knowledge, with 1,174 intellectual assets (patents, disclosures, publications and trade secrets) generated by NRC research leaders.

- The NRC expanded collaborations by signing new agreements for Collaboration Centres with the University of Manitoba, the Centre hospitalier universitaire (CHU) Sainte-Justine and the Fields Institute. The NRC also collaborated with academia and industry in bio-manufacturing, maritime and oceanography, and artificial intelligence (AI). These collaborations will result in science and technology advancements for tomorrow’s economy, and improvement in the quality of life for Canadians and people around the world.
- The NRC used innovative research in energy, power, transportation and mining to advance the goal of a cleaner, more resilient economy. A notable achievement in 2019–20, was collaborative work with the University of Alberta to increase storage capacity of lithium-ion batteries, a potential game-changer for cell phones.
- Leveraging research expertise in natural language processing, nanotechnologies and advanced manufacturing, the NRC contributed to the development of innovations that will help Canada find solutions to fundamental challenges, such as the preservation of Indigenous languages and understanding the nature of our galaxy.

### Innovative businesses grow

Working with industry, government and academia, the NRC’s scientific experts and industrial technology advisors support a broad range of science and innovation activities, including helping SMEs to scale up, access global value chains and become internationally competitive.

- The NRC officially opened an office in Japan and deployed an NRC representative to Germany to strengthen international innovation relationships, foster new collaborations and promote partnerships with stakeholders in various fields.

- The NRC improved business support, with 92 percent of clients reporting positive benefits from working with the NRC, such as increased jobs, sales, or R&D expenditure and in 2019–20, NRC IRAP provided support to 8,034 SME firms. NRC IRAP clients experienced 31 percent growth in revenue and 20 percent growth in employment (from 2016–2018).
- In April 2020, NRC IRAP successfully launched the new Innovation Assistance Program, less than one week after being announced by the Prime Minister, to provide a wage subsidy to innovation-based SMEs in financial need due to the economic impacts of COVID-19.

### **Evidence-based solutions inform decisions in government priority areas**

The NRC has become a platform for connecting expertise across Canada's innovation system in support of enabling solutions to public issues of national importance. With investments from OGDs for collaborative work and 1,228 publications in government priority areas, the NRC advanced the following results within the public domain:

- The first four NRC Challenge Programs were launched in Disruptive Technology Solutions for Cell and Gene Therapy, Artificial Intelligence for Design, Novel Materials for Clean Fuels, and High-Throughput and Secure Networks.
- The NRC continued to contribute to the [Innovation Superclusters Initiative](#)<sup>iii</sup> by developing new support programs including the Sustainable Protein Production program and Artificial Intelligence for Logistics program.
- Collaborations continued with OGDs and industry partners to take action against climate change on multiple fronts, including research into technologies to improve transportation safety, power and electricity systems, and fire protection services.

### **Internal services**

The NRC continued to improve its internal services in 2019–20, including the simplification of internal processes, and substantively closing off NRC Dialogue after two years of internal consultations and two additional years of actions in support of the NRC's renewed mission and values. Building on Dialogue, the NRC's five-year Strategic Plan "From Dialogue to Action, Excellence to Impact" was released in 2019–20. The plan was developed to solidify and strengthen the NRC's role in Canada's research and innovation system.

- To enhance the organization's ability to attract, develop and retain a diverse, talented, healthy and engaged workforce, the NRC also released its Strategic Human Resources Plan with initiatives in equity, diversity and inclusion, wellness, and leadership development.
- The NRC introduced its first Ombudsperson, to promote a harassment-free, ethical workplace where staff feel safe to raise issues on scientific integrity, research ethics and harassment in a trusted, neutral space.
- The NRC continued to modernize its IT infrastructure for improved support across the organization and continued its comprehensive review of NRC buildings and real estate.

For more information on the National Research Council's plans, priorities and results achieved, see the "Results: what we achieved" section of this report.

## Results: what we achieved

### Core Responsibility: Science and Innovation

**Description:** Grow and enhance the prosperity of Canada through: undertaking, assisting and promoting innovation-driven research and development (R&D); advancing fundamental science and Canada's global research excellence; providing government, business and research communities with access to scientific and technological infrastructure, services and information; and supporting Canada's skilled workforce and capabilities in science and innovation.

The NRC has three departmental results for tracking and reporting against its core responsibility:

- scientific and technological knowledge advances;
- innovative businesses grow; and
- evidence-based solutions inform decisions in government priority areas.

Canada and the world faced unprecedented challenges in the economic, technological and environmental domains in 2019–20 and the NRC was able to deliver on its commitments in these areas by proactively identifying and mitigating potential risks. Through a new, consultative semi-annual risk process, including in-year stock-taking and adjustments, the NRC focused on: ensuring capabilities were available to deliver R&D programs in a timely manner; enabling NRC IRAP's ability to maintain high quality and innovative programs despite rapid and significant scale-up; continuing to develop the NRC Wellness Strategy to facilitate a healthy and productive workplace; and introducing new enabling technologies to support the workforce and increase the organization's productivity.

### Results:

#### Departmental Result 1: Scientific and technological knowledge advances

The NRC contributes to research excellence and advances scientific and technological knowledge by creating intellectual assets, publishing scholarly papers, and attracting and retaining leaders in science, technology, engineering and mathematics (STEM). Although the NRC's citation score of 1.38 was slightly below its target of 1.50, it surpassed its target for intellectual assets generated by NRC research leaders, with a total of 1,174 patents, disclosures, publications and trade secrets, and increased its ratio of women in STEM above the Canadian average labour market availability (1.01).

The [NRC Ideation Fund](#)<sup>iv</sup> provides funding to encourage, test, and validate transformative, self-directed, exploratory research ideas generated by NRC staff and external collaborators. In 2019–20, three successful Small Teams projects were identified in the areas of astronomical interferometry, antimicrobial resistance, and digital transformation and the Ideation New Beginnings Fund approved 45 projects for funding. 86 collaborative projects have been funded to date, which have collectively received \$1.8M in funding.

The NRC’s collaborative R&D projects combine the brightest minds and leading-edge equipment to advance knowledge and drive innovation, enabling Canada to develop internationally recognized scientific achievements.

- The NRC joined forces with Launchworks Manufacturing Lab and its sister company, Cryopak Canada, to create the Laboratory of Industrial Fluidic Translation. This one-stop shop offers knowledge in nanofabrication and lab-on-a-chip technologies, in addition to manufacturing expertise for bio-device companies to accelerate microfluidic bio-devices.
- The Ottawa AI Alliance, a collaboration between the NRC, University of Ottawa and Carleton University, celebrated the success of its second annual workshop, which enhanced networking for AI researchers in the National Capital Region. The NRC also built relationships with British Columbia-based universities and organizations within the AI ecosystem, which resulted in new agreements with Simon Fraser University and the University of British Columbia.

By advancing research on energy storage technology, clean fuels, renewable materials, and energy efficient tools and technologies, the NRC contributed research to help reduce the environmental footprint created by modern life.

- A successful partnership between the NRC and Mason Graphite to develop a conversion process for battery-grade graphite for optimized use in electric vehicle batteries and other applications resulted in a 2019 Innovation Award nomination with the Association pour le développement de la recherche et de l’innovation du Québec.
- A breakthrough that could change the way Canadians use mobile devices was achieved through collaborative work with the University of Alberta’s Department of Physics to double the charge storage capacity of lithium-ion batteries.
- New test standards and diagnostic tools were developed for repurposing certain sub-modules of end-of-life batteries to avoid landfill accumulation.
- The NRC completed the commissioning of a unique smart-grid system for the production of combined heat and power from a range of renewables, including biomass.
- Through its collaboration with Alberta Innovates, the NRC developed materials and processes for degradable adhesives employing Nanocrystalline Cellulose. The NRC also developed a process in collaboration with Raymor Industries that enables 99.9 percent purity for semiconducting single walled carbon nanotubes, a promising nanotechnology for the development of energy-efficient computing.

#### Reducing lithium-ion battery failure

The world’s first full-scale test of a thermal runaway initiation mechanism (TRIM) was performed on a fully operational electric vehicle. TRIM, which tests the ability of a lithium cell to resist cascading failure to other cells in a larger battery pack, which can lead to overheating and explosions, will be used to identify how packaging materials, cell spacing and thermal management strategies can be deployed to reduce battery failures.

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To enable a cleaner, healthier and more sustainable future for Canadians, the NRC conducted environmental research in 2019–20 to advance climate-resilient infrastructure and develop innovations to protect against threats to the environment.

- The NRC designed and installed a structural and geotechnical monitoring system on a test section of Via Rail live track. The system measures track temperature, rail strain and track/foundation deformation caused by heat waves, freeze-thaw cycles and other climate effects. The data will help improve future railway installations and rail operations safety in permafrost-rich regions where more frequent freeze-thaw cycles are a serious concern.
- NRC researchers have been collaborating with Tata Steel Minerals Canada to revegetate and restore an abandoned mining site in Schefferville, Quebec. The NRC examined and characterized the mineral matrix of the site and is now generating biochar-based nutrients to help retain moisture and provide a carbon source absent from the waste rock.

