Canadian Space Agency

2021–22

Departmental Plan

The Honourable François-Philippe Champagne, P.C., M.P.
Minister of Innovation, Science and Industry

Catalogue Number: ST96-10E-PDF
ISSN: 2371-7777

Table of contents

From the Minister

The Canadian Space Agency (CSA) and the Innovation, Science and Economic Development Canada (ISED) are working to position Canada as an innovation leader on the global stage by fostering a diverse, growing, competitive, and sustainable economy that benefits all Canadians.

The Honourable François-Philippe Champagne
Minister of Innovation, Science and Industry

While our government's priority continues to be fighting COVID-19 and protecting Canadians' health and safety, we are committed to fostering conditions for investment, enhancing Canadian innovation, and driving growth in key sectors. Together, we will strengthen the Canadian economy and restore consumer confidence through strategic actions, including investing in training for workers, and supporting Canadian businesses as they adapt and grow in a knowledge-based economy.

Throughout 2021–22, the CSA will continue to implement Canadian Space Strategy: *Exploration, Imagination, Innovation*[i], which will help ensure that Canadians are ready to take advantage of the jobs of tomorrow, while enabling our space industry and academic institutions to be part of the new space economy. Thanks to the unique opportunities that space provides, the investments that we are making in space will contribute to Canada emerging from COVID-19 with strength and resilience. Canada will also continue to partner with NASA on the Lunar Gateway—a project that will see humans return to the moon and set the stage for further exploration to Mars—through the contribution of the next-generation Canadarm3. This contribution will earn Canada two flights for Canadian astronauts to the Moon. The first flight is scheduled on Artemis II in 2023.

In addition, the CSA will advance its activities in space-based Earth Observation (SBEO), which will help tackle complex challenges, including climate change. CSA's activities in 2021–22 will build upon Canada's long and proud history of leadership in space science, technology, and exploration.

Finally, in tackling some of today's most pressing challenges, such as climate change, we will continue to invest in science and research. We will also ensure that federal research is fully available to the public; that researchers can freely share their work; and that evidence-based approaches are utilized when making decisions. In doing so, we will facilitate the kind of new discoveries made by Canada's leading researchers and academics.

Together with Canadians of all backgrounds, regions and generations, we are building a strong culture of innovation to position Canada as a leader in the global economy. For more information, it is our pleasure to present the 2021–22 Departmental Plan for the CSA.

Plans at a glance

Throughout 2021–22, the CSA's focus remains on the implementation of the Canadian Space Strategy: *Exploration, Imagination, Innovation*[i], which was announced by the Minister of Innovation, Science and Economic Development on March 6, 2019. This strategy aims to create the right conditions for the growth of the Canadian space sector; ensure that Canada's space scientists are offered a rich environment in which to pursue science excellence; fully realize the benefits of space for Canadians; and ultimately help strengthen Canada's place in space. CSA's priorities for 2021–22 are fully in line with the Canadian Space Strategy and the CSA's Departmental Results Framework (DRF) and program inventory, and will enable the CSA to make progress on achieving its mandate and deliver unparalleled value for Canadians in a way that only space can provide.

Priority 1—Lunar Program

In 2021–22, Canadian industry will continue the technical definition of Canadarm3[ii], our country's contribution to the US-led Lunar Gateway[iii] initiative and the centrepiece of Canada's Space Strategy, while also defining the socio-economic benefits anticipated from this major investment. This contribution will earn Canada two flights for Canadian astronauts to the Moon and the first flight is scheduled on Artemis II[iv] in 2023. The CSA's Lunar Exploration Accelerator Program[v] (LEAP) will also continue to put together the science, technology and commercial building blocks that will enable Canada to seize opportunities and make Canada a partner of choice for space exploration. As the current Chair of the International Space Exploration Coordination Group,[vi] Canada will work with 26 international space agency partners to coordinate future lunar and Mars exploration activities. As part of renewed international focus on sustainable human presence on the Moon, in 2021–22 the CSA will continue to conduct advanced studies on potential Canadian contributions to lunar surface exploration.

Priority 2—Engage Young Canadians: Junior Astronauts

Through the Junior Astronauts[vii] campaign, the CSA was successful in engaging with over 58,000 youth in every province and territory of Canada until the COVID-19 pandemic forced school closures and travel restrictions. In summer 2021, the Junior Astronauts campaign will culminate with selected youth in grades 6 to 9 from across Canada taking part in Junior Astronauts Camp activities remotely, with CSA astronauts, scientists, and engineers.