In support of the International Year of Indigenous Languages, the NRC leveraged its research expertise in natural language processing, AI and text analytics to make important contributions to speech- and text-based technologies to assist with stabilizing, revitalizing, and reclaiming Indigenous languages; help engage young people in learning Indigenous languages; and increase language use in every day contexts. Specifically, the NRC:

- Released WordWeaver, an open source code and graphical user interface to create online verb conjugation tools for Iroquoian languages;
- Delivered a predictive text software for SENĆOŦEN for people to benefit from the speed and ease of having predictive text at their fingertips when typing on mobile device;
- Enabled keyword searching of audio recordings in Inuktitut, Cree, and other Indigenous languages with the Computer Research Institute of Montreal, the Pirurvik Centre and the Canadian Broadcasting Corporation;
- Developed technologies for Inuktitut language learners and professionals that reinforce Inuktitut's status as an official language; and,
- Contributed to language course creation for Kwak'wala, Michif, Mi'kmaw and Naskapi.

Research to advance efficiency-based innovations through disruptive technologies led NRC researchers to create a world-leading technology in laser consolidation for additive manufacturing, which has been licensed to Canadian-owned Burloak Technologies. The technology allows clients to go straight from computer-aided design to manufacturing complex components and intricate features otherwise impossible using conventional processes.

The NRC's deep and diverse expertise in emerging technologies was deployed to address fundamental questions of science and advance enabling technologies designed to spur Canadian innovation in the future. In 2019–20, the NRC contributed to knowledge breakthroughs in the following areas:

- The NRC explored quantum communication in real-world conditions by establishing an intra-city free-space quantum communication network, and developing a prototype quantum

communication network.

- With scientific and technical support from the NRC, the Canadian Hydrogen Intensity Mapping Experiment (CHIME), is now routinely performing observations and made many significant discoveries, including the detection of eight new repeating Fast Radio Bursts (FRBs) and the first FRB detection from an object within the galaxy. The NRC also successfully completed the integration and testing of the Gemini High-resolution Optical SpecTrograph (GHOST), which will provide best-in-class, high-resolution spectroscopic capabilities to the Gemini user community for a broad range of science.
- The NRC supported advanced research in sub-atomic physics through program stewardship and contribution payments of \$55M to TRIUMF, Canada’s particle accelerator centre. Stewardship activities included two site visits by the Advisory Committee on TRIUMF (ACOT) and the review of trimester reports on performance achievements across TRIUMF’s research activities, including particle physics, nuclear physics, nuclear medicine, materials science and theory.

To support women researchers and showcase how they are at the heart of many scientific achievements and technology breakthroughs, in 2019–20 the NRC:

- Held six Women in STEM luncheons across Canada, providing a platform for the NRC’s women researchers to share ideas and learn from each other;
- Hosted a Women in STEM Symposium on the International Day of Women and Girls in Science. Almost 300 participants from 12 federal departments and agencies convened to share information about their projects, celebrate successes, form networks and discuss ways to improve equity, diversity and inclusion (EDI) across the federal government. A program called the Dimensions Charter, led by the Natural Sciences and Engineering Research Council to address barriers faced by under-represented and disadvantaged groups in post-secondary research institutions was endorsed at the symposium; and
- Participated in workshops across Canada focused on leadership development, organizational values, diversity within teams, effective communication and cultural change, as part of its partnership with Engendering Success in STEM, a collaborative research consortium focused on breaking down biases for women in STEM.

## Departmental Result 2: Innovative businesses grow

The NRC continued to accelerate the growth of SMEs in 2019–20 by providing them with a comprehensive suite of innovation services, advice and funding. Through this work, the NRC helped SMEs build innovative capabilities, scale up and take their ideas to market.

NRC IRAP funded innovative projects for over 3,300 Canadian SMEs, enabling its clients to support over

### Supporting youth employment

In 2019–20, NRC IRAP supported the placement of 668 graduates in quality jobs with innovative Canadian SMEs through the Youth Employment Strategy. Of those graduates that have completed the internship, 86 percent reported that they were employed or self-employed after the experience.

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11,400 Canadian jobs and provided advice to an additional 4,700 unfunded firms. NRC IRAP support has helped clients grow their revenues by 31 percent and employment by 20 percent (from 2016 to 2018), significantly exceeding targets.

While client financial investment in technology development support increased last year to \$88.5M, it fell short of the NRC's ambitious target of \$92.5M. The implementation of the NRC's Strategic Plan re-focused the priorities of research centres, resulting in a shift from serving the broad needs of industry clients to building more strategic partnerships with Canadian private sector and academic partners that support NRC priorities, and positioning the NRC as a convener within the innovation eco-system. Revenue was also affected by the need to dedicate time to building relationships with new clients, and developing and launching the organization's new suite of seven year multi-party Challenge Programs. In addition, cyclical market factors had an impact on NRC clients in the photonics space, which accounted for a significant portion of this missed target.

In 2019–20, NRC IRAP formed a client engagement team comprised of 16 advisors located across NRC IRAP regional offices that provide customized support and extend NRC IRAP's impact on the growth of Canadian SMEs. The team has introduced over 560 new potential clients to NRC IRAP and provided specialized advisory services to over 520 new and existing NRC IRAP clients.

The NRC delivered the Innovative Solutions Canada (ISC) Program with Innovation, Science and Economic Development (ISED). NRC IRAP forms part of the ISC Secretariat, which provides program design expertise, technical assessments of potential ISC challenges from 20 federal departments, and assessments of SME applications. The NRC continues to be the leading department in terms of challenge projects – with eight new challenges posted in 2019–20, and an additional eight challenges in the pipeline.

The NRC continued to work with the European Association of Research and Technology Organizations (RTO), and the RTO International Network, which involves engagement with equivalent international organizations. In 2019–20, the network strengthened its membership to include Australia, Japan and South Korea, as well as major European players such as Germany, Finland, the Netherlands and others. This network creates value by enabling the exchange of information and lessons learned, as well as exploring where joint efforts may be facilitated in key areas such as the pandemic response.

On average, 12 percent of Canadian firms export to global markets, however, NRC IRAP firms significantly surpassed this statistic with 32 percent exporting in 2017. Through the delivery of international programs and initiatives, significant progress was made in NRC IRAP's International Strategy, enabling innovative Canadian SMEs to expand into global markets.

- NRC IRAP continued to collaborate with Global Affairs Canada (GAC) to deliver the CanExport Program, which helps Canadian SMEs develop new export opportunities. In 2019–20, the program supported over 2,850 projects to 115 foreign markets.

- NRC IRAP’s combined advisory support and investment in international projects of more than \$22.8M, including GAC’s Canadian International Innovation Program (CIIP) contributions, enabled the commencement of 160 new projects to accelerate the global growth of firms.
- To help build an industry pipeline for international growth, NRC IRAP conducted six International Co-Innovation Action Plan workshops, which led to a total of \$1.97M in NRC IRAP funding to help 43 projects supporting Canadian firms as they prepare for international expansion. The NRC supported 28 incoming and 18 outgoing missions and visits involving NRC research centres and executives to establish new partnerships and facilitate collaboration with 150 foreign scientists.
- Several new Memorandums of Understanding (MOUs) extended long-term partnerships with the National Institute of Advanced Industrial Science and Technology, Advanced Telecommunications Research Institute International, and Mitsubishi. This will enable partnerships with Japanese multinational enterprises to strengthen the NRC’s research and innovation collaboration and accelerate the accessibility of Canadian SMEs into Global Value Chains. To date, 12 research collaboration agreements have been signed to facilitate these kinds of partnerships.

### Building an international presence

The first international on-the-ground presence was established in Tokyo, Japan in October 2019 and in Munich, Germany in December 2019. The NRC is now working more closely with German and Japanese research institutions, industry, and government science and innovation programs to accelerate collaborations and progress for its R&D programs and SME clients within the two countries.

The NRC’s International Innovation Office enhanced governance for activities and investments in 2019–20, to ensure an optimized NRC international presence. Some highlights include:

- The NRC completed 20 successful Prime the Pump<sup>1</sup> (PtP) collaborative projects with the United Kingdom (UK) and Germany. In addition, a \$110K investment saw 11 projects commencing with Japan PtP this year.
- NRC IRAP invested \$4M to support new projects with the UK, and co-led two missions of Canadian SMEs to the UK, including the EUREKA Global Innovation Summit.
- The NRC’s relationship with Germany was enhanced through three SME missions delivered as part of the CIIP program. Additionally, a \$3M NRC IRAP investment was made through the EUREKA program for Canadian SMEs to support new projects with German partners.
- The NRC grew its presence in Japan by sending an AI-focused delegation of Canadian SMEs to the renowned Innovation Leaders Summit, which resulted in NRC IRAP investments of \$625K for Canadian firms to start collaborations with Japanese partners.