Priority 3—Space-Based Earth-Observation and Climate Change Science

The economic potential of space-based data has grown significantly in recent years. In 2021–22, the CSA, working collaboratively with Environment and Climate Change Canada (ECCC) and Natural Resources Canada (NRCan), will continue to lead the whole-of-government space-based Earth Observation (SBEO) initiative to define strategic investments, flexible programming, and strong partnerships with stakeholders from across the Government of Canada as well as industry

and academia, to best deliver data that meets the needs of the community and government priorities such as climate change. Work will continue to better define and evaluate potential missions (upstream) and data management infrastructure (midstream) for data exploitation and uptake (downstream).

In 2021–22, the CSA will pursue multiple SBEO and climate change science activities. For example, an assessment of Canada's potential contribution to NASA's Aerosol—Clouds, Convection, Precipitation[viii] (A-CCP) mission, which will lead to improved forecasts of extreme weather events and air quality. With regards to improving climate projections; in 2021–22, the CSA will continue work on WildFireSat,[ix], a satellite equipped with infrared technology to monitor active wildfires from space; and smartEarth,[x] an application development funding initiative that fosters an intelligent use of satellite data to develop solutions to key challenges on Earth, including those arising from climate change.

Priority 4—CSA's Contribution to COVID-19 Economic Recovery

Thanks to the unrivalled opportunities that space provides for Canadians, the CSA is well placed to contribute to Canada's economy emerging from COVID-19 in a strong and resilient position through investments in the space sector and academia. In 2021–22, the CSA will continue to re-prioritize some of its activities and funding, through programs such as the Space Capacity Development Program (SCDP), to provide further short-term support to the Canadian space sector and academic institutions during these difficult times. These investments will provide relief for economic hardships to Canada's firms and space scientists and allow them to maintain their capabilities during the pandemic and also conduct additional innovative research and development projects that will better position Canada to take advantage of the economic recovery.

For more information on the Canadian Space Agency's plans, priorities and planned results, see the "Core responsibilities: planned results and resources, and key risks" section of this report.

Core responsibilities: planned results and resources, and key risks

This section contains detailed information on the department's planned results and resources for each of its core responsibilities. It also contains information on key risks related to achieving those results.

Canada in Space

Description

The CSA coordinates the space policies and programs of the government of Canada; ensures that other government departments and agencies have access to space data, information, and services to deliver on their mandate; plans, directs and manages projects relating to scientific or industrial space research and the development of space science and technology; promotes the transfer and diffusion of space technology to and throughout the Canadian industry; and encourages the commercial exploitation of space capabilities, technology, facilities and systems. The CSA also aims to build Canada's capacity and engage the next generation of space scientists and engineers, and provide opportunities to inspire young people to develop the required skills and to pursue studies and careers in science, technology, engineering, and math (STEM).

Planning highlights

The planning highlights outlines the four departmental results detailed in the CSA's Departmental Results Framework. Each departmental result is an important element that demonstrates the impact of the CSA on the lives of Canadians.

Result 1—Space research and development advance science and technology

Through advancements in science and technology resulting from research and development in the space sector, the CSA enables the first steps in the continuum of change that will result in socio-economic benefits for Canadians.

In addition to providing continuing critical robotic operations on the International Space Station[xi] (ISS) with Canadarm2[xii] and Dextre,[xiii] in 2021–22 the CSA will provide opportunities for industry and academia to perform studies and technology development that will help define options for Canada's participation in international human exploration initiatives beyond low Earth orbit.

The Canadarm3[ii] Phase A contract was announced in December 2020 and signals the beginning of the development of this highly complex project. This initial contract with the selected Canadian prime contractor will set out both the Canadarm3 technical definition and value proposition that will be applied during the subsequent development phases. This will help maximize the economic impact of this investment under the framework of the Industrial and Technological Benefits Policy,[xiv] which aims at leveraging federal procurement contracts to support job creation, innovation and economic opportunities across the country. The Canadarm3 will continue to build

on technologies developed and proven on the ISS. This next-generation smart robotic system is built for the future. Not only will it be instrumental in operation and maintenance of the Gateway station itself, it will also open the door for Canadian science and research on and around the Moon and eventually extend humanity's reach outward to Mars and beyond. In parallel, forward work on the Gateway External Robotic Interfaces (GERI), initiated last year with a definition phase, will be approved early in 2021–22. This project will deliver the base points for Canada's robotics on early Gateway modules and for partners' payloads to be handled by Canadarm3. The technical statement of work for the subsequent phases (covering the detailed definition through development phases of the interfaces, and their delivery) of GERI have been assembled, and negotiation with the contractor is ongoing. With this contract in place early in 2021–22, industry will enable and assure Canada is meeting its commitments with the subsequent eventual contribution of Canadarm3, which relies on these interfaces being prepositioned on the Gateway.