<sup>1</sup> Prime the Pump is a series of competitive calls for collaborative activities between NRC and Germany, Japan and the UK within the framework of NRC’s International Strategy. Funds received by researchers were dedicated to supporting costs such as the organization of workshops and incremental material in support of starting collaborations on concrete joint projects with a view of establishing long-term partnerships.

In 2019–20, the NRC expanded its support to Canadian SMEs and academia through increased access to infrastructure.

- A three-tiered approach was introduced as part of the Strategic Account Management framework to support the categorization of companies based on potential impact; improve alignment with research centre capabilities, programs and strategic direction; and identify potential for future strategic relationships. The NRC uploaded its entire IP portfolio to ISED's ExploreIP database, a new online resource for businesses to explore possible licensing and collaboration opportunities with public sector patent holders.
- The NRC continued to offer a labour fee reduction for its R&D services, with more than 425 agreements signed with eligible SMEs and academic institutions.

Leveraging research facilities and expertise, and NRC IRAP funding and advisory services, the NRC collaborated with SMEs to bring emerging technologies that benefit Canadians to market.

- During the 2019 Paris Air Show, the NRC joined Transport Canada (TC) and Québec's Consortium for Research and Innovation in Aerospace, to participate in a call for proposals for unmanned systems projects, with one of them receiving funding from NRC IRAP.
- In 2019–20, the NRC submitted a patent application for a technology to enable contact-based inspection and maintenance by drone, allowing robust docking and support of forces sufficient to take contact measurements and eventually deploy active processes from an articulated robot.
- Guelph-based Artemis Technologies Inc. inaugurated its own in-house bio-manufacturing capacity in 2019–20 based on NRC technology, enabling the production of over 10M vaccine baits a year to protect wildlife from rabies.
- In consultation with the NRC, Formation Biologics Inc. (Forbius) advanced a potential breakthrough treatment for cancer and fibrosis to clinical trials, with results expected as early as 2020–21. The initial proof of concept for a biologic was developed by the NRC, after which it was further developed with, and licensed to, Forbius.
- Zymeworks Inc., a leading Canadian biotechnology company, extended its collaboration with the NRC by an additional five years and finalized an agreement to acquire a proprietary NRC antibody.

### **Departmental Result 3: Evidence-based solutions inform decisions in government priority areas**

The NRC continued to develop and support key government priorities through targeted research and collaboration initiatives, such as its four Challenge Programs and five Superclusters Support Programs. To date, 69 collaborative projects in support of these programs have been funded by a total of \$12.9M in grants and contributions. To advance evidence-based policy solutions in areas of importance to Canada, the NRC greatly exceeded its target for investment in collaborative work with OGDs, generating \$77.7M in revenue. Although the number of scientific and technical publications generated in government priority areas was slightly below the target, the

NRC produced 1,228 publications to inform evidence-based policy solutions in areas of importance to Canada.

The NRC’s seven-year, mission-oriented Challenge Programs bring together the unique strengths of innovators from OGDs, academia and industry to foster transformative discoveries and technological breakthroughs that benefit Canadians. In 2019–20, the NRC made significant progress on its Challenge Program suite, including:

- **Materials for Clean Fuels:**<sup>v</sup> Seven collaborative research grant and contribution (G&C) agreements were executed for a total of \$2.6M in multi-year funding. Research focused on discovering and developing membranes, catalysts and other materials for use in early-stage exploratory technologies that will reduce the cost of producing and storing clean hydrogen fuel and convert captured carbon dioxide into renewable fuels and chemical feedstocks.
- **High Throughput and Secure Networks:**<sup>vi</sup> The program started 26 collaborative G&C funded projects and launched the Optical Satellite Consortium to accelerate Canadian leadership in telecommunications. The program also established contributions for projects with Canadian companies, including with a First Nation SME, Nuvujaq, and quantum security SME, evolutionQ, to support secure, affordable gigabit broadband services in rural and remote communities in Canada.
- **Disruptive Technology Solutions for Cell and Gene Therapy:**<sup>vii</sup> In addition to advancing the program’s \$5.3M foundational investment projects signed in 2018–19, one major G&C investment was awarded in 2019–20 to establish capacity for viral gene therapy manufacturing in Canada. In total, 21 collaborative agreements were initiated for future equipment or collaborative research investments. Against these, a total of \$4.2M in multi-year G&C agreements were executed. The launch of the program garnered national media coverage due to the NRC’s planned collaborative effort to create a better version of Glybera – the world’s first gene therapy.
- **AI for Design:**<sup>viii</sup> 10 collaborative projects were launched last year with grant funding for collaborators’ highly qualified personnel working on AI research. An exploratory call was conducted by the NRC and Innovate UK to better understand the commercial state of AI, and targeted AI in food processing and advanced manufacturing sectors, and a total of nine projects were selected for funding.

#### Leveraging AI for research

The NRC launched the Artificial Intelligence for Molecular Sciences high performance computing cluster, which has been used by NRC researchers and collaborators to crunch massive amounts of biological data using algorithms. The NRC and Shared Services Canada (SSC) launched a second high performance computing cluster, known as Trixie, to explore AI for design problems specific to the COVID-19 pandemic.

In 2019–20, the NRC supported [Canada’s five Innovation Superclusters](#)<sup>ix</sup> by providing access to its research facilities, personnel and NRC IRAP project assessment services as needed.

- The NRC put in place a Sustainable Protein Production program and executed four grant projects and three contribution projects to support the [Protein Industries Supercluster](#).<sup>x</sup> The program will contribute to a Canadian plant protein ecosystem and increase R&D capacity to develop plant-based proteins and co-products. Industry resources were created and made publically available in collaboration with the Agri-food Innovation Council, Bivizio, McGill University and Western Economic Diversification Canada.
- The NRC’s Advanced Manufacturing program, in support of the [Next Generation Manufacturing Supercluster](#),<sup>xi</sup> continued to develop modelling and simulation capabilities, which were deployed to industry members through Industrial R&D Groups such as ALTec. In the first four years of this program, ALTec carried out 25 projects valued collectively at \$8M.
- In support of the [Scale AI Supercluster](#)<sup>xii</sup> and [Digital Technology Supercluster](#),<sup>xiii</sup> the NRC launched the Artificial Intelligence for Logistics program to secure a broad data foothold for Canadian SMEs and academics, and enable the development of diverse new AI logistics technologies. The NRC also launched five projects under its Digital Supercluster support program to create linkages between NRC experts, academic researchers and supercluster members in the areas of precision health, digital twinning and data commons.
- The NRC developed new methods, using AI, to forecast ice in ways that traditional physics-based methods cannot. In support of the [Ocean Supercluster](#),<sup>xiv</sup> and under the direction of the Arctic program, the Beaufort Sea Engineering Database Joint Industry Project wrapped up after almost 10 years. The database is being used by the Inuvialuit Regional Corporation for their input to the government-conducted Beaufort Sea Strategic Regional Environmental Assessment.

#### Strong practices recognized in evaluation of Automotive and Surface Transportation (AST) Program

An evaluation of the NRC’s AST Program found that industrial R&D groups are an effective means to expand and sustain engagement, and ensure research priorities are aligned with industry trends. As part of the evaluation, a committee of experts concluded that the program’s sharing of IP through its ALTec R&D group is an innovative practice to support members and demonstrate leadership.

In 2019–20, the NRC leveraged its global scientific leadership in biologics and vaccine development, medical devices, and food production to advance health technologies, policies and standards to address the health-related pressures affecting Canadians today.

- The NRC completed Cannabis Certified Reference Material and standard testing methods for cannabinoids and pesticides. It also established agreements with Health Canada (HC) on vape liquid characterization, and Justice Canada to evaluate drug testing devices.
- The NRC and GB Sciences worked to develop a treatment for Parkinson’s disease by using advanced Zebrafish models to test GB Sciences’ cannabinoid mixtures – a crucial step in providing treatment to those living with this disease.
- The NRC worked with several OGD and industry partners to provide expertise in growing food in controlled environments, with the goal of providing food production technologies

that help Northern and remote communities access fresh food year-round.

- The NRC launched a new collaboration with North American biopharmaceutical company, VBI, to test vaccine candidates that will protect against COVID-19 as well as the SARS and MERS coronaviruses. VBI is using unique COVID-19 antigens designed by the NRC to accelerate the evaluation and selection of its optimal candidate vaccine. The NRC also partnered with the University of Saskatchewan’s VIDO-Intervac.

Last year, the NRC made great strides toward updating Canada’s design codes, standards and guidelines as part of the Climate Resilient Buildings and Core Public Infrastructure Initiative.

- The NRC contributed to the National Wildland Fire Urban Interface Guidelines, which are planned for completion in 2020, and new National Guidelines for Flood Resiliency of Buildings to be published in 2021.
- In April 2019, the NRC provided municipalities, developers and other interested parties with direct, free access to the electronic editions of the National Building Code, the National Fire Code, the National Plumbing Code and the National Energy Code for Buildings — ensuring information needed to build climate resilient communities is readily available. Last year the NRC undertook \$4M of research to address provincial and territorial priorities underlying variations from the National Model Building Codes, including mass timber construction, climate resilience, health and indoor environment quality, flooding, durability, and energy efficiency.

The NRC worked collaboratively with OGDs and industry partners in 2019–20 to take action against climate change on multiple fronts – positioning the country to achieve a net-zero emissions economy by 2050.

- The NRC continued its work with TC, the Royal Military College and Crown-Indigenous Relations and Northern Affairs Canada to find ways to reinforce winter roads by increasing predictability of load-bearing capacity to ensure safe travel, especially on roads with thinner ice due to changing environmental conditions. In 2019–20, the NRC’s Arctic program was expanded to include new collaborators and pilot test locations for further support of Canada’s sustainable development in the North, while improving the quality of life for Northerners through more reliable infrastructure.
- The NRC partnered with Enviri, a subsidiary of Hydro Ottawa, to refine and commercialize an NRC-developed technology for detecting water damage to buried electrical distribution cables. The technology has resulted in considerable cost savings as it allows Hydro Ottawa to focus maintenance work on degraded cables.
- The NRC launched the Integrated Aerial Mobility program with seven master projects addressing Remotely Piloted Aircraft Systems (RPAS) priority areas. Working with TC, the NRC explored innovative applications to safely and reliably integrate RPAS, commonly known as drones or unmanned aircraft systems, into Canada’s airspace.
- The NRC worked with the Canadian Space Agency (CSA) on a project to map wildland fires using CSA’s infrared space-borne instrument (EMIR) on-board the NRC’s Twin Otter.

- In collaboration with HC and Environment and Climate Change Canada, the NRC has been actively engaged in conducting research activities to protect the health and well-being of Canadians through the [Addressing Air Pollution Horizontal Initiative \(AAPHI\)](#).<sup>xv</sup> The NRC's contributions cover a range of studies, including radon control and mitigation, reducing the impacts of wildfire smoke indoors, managing formaldehyde, and improving ventilation in homes.

### **Gender-based analysis plus**

The NRC-IRAP pan-Canadian Client Inclusivity Team recognizes that Canada's future economic success requires that firms owned or led by underrepresented groups have equal opportunity to reach their full potential. In 2019–20, the Terms of Reference for this task force were developed, in addition to the following achievements:

- A preliminary analysis of funded firms was conducted by NRC IRAP to determine the diversity of its client base. The result indicates NRC IRAP support of approximately 15 percent women-led businesses which is aligned with percentages reported by OGDs.
- A comprehensive data collection strategy has been approved to determine the participation rates of women-led business and other underrepresented groups in NRC IRAP programs and services. As part of this strategy, NRC IRAP will be adding a request for firms led by underrepresented groups to self-identify during the intake process. This includes developing an enterprise-level tool for data collection as well as the corresponding business processes and privacy policies.

The NRC's Office of Audit and Evaluation developed and implemented an approach to incorporate GBA+ into its evaluations to highlight ways in which NRC research impacts diverse populations, including: applications to support aging populations, persons with obesity, persons with disabilities, and diverse groups such as Indigenous communities; future opportunities for new transportation programs to support mobility; and ways to adapt the National Model Building Codes for unique challenges faced by Indigenous communities in remote Northern locations.

### **Experimentation**

In 2019–20, the NRC experimented with new collaborative approaches by continuing to develop and strengthen its [Collaboration Centres](#)<sup>xvi</sup> and collaborative partnerships, in addition to signing new agreements with the University of Manitoba in advanced manufacturing, CHU Sainte-Justine in therapeutics for childhood leukemia, and the Fields Institute in mathematical sciences and analytics.

- The University of Toronto and the NRC Centre for Research and Applications in Fluidic Technologies generated IP related to bioprinting of skin for regenerative medicine, which is now being evaluated for patent protection. In addition, it established a satellite site at Saint Michael's Hospital to develop microfluidic approaches for sepsis patients based on a genomic analysis supported by the NRC's proprietary microfluidic PowerBlade technology.

The [2019–20 Evaluation of the NRC’s Medical Devices Program](#)<sup>xvii</sup> validated the international recognition of NRC work in microfluidics and the potential of the PowerBlade technology. A committee of experts acknowledged that the NRC’s microfluidic technology has applications beyond the current SME base.

- The NRC and Memorial University of Newfoundland officially launched the Karluk Collaboration Space to position Canada as a leader in world-class research, spanning disciplines as varied as maritime technology, oceanography, naval architecture engineering and the digitization of seaways.

In support of experimentation, NRC IRAP continued several key pilot initiatives, including launching a framework for Large Value Contributions (LVC) to SMEs over \$1M and leveraging its new Terms and Conditions to enable an increased contribution threshold of \$10M.

- NRC IRAP established a pilot program with BDC to help innovative firms improve their access to large-scale growth funding. An MOU between NRC IRAP and BDC established formal interaction to share information and facilitate reciprocal client hand-off with the purpose of increasing access to capital for SMEs, expanding reach and impact, and improving financial risk management. As a result, BDC has created a new financial product with very favourable terms that has resulted in more than 10 client success stories.
- A continuous submission process was implemented for the NRC IRAP Certificate Program to allow SMEs to take advantage of the NRC’s research capabilities at any point in a fiscal year. Last year, the NRC supported 81 collaboration projects with SMEs, with issued certificates valued at \$2.1M. Each year, NRC IRAP Certificate Program results are reviewed to identify possible improvements to program reach and process.
- The NRC actively worked to increase collaboration with Canadian SMEs toward advancing technologies for autonomous flight. In 2019–20, they provided expert technical and research services to over 20 SMEs working in the autonomous vehicle industry.
- Launched as a pilot, the LVC framework continues to evolve. A review in November 2019 looked at the first six months of program delivery, leading to implementation of improvements to the framework at the end of the year. 12 LVC projects were approved in 2019–20, with a total NRC IRAP contribution of \$42.9M. Of these, five projects received greater than \$3M in financial support and were reviewed and recommended by the NRC IRAP Investment Review Committee. The first approved project with Ross Video Limited was announced in July 2019.

The NRC further supported experimentation in 2019–20 with its TimeLink (TL) service. The service was successfully tested and operated to provide very high precision, traceable time within the cities of Ottawa, Toronto and New York. A collaboration agreement was signed to install three additional units in northern Canadian communities to test performance in challenging environments. In addition, the NRC has installed the TL system at the Toronto Stock Exchange, facilitating timestamping of financial transactions.

## Results achieved

Departmental Result Indicators	Targets	Date to achieve target	2019–20 Actual results	2018–19 Actual results	2017–18 Actual results
<b>Departmental Result 1: Scientific and technological knowledge advances</b>					
Citation score of NRC-generated publications relative to the world average <sup>1</sup>	1.50	March 31, 2020	1.38	1.51	1.45
Number of unique intellectual assets (e.g., patents, disclosures, publications) generated by NRC research leaders <sup>2</sup>	1,142	March 31, 2020	1,174	1,153	1,099
Ratio of the NRC's workforce made up of underrepresented groups relative to Canadian average labour market availability in Science, Technology, Engineering, and Mathematics (STEM) <sup>3</sup>	1.00	March 31, 2020	1.01	1.02	0.98
<b>Departmental Result 2: Innovative businesses grow</b>					
Percentage of R&D clients who report positive benefits (e.g., increase in jobs, sales, R&D expenditures or other) of working with the NRC	86%	March 31, 2020	92%	90%	86%
Percentage revenue growth of firms engaged with the NRC (IRAP-engaged firms) <sup>4</sup>	20%	March 31, 2020	31%	27%	25%
Percentage growth in Canada's S&T related jobs through NRC supported firms (IRAP-engaged firms) <sup>4</sup>	10%	March 31, 2020	20%	18%	13%
Client financial investment in technology development support by NRC research and development services and scientific and technological infrastructure	\$92.5M	March 31, 2020	\$88.5M <sup>5</sup>	\$79.7M	\$87.0M
<b>Departmental Result 3: Evidence-based solutions inform decisions in Government priority areas</b>					
NRC investment in collaborative work with other federal government departments in Government priority areas	\$54.9M	March 31, 2020	\$77.7M	\$93.1M	\$82.4M
Number of scientific and other publications (e.g., technical papers, committee proceedings, reports) generated by NRC research leaders in Government priority areas, tracked by calendar year <sup>6</sup>	1,318	March 31, 2020	1,228	1,279	1,235

<sup>1</sup> Field-Weighted Citation Impact Score (FWCI) measured over a period of three calendar years. Based on NRC peer-reviewed publications indexed in Scopus as of April 2020.

<sup>2</sup> Based on NRC peer reviewed publications indexed in Scopus as of April 2020. Sum of patents, disclosures, publications and trade secrets generated by NRC activities.

<sup>3</sup> The indicator is focused on the workforce representation of women up to FY-end 2019–20. 2017–18 and 2018–19 results are based on 2011 census data; 2019–20 results are based on 2016 census data.

<sup>4</sup> Measured over a period of two calendar years and lagging by two years.

<sup>5</sup> In order to improve the consistency of its communicated financial information, the NRC has added to this indicator revenue elements related to the sales of goods, royalties, leasing and other services that were not fully captured previously. These adjustments resulted in an added \$12.5M that would not have been reflected in previous years.

<sup>6</sup> Scopus database allows tagging to multiple research areas, thus the number of publications by priority area could be larger than the total number of publications generated by the organization. Based on NRC peer reviewed publications indexed in Scopus as of April 2020.

## Budgetary financial resources (dollars)

2019–20 Main Estimates	2019–20 Planned spending	2019–20 Total authorities available for use	2019–20 Actual spending (authorities used)	2019–20 Difference (Actual spending minus Planned spending)
1,051,040,644	1,051,040,644	1,199,881,256	1,059,106,699	8,066,055

## Human resources (full-time equivalents)

2019–20 Planned full-time equivalents	2019–20 Actual full-time equivalents	2019–20 Difference (Actual full-time equivalents minus Planned full-time equivalents)
3,169.7	3,115.5	(54.2)

Financial, human resources and performance information for the NRC’s Program Inventory is available in [GC InfoBase](#).<sup>xviii</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:

- ▶ Acquisition Management
- ▶ Communications Services
- ▶ Financial Management
- ▶ Human Resources Management
- ▶ Information Management
- ▶ Information Technology Management
- ▶ Legal Services
- ▶ Materiel Management
- ▶ Management and Oversight
- ▶ Real Property Management

Building on the extensive consultations undertaken during the NRC Dialogue process in 2016 and the resulting “reimagining” of the NRC, the five-year Strategic Plan was released in 2019–20, to enhance the NRC’s three core roles, reinforce NRC research strengths and better position the organization as a collaborative partner with government, industry, and academia. Guided by five overarching strategic areas of focus: enabling a more sustainable economy; supporting a healthier future; innovating the everyday; creating Canadian wealth through innovation; and understanding our world, the plan will achieve its goals and outcomes through research centre initiatives and corporate enabling strategies.

Stemming from the Dialogue Action Plan, a review and simplification of five internal business processes was launched in an effort to make it easier to do business within the NRC: project management, procurement, contracting-in, hiring and onboarding. Led full-time by a senior executive, a team dedicated to the 18-month project was formed, with project management identified as the first initiative. Employee feedback was collected through interviews, surveys and workshops and a steering committee composed of senior management and external members provided guidance.

In 2019–20, the NRC also released its Strategic HR Plan, a companion document to the NRC Strategic Plan, and implemented several of its initiatives to enhance the organization's ability to attract, develop and retain a diverse, talented, healthy and engaged workforce. To advance the organizational wellness strategy, a number of activities were implemented, including:

- Hiring of a dedicated wellness advisor and launch of a wellness and mental health resources portal to provide staff with centralized access to tools and resources;
- Continued promotion of mental health supports, including the Employee Assistance Program and LifeSpeak, an online health and wellness platform;
- Promotion of mental health awareness activities such as Canadian Mental Health Week, Healthy Workplace Month, Bell Let’s Talk and guest speakers from the Federal Speakers Bureau on Healthy Workplaces;
- Launch of a new Leave with Income Averaging Program that allows employees to take extended periods of time away from the office;
- Assignment of a common performance commitment for NRC executives to foster workplace wellness and contribute to a psychologically healthy workplace.

To foster a diverse and representative workforce, barrier-free NRC, and inclusive workplace culture, the NRC continued to implement its EDI strategy. In 2019–20:

- Gaps and representation targets for the four employment equity (EE) designated groups were incorporated into workforce planning tools;
- An online self-identification process and campaign was launched;
- HR specialists and hiring managers were equipped with tools, resources and training to increase diversity in the hiring process;
- A preferred EE staffing approach in the hiring of students was used;

- EDI awareness and education was increased through the launch of a resources page, mandatory training for staff and promotion of EDI events and milestones internally and on NRC social media;
- Outreach efforts to diverse groups were increased, including support for EDI events; and,
- A common EDI commitment for executives was assigned with a focus on increasing representation.

To help advance Canada’s process of reconciliation with Indigenous peoples, in 2019–20 the NRC began work on an Indigenous engagement strategy that responds to specific Calls to Action from the 2015 Truth and Reconciliation Commission report. Through a process of co-design and co-creation, supported by an external advisory committee, this strategy will enable the NRC, in partnership with Indigenous Peoples, to catalyze economic growth of Indigenous businesses; engage in dialogue, knowledge-sharing and R&D projects with Indigenous communities; and attract, retain and advance an Indigenous workforce.

In addition, intercultural training workshops were delivered to NRC leadership on developing, strengthening and sustaining the important and meaningful relationships, involvement and engagement with Indigenous communities regarding research with and for these communities.

Launched in 2019–20, the NRC Leadership Development Framework was designed to equip current supervisors, develop aspiring and high potential leaders, and support the development of leadership competencies through a suite of new tools, courses and programs. An executive talent mapping exercise was introduced to the annual Merit Review process and several executives were selected for learning programs from CSPS and the Association of Professional Executives of the Public Service.

Implementation of the STEM Training Continuum continued with the goal of developing the talent pipeline and nurturing the next generation of research and innovation leaders. In 2019–20, there were 556 opportunities for students at the college, undergraduate and graduate levels. In addition, 11 post-doctoral fellows and 23 research associates were hired, and the NRC participated in university career fairs and events, including those designed to target diverse groups. An Ambassador Program was launched to identify STEM professionals to promote the NRC and engage the next generation of talent, and the NRC participated in high school engagement activities, including the STEM Fellowship Big Data Challenge and work with organizations such as Let’s Talk Science and Shad Canada.

To contribute to a safe, healthy and respectful workplace, the NRC introduced its first Ombudsperson, and began offering confidential services through Informal Conflict Resolution and training sessions for NRC employees on preventing and resolving conflicts. Within the first year, the NRC Ombudsperson conducted over 140 outreach activities and identified common workplace issues which were raised with senior management for resolution. The 2019 Public Service Employee Survey results demonstrated a significant improvement from previous years in the promotion of a harassment-free, ethical workplace.

The NRC continued to conduct a comprehensive review of its buildings and real estate to support the development of an NRC Accommodation Plan. The plan will identify buildings to maintain, renovate and/or repurpose, buildings to vacate and dispose of, and new required modern research buildings. A 15-year high-level Montreal Road Campus Plan was presented to senior management for endorsement and condition assessments have been completed for 38 percent of buildings at Montreal Road and Sussex with assessments of other buildings at Montreal Road and Uplands underway.

### 2019 Public Service Employee Survey

The NRC saw significant improvements in key areas of concern, including:

- Increase of 17 percent for raising awareness of mental health in the workplace;
- Increase of 10 percent for a psychologically healthy workplace;
- Increase of 10 percent for supporting employee career development; and
- Increase of 8 percent for promotion opportunities within the NRC.

The NRC worked with SSC to modernize its IT infrastructure for improved support across the organization, including:

- Successful transition of over 90 percent of its workforce to telework within a two week period in March 2020 to protect the health and safety of staff, and the rapid introduction of new equipment and virtual tools to keep staff connected and engaged;
- Operationalization of high performance computing systems and testing of new approaches to modernize NRC's research infrastructure;
- Transition of 30 research infrastructure projects or software services to the cloud and the launch of a new application for external collaboration and secure information exchanges between clients and collaborators;
- Refining of the NRC-SSC framework "Technology as a Service" to include conditions for NRC management of IT infrastructure as an extension of a research environment and identification of three new systems to support specialized research work;
- Development of a network of technology liaison officers for each of the 14 research centres to better understand the research environment and creation of digital roadmaps to identify high priority activities.

In 2019–20, the NRC Emergency Management Program was developed, implemented and operationalized, resulting in NRC Alerts, an NRC Emergency Information Line, training for the Incident Command Team and Chief Building Emergency Officers, an emergency management framework and strategic plan, and an emergency planning guide.

**Budgetary financial resources (dollars)**

2019–20 Main Estimates	2019–20 Planned spending	2019–20 Total authorities available for use	2019–20 Actual spending (authorities used)	2019–20 Difference (Actual spending minus Planned spending)
135,834,451	135,834,451	166,709,880	155,495,166	19,660,715

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

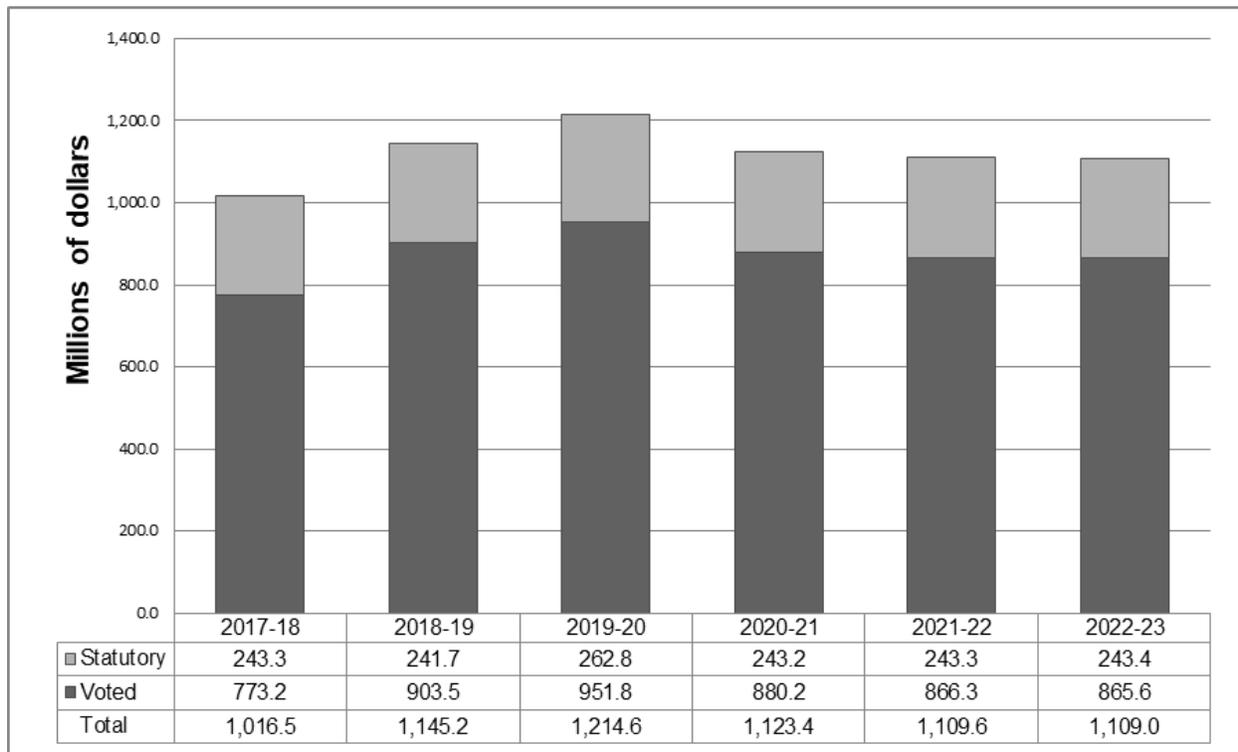
2019–20 Planned full-time equivalents	2019–20 Actual full-time equivalents	2019–20 Difference (Actual full-time equivalents minus Planned full-time equivalents)
866.2	993.9	127.7

## Analysis of trends in spending and human resources

### Actual expenditures

#### Departmental spending trend graph

The following graph presents planned (voted and statutory spending) over time.



The NRC's actual spending trend over the last three years has increased, with spending of \$1,214.6M in 2019–20, representing growth of \$69.4M from the \$1,145.2M spent in 2018–19. This increase is largely associated with permanent funding provided by the 2018 Federal Budget. Most significantly, Budget 2018 provided NRC IRAP with an additional \$50M in 2019–20, of which \$43.0M was received for grants and contributions. Other items that contributed to the 2019–20 spending variance includes the rising cost of salaries, increase of grants and contributions spending and sunsetting of the Canada Accelerator and Incubator Program in 2018–19. Specifically:

- Salary expenditures, not including employee benefit costs, increased by \$27.1M in 2019–20 as a result of renewed collective agreements, of which \$7.5M of the variance relates to one-time expenditures for retroactive payroll liabilities;
- Increase of grants and contributions spending of NRC IRAP – Contribution to Firms and Organizations of \$18.9M in addition to the Budget 2018 funding;
- Decrease of \$18.0M due to sunsetting of the Canada Accelerator and Incubator Program in 2018–19; and

- Decrease of \$10.7M in capital expenditures mainly attributable to Federal Infrastructure Initiative.

The following variance explanations provide additional details between 2019–20 plans to actuals and year-over-year results.

Actual spending of \$1,214.6 in 2019–20 in comparison to planned spending of \$1,186.6M represents an overall increase of \$27.7M (2.3 percent). The variance from 2019–20 plans is attributable to expenditure increases of \$29.1M in operating and \$17.1M in statutory spending, offset by decreases of \$13.6M in grants and contributions and \$7.3M in capital expenditures. The most significant cause of increased spending in operating results from the funding related to the signature of collective bargaining agreement (\$21.9M). The decrease of \$13.6M in grants and contributions resulted mainly from a \$26.0M reprofile from 2019–20 to future years to account for project delays associated with Canada’s participation in the construction of the Thirty Meter Telescope, offset by an increase of \$10M for the Youth Employment and Skills Strategy.

Overall, year-over-year fluctuations within the NRC’s actual spending largely results from transfer payment programs and operational costs. The following table summarizes 2019–20 spending and year-over-year variances.

<i>In millions of dollars</i>	2019–20 Spending	Variance from 2018–19	Variance from 2017–18
IRAP – Firms and Organizations	320.3	62.0	150.5
IRAP - Canada Accelerator and Incubator Program	-	(18.0)	(24.0)
International Astronomical Observatories Program	29.0	1.3	7.1
TRIUMF	55.2	(2.1)	0.6
Collaborative Science, Technology and Innovation Program	14.1	5.0	14.1
NRC IRAP - Youth Employment and Skills Strategy	15.1	(2.0)	(7.4)
All other	1.5	(0.2)	0.3
<b>Grants and Contributions</b>	<b>435.2</b>	<b>46.0</b>	<b>141.2</b>
Federal Infrastructure Initiative	17.4	(13.4)	(21.5)
All other	33.6	2.7	2.9
<b>Capital</b>	<b>51.0</b>	<b>(10.7)</b>	<b>(18.6)</b>
<b>Operating</b>	<b>465.6</b>	<b>13.0</b>	<b>55.9</b>
<b>Statutory Revenue</b>	<b>199.1</b>	<b>17.1</b>	<b>8.1</b>
<b>Other Statutory (i.e. Employee Benefits)</b>	<b>63.7</b>	<b>4.0</b>	<b>11.5</b>
<b>Total Expenditures</b>	<b>1,214.6</b>	<b>69.4</b>	<b>198.1</b>

## Budgetary performance summary for Core Responsibilities and Internal Services (dollars)

Core Responsibility and Internal Services	2019–20 Main Estimates	2019–20 Planned spending	2020–21 Planned spending	2021–22 Planned spending	2019–20 Total authorities available for use	2019–20 Actual spending (authorities used)	2018–19 Actual spending (authorities used)	2017–18 Actual spending (authorities used)
Science and Innovation	1,051,040,644	1,051,040,644	989,143,374	975,339,645	1,199,881,256	1,059,106,699	992,172,039	787,453,668
Internal Services	135,834,451	135,834,451	134,299,236	134,298,191	166,709,880	155,495,166	153,031,813	229,069,769
<b>Total</b>	<b>1,186,875,095</b>	<b>1,186,875,095</b>	<b>1,123,442,610</b>	<b>1,109,637,836</b>	<b>1,366,591,136</b>	<b>1,214,601,865</b>	<b>1,145,203,852</b>	<b>1,016,523,437</b>

Expenses and FTEs related to National Science Library, Research Information Technology Platforms and Special Purpose Real Property were not reallocated to the Science and Innovation Core Responsibility for 2017–18 because the reporting structure was not in place to allow the NRC to report on the Departmental Results Framework and Program Inventory of record for 2019–20.

## Actual human resources

### Human resources summary for core responsibilities and Internal Services

Core Responsibility and Internal Services	2017–18 Actual full-time equivalents	2018–19 Actual full-time equivalents	2019–20 Planned full-time equivalents	2019–20 Actual full-time equivalents	2020–21 Planned full-time equivalents	2021–22 Planned full-time equivalents
Science and Innovation	2,997.3	3,062.6	3,169.7	3,115.5	3,219.7	3,223.7
Internal Services	981.9	887.6	866.2	993.9	872.2	877.2
<b>Total</b>	<b>3,979.2</b>	<b>3,950.2</b>	<b>4,035.9</b>	<b>4,109.4</b>	<b>4,091.9</b>	<b>4,100.9</b>

Expenses and FTEs related to National Science Library, Research Information Technology Platforms and Special Purpose Real Property were not reallocated to the Science and Innovation Core Responsibility for 2017–18 because the reporting structure was not in place to allow the NRC to report on the Departmental Results Framework and Program Inventory of record for 2019–20.

The NRC's actual 2019–20 FTEs (4,109.4) has increased by 159.2 FTEs (4 percent) when compared to the 2018–19 FTE level (3,950.2). The increase is mostly attributable to increases in student hiring, creation of collaboration centres and additional funding received to support NRC programs.

The NRC's actual FTEs has remained stable when compared to 2019–20 planned FTEs (4,035.9), which represents a minor increase of 1.8 percent.

Description	2019–20 FTEs	Variance from 2018–19	Variance from 2017–18
Research and Development FTEs	2,477.2	77.2	68.9
Industrial Research Assistance Program FTEs	424.2	26.6	36.9
Internal Services and Enabling Services FTEs	1,208.0	55.4	24.4
<b>Total NRC FTEs</b>	<b>4,109.4</b>	<b>159.2</b>	<b>130.2</b>

## Expenditures by vote

For information on the NRC's organizational voted and statutory expenditures, consult the [Public Accounts of Canada 2019–2020](#).<sup>xix</sup>

## Government of Canada spending and activities

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

## Financial statements and financial statements highlights

### Financial statements

The NRC's financial statements (audited) for the year ended March 31, 2020, are available on the [NRC's website](#).<sup>xx</sup>

### Financial statements highlights

#### Condensed Statement of Operations (audited) for the year ended March 31, 2020 (dollars)

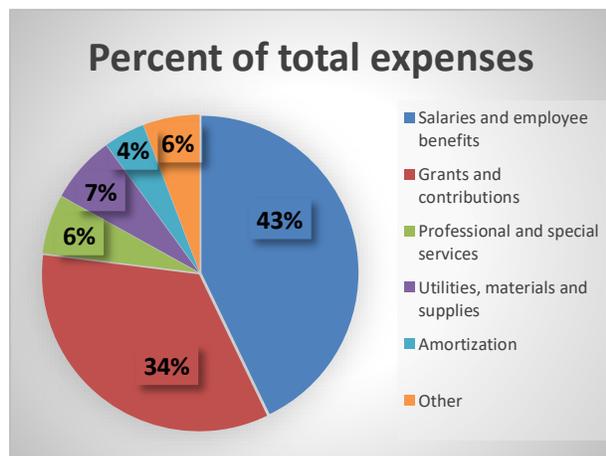
Financial information	2019–20 Planned results	2019–20 Actual results	2018–19 Actual results	Difference (2019–20 Actual results minus 2019–20 Planned results)	Difference (2019–20 Actual results minus 2018–19 Actual results)
Total expenses	1,213,841,000	1,224,535,000	1,123,688,000	10,694,000	100,847,000
Total revenues	193,428,000	183,434,000	198,185,000	(9,994,000)	(14,751,000)
Net cost of operations before government funding and transfers	1,020,413,000	1,041,101,000	925,503,000	20,688,000	115,598,000

The NRC’s consolidated financial statements include both the NRC and its portion of the accounts of the Canada-France-Hawaii Telescope Corporation (CFHT) and TMT International Observatory LLC (TIO). The NRC relationship with CFHT and TIO meets the definition of a government partnership under Canadian public sector accounting standards, which requires that its results be proportionally consolidated within those of the NRC. All inter-organizational balances and transactions are eliminated as part of the consolidation process. CHFT and TIO statements as at December 31, 2019 have been proportionally consolidated with the NRC's March 31 accounts.

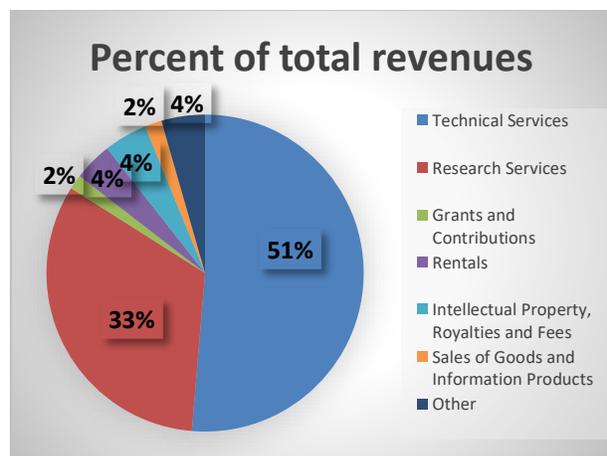
The NRC’s consolidated total expenses of \$1,225M in 2019–20 represent an increase from \$1,124M in 2018–19. The NRC’s major expense components are salaries and employee benefits (\$525M) and grants and contributions (\$418M), representing 77 percent of total expenses. The \$101M increase is primarily due to an increase in grants and contributions of \$50M as a result of new funding from Budget 2018, an increase in salary and benefits of \$45M mainly due to renewed collective agreements and an increase in the number of full-time employees, and an increase of \$4M in professional services. Most of the other expense categories appearing in the consolidated financial statements were stable in comparison to 2018–19. The planned expenses, as reported in the NRC’s Consolidated Future Oriented Financial Statements in the 2019–20 Departmental Plan were \$1,214M. The variance between planned and actual results of \$11M is primarily due to increases in grants and contributions (\$9M).

The NRC generates revenue which can be reinvested in operations. The NRC’s consolidated total revenues of \$183M in 2019–20 represent a decrease from \$198M in 2018–19. The NRC’s major revenue components were research services (\$60M) and technical services (\$94M), representing 84 percent of revenues. The planned revenue, as reported in the NRC’s Consolidated Future Oriented Financial Statements in the 2019–20 Departmental Plan was \$193M. The total variance of \$10M is largely attributed to grants and contributions (\$8M lower than the planned results), and research services (\$5M lower than the planned results).

**Expenses by Type (2019–20)**



**Revenues by Type (2019–20)**



**Condensed Statement of Financial Position (audited) as of March 31, 2020  
(dollars)**

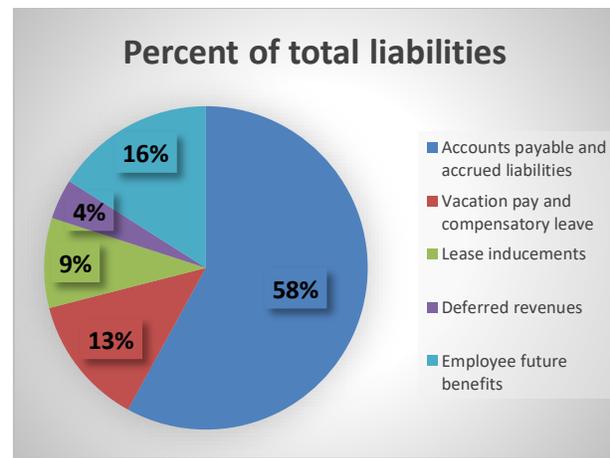
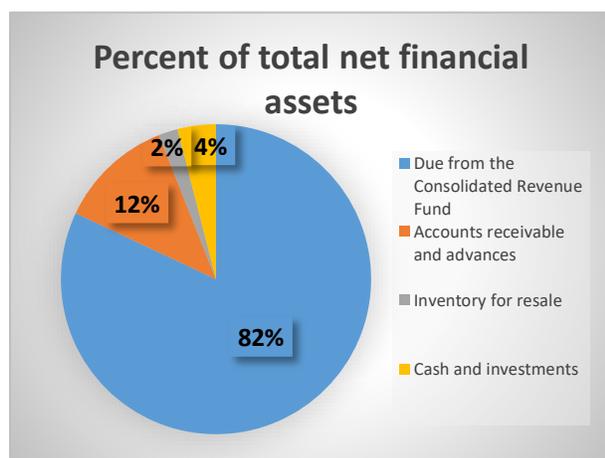
Financial Information	2019–20	2018–19	Difference (2019–20 minus 2018–19)
Total net liabilities	281,326,000	344,513,000	(63,187,000)
Total net financial assets	306,156,000	392,785,000	(86,629,000)
Departmental net financial assets	24,830,000	48,272,000	(23,442,000)
Total non-financial assets	727,766,000	692,314,000	35,452,000
Departmental net financial position	752,596,000	740,586,000	12,010,000

The NRC’s consolidated net financial assets totalled \$306M as at March 31, 2020, a decrease of \$87M from the March 31, 2019 balance of \$393M. The balance is made up of the Consolidated Revenue Fund (CRF), accounts receivable, inventory for resale and cash and investments. The decrease is primarily due to an \$81M decrease of the CRF.

The NRC’s consolidated liabilities consist of accounts payable and accrued liabilities, vacation and compensatory leave, lease inducements, deferred revenues, lease obligation for tangible capital assets and employee future benefits. The balance as at March 31, 2020 of \$281M represents a \$63M decrease from the March 31, 2019 balance of \$345M. The decrease is primarily due to a \$64M decrease in accounts payable and accrued liabilities payable.

**Net Financial Assets as at March 31, 2020**

**Liabilities as at March 31, 2020**



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## Additional information

### Organizational profile

**Appropriate ministers:** The Honourable Navdeep Bains, P.C., M.P., Minister of Innovation, Science and Industry

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

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

**Enabling instrument:** *National Research Council Act*,<sup>xxi</sup> R.S.C. 1985, c. N-15

**Year of incorporation / commencement:** 1916

**Other:** The NRC is a departmental corporation of the Government of Canada, reporting to Parliament through the Minister of Innovation, Science and Industry. The NRC works in partnership with members of the Innovation, Science and Economic Development Portfolio to leverage complementary resources to promote science and research 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. The NRC's Council provides independent strategic advice to the NRC President and it reviews organizational performance. The President provides leadership and strategic management and is responsible for the achievement of the NRC's long-range goals and plans in alignment with government priorities as reflected in his mandate letter. Each of the NRC's Vice-Presidents is responsible for a number of areas composed of programs and research 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.

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

“Raison d'être, mandate and role: who we are and what we do” is available on the [NRC's website](#).<sup>xx</sup>

For more information on the department's organizational mandate letter commitments, see the [Ministers' mandate letters](#).<sup>xxii</sup>

## Reporting framework

The NRC’s Departmental Results Framework and Program Inventory of record for 2019–20 are shown below.<sup>6</sup>

Core Responsibility: Science and Innovation		Internal Services	
Departmental Results Framework	Departmental Result: Scientific and technological knowledge advances		11. Citation score of NRC-generated publications relative to the world average
			12. Number of unique intellectual assets (e.g., patents, disclosures, publications) generated by NRC research leaders
			13. Ratio of the NRC’s workforce made up of underrepresented groups relative to Canadian average labour market availability in Science, Technology, Engineering, and Mathematics (STEM)
Departmental Results Framework	Departmental Result: Innovative businesses grow		14. Percentage of R&D clients who report positive benefits (e.g., increase in jobs, sales, R&D expenditures or other) of working with the NRC
			15. Percentage revenue growth of firms engaged with the NRC (IRAP-engaged firms)
			16. Percentage growth in Canada’s S&T related jobs through NRC supported firms (IRAP-engaged firms)
			17. Client financial investment in technology development supported by NRC research and development services and scientific and technological infrastructure
Departmental Results Framework	Departmental Result: Evidence-based solutions inform decisions in Government priority areas		18. NRC investment in collaborative work with other federal government departments in Government priority areas
			19. Number of scientific and other publications (e.g., technical papers, committee proceedings, reports) generated by NRC research leaders in Government priority areas
Program Inventory	Advanced Electronics and Photonics		
	Aerospace		
	Aquatic and Crop Resource Development		
	Automotive and Surface Transportation		
	Business Management Support (Enabling)		
	Collaborative Science, Technology and Innovation Program		
	Construction		
	Design & Fabrication Services (Enabling)		
	Digital Technologies		
	Energy, Mining and Environment		
	Herzberg Astronomy & Astrophysics		
	Human Health Therapeutics		
	Industrial Research Assistance Program		
	International Affiliations		
	Medical Devices		
	Metrology		
	Nanotechnology		
	National Science Library		
	Ocean, Coastal and River Engineering		
	Security and Disruptive Technologies		
Special Purpose Real Property (Enabling)			
Research Information Technology Platforms (Enabling)			
TRIUMF			

<sup>6</sup> See [GC InfoBase](#)<sup>xviii</sup> for the full names and descriptions of the Departmental Results Indicators in the NRC’s Departmental Results Framework.

## Supporting information on the program inventory

Financial, human resources and performance information for the NRC's Program Inventory is available in the [GC InfoBase](#).<sup>xviii</sup>

## Supplementary information tables

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

- ▶ [Departmental Sustainable Development Strategy](#)
- ▶ [Details on transfer payment programs of \\$5 million or more](#)
- ▶ [Gender-based analysis plus](#)
- ▶ [Genomics R&D Initiative \(GRDI\)](#)

## 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>xxiii</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  
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) 991-9096  
TTY number: (613) 949-3042  
E-mail: [info@nrc-cnrc.gc.ca](mailto:info@nrc-cnrc.gc.ca)  
Web address: <https://nrc.canada.ca/en/>



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## 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.

**core responsibility** (responsabilité essentielle)

An enduring function or role performed by a department. The intentions of the department with respect to a core responsibility are reflected in one or more related departmental results that the department seeks to contribute to or influence.

**Departmental Plan** (plan ministériel)

A report on the plans and expected performance of an appropriated department over a 3-year period. Departmental Plans are usually tabled in Parliament each spring.

**departmental priority** (priorité)

A plan or project that a department 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 departmental results.

**departmental result** (résultat ministériel)

A consequence or outcome that a department seeks to achieve. A departmental result is often outside departments' immediate control, but it should be influenced by program-level outcomes.

**departmental result indicator** (indicateur de résultat ministériel)

A quantitative measure of progress on a departmental result.

**departmental results framework** (cadre ministériel des résultats)

A framework that connects the department's core responsibilities to its departmental results and departmental result indicators.

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

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

**experimentation** (expérimentation)

The conducting of activities that seek to first explore, then test and compare the effects and impacts of policies and interventions in order to inform evidence-based decision-making, and improve outcomes for Canadians, by learning what works, for whom and in what circumstances.

Experimentation is related to, but distinct from innovation (the trying of new things), because it involves a rigorous comparison of results. For example, using a new website to communicate with Canadians can be an innovation; systematically testing the new website against existing outreach tools or an old website to see which one leads to more engagement, is experimentation.

**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. For a particular position, the full-time equivalent figure is the ratio of number of hours the person actually works divided by the standard number of hours set out in the person's collective agreement.

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

An analytical process used to assess how diverse groups of women, men and gender-diverse people experience policies, programs and services based on multiple factors including race ethnicity, religion, age, and mental or physical disability.

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

For the purpose of the 2019–20 Departmental Results Report, those high-level themes outlining the government's agenda in the 2019 Speech from the Throne, namely: Fighting climate change; Strengthening the Middle Class; Walking the road of reconciliation; Keeping Canadians safe and healthy; and Positioning Canada for success in an uncertain world.

**horizontal initiative** (initiative horizontale)

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

**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 to the expected result.

**planned spending** (dépenses prévues)

For Departmental Plans and Departmental Results Reports, planned spending refers to those amounts presented in 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.

**program** (programme)

Individual or groups of services, activities or combinations thereof that are managed together within the department and focus on a specific set of outputs, outcomes or service levels.

**program inventory** (répertoire des programmes)

Identifies all the department's programs and describes how resources are organized to contribute to the department's core responsibilities and results.

**result** (résultat)

A 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.

**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 Minister of Innovation, Science and Industry Mandate Letter, <https://pm.gc.ca/en/mandate-letters/2019/12/13/minister-innovation-science-and-industry-mandate-letter>
- ii NRC President’s Mandate Letter, <https://nrc.canada.ca/en/corporate/about-nrc/mandate-letter-mr-iain-stewart-september-6-2018>
- iii Innovation Superclusters Initiative, <https://www.ic.gc.ca/eic/site/093.nsf/eng/home>
- iv NRC Ideation Fund, <https://nrc.canada.ca/en/research-development/research-collaboration/programs/ideation-fund-where-breakthroughs-begin>
- v Materials for Clean Fuels Challenge Program, <https://nrc.canada.ca/en/research-development/research-collaboration/programs/materials-clean-fuels-challenge-program>
- vi High-Throughput and Secure Networks Challenge Program, <https://nrc.canada.ca/en/research-development/research-collaboration/programs/high-throughput-secure-networks-challenge-program>
- vii Disruptive Technology Solutions in Cell and Gene Therapy Challenge Program, <https://nrc.canada.ca/en/research-development/research-collaboration/programs/disruptive-technology-solutions-cell-gene-therapy-challenge-program>
- viii AI for Design Challenge Program, <https://nrc.canada.ca/en/research-development/research-collaboration/programs/artificial-intelligence-design-challenge-program>
- ix Canada’s Five Innovation Superclusters, <https://www.ic.gc.ca/eic/site/093.nsf/eng/home>
- x Protein Industries Supercluster, <https://www.ic.gc.ca/eic/site/093.nsf/eng/00012.html>
- xi Next Generation Manufacturing Supercluster, <https://www.ic.gc.ca/eic/site/093.nsf/eng/00010.html>
- xii Scale AI Supercluster, <https://www.ic.gc.ca/eic/site/093.nsf/eng/00009.html>
- xiii Digital Supercluster, <https://www.ic.gc.ca/eic/site/093.nsf/eng/00011.html>
- xiv Ocean Supercluster, <https://www.ic.gc.ca/eic/site/093.nsf/eng/00013.html>
- xv Addressing Air Pollution Horizontal Initiative (AAPHI), <https://www.canada.ca/en/environment-climate-change/services/sustainable-development/strategic-environmental-assessment/public-statements/addressing-air-pollution.html>
- xvi Collaboration Centres, <https://nrc.canada.ca/en/research-development/research-collaboration/collaboration-centres>
- xvii 2019–20 Evaluation of NRC’s Medical Devices Program, <https://nrc.canada.ca/en/corporate/planning-reporting/evaluation-nrcs-medical-devices-research-centre>
- xviii GC InfoBase, <https://www.tbs-sct.gc.ca/ems-sgd/edb-bdd/index-eng.html#start>
- xix Public Accounts of Canada, <http://www.tpsgc-pwgsc.gc.ca/recgen/cpc-pac/index-eng.html>
- xx National Research Council website, <https://nrc.canada.ca/en/corporate/planning-reporting/financial-performance-reporting>
- xxi *National Research Council Act*, <https://laws-lois.justice.gc.ca/eng/acts/N-15/index.html>
- xxii Ministers’ mandate letters, <https://pm.gc.ca/en/mandate-letters>
- xxiii Report on Federal Tax Expenditures, <https://www.canada.ca/en/department-finance/services/publications/federal-tax-expenditures.html>