These interfaces are critical elements of the robotic system that will be mounted on the various modules of the Gateway[iii], allowing the Canadarm3[ii] to "walk" along the Gateway and position itself to capture and berth approaching vehicles, move objects around, reconfigure station modules or support crew during space walks. In return for our participation in Gateway, NASA has committed to fly two Canadian astronauts to deep space, including one on the Artemis II[iv] mission, making a Canadian the first international partner to fly to the Moon. Canada will also have access to science opportunities in deep space, all the while demonstrating the technologies and capabilities required for the eventual human exploration of Mars. In 2021–22, the CSA will also prepare a proposal for the continuation of Canada's participation in the ISS beyond 2024[xv], to support operations, science, commercialization and Canadian astronaut flights to this unique international laboratory.

In 2021–22, the CSA will also continue the development of the Quantum Encryption and Science Satellite[xvi] (QEYSSat). QEYSSat is a communication demonstration mission for secure encryption key distribution which will allow the demonstration of distributing quantum keys over long distances using newly developed Quantum Key Distribution (QKD) technology through a laser link. The launch is currently planned toward the end of 2022.

With the aim of providing new space-based solutions to monitor the Earth and respond to global challenges, the CSA will advance the technology readiness levels (TRL) of several instruments, culminating in large-scale demonstrations on various platforms. Some examples of this include a demonstration model for the imaging Fourier Transform Spectrometer to be used for a proposed Arctic Observational Mission (AOM); and the undertaking of the High-Altitude Aerosols, Water Vapor and Ice Clouds Campaigns (HAWC) initiative to demonstrate measurement capabilities of three innovative instruments being considered for contribution to NASA's A-CCP[viii] climate-weather-air quality observing mission.

In 2021–22, the CSA will launch the next wave of the Space Technology Development Program[xvii] (STDP) investments in promising technologies to advance science and technology. These investments will lead to the development of new cutting-edge space technologies for the future and ensure Canada remains a leading space faring nation. They will also support Canada's Business Expenditures on Research and Development (BERD) in the space sector, which is expected to reach $324M in 2021–22.

From a space science perspective, the CSA's investments in space astronomy and planetary exploration missions will provide opportunities for Canadian scientists to participate in international space missions and gain access to scientific data.

The James Webb Space Telescope[xviii] launch is planned for October 31, 2021, a major milestone for Canada's space astronomy program. Canadian astronomers will have the right to use 5% of the observation time on one of the most sophisticated observatories of all times. In addition, Canadian astronomers will be allowed to compete for observation time on Japan's XRISM[xix] mission, which is scheduled for launch in February 2022. With regards to planetary exploration, OSIRIS-REx[xx] is on its way back from asteroid Bennu with precious samples on board, of which 4% will come to Canada. At the same time, the CSA will continue the support for the Alpha-Particle X-ray Spectrometer on NASA's highly successful Curiosity[xxi] rover on the surface of Mars.

In 2021–22, the CSA will also support the advancement of Earth science and contribute to the understanding of climate change through the ongoing support of the SCISAT[xxii] mission. Since it was launched in 2003, SCISAT data has been used by over 1,600 researchers in over 35 countries, resulting in 547 journal articles and 53 scientific discoveries.

In 2021–22, the SCISAT mission will publish a new dataset which will also include all major Greenhouse gases. SCISAT datasets advance Earth system science, our understanding of carbon in the atmosphere, and are major Canadian contributions to monitoring the ozone layer (United Nations Montreal Protocol[xxiii]) and maintaining space-based climate surveillance efforts. In addition, the CSA will prepare a new study to determine the best approach for Canada to continue monitoring the atmosphere and ensure data continuity of SCISAT.

By providing access to high-quality scientific data and supporting researchers, the CSA will contribute to science excellence and help maintain Canada's international ranking among Organisation for Economic Co-operation and Development (OECD) nations with respect to the average relative citation score of space-related publications.

Result 2—Canadians engage with space

Space provides a unique playground to capture the hearts and minds of the next generation of Canadian innovators. By taking advantage of Canadians' interest in space and by providing

opportunities for youth to acquire the skills to pursue studies and careers in STEM, the CSA will support the development of the next generation of space scientists and engineers.

Through its Junior Astronauts[vii] campaign, the CSA successfully engaged over 58,000 youth in every province and territory of Canada until the COVID-19 pandemic forced school closures and travel restrictions. Selected participating schools and youth organizations from across Canada received a virtual visit from an astronaut during the 2020–21 school year. In summer 2021, the Junior Astronauts campaign culminates with selected youth in grades 6 to 9 from across Canada taking part in Junior Astronauts Camp activities remotely, with CSA astronauts, scientists, and engineers.

In 2021–22, the CSA will continue to implement the Canadian CubeSat Project[xxiv] (CCP). The CCP supports 15 Canadian teams, from across the country, made up of post-secondary professors and their students that are participating in the development of real space missions. In 2021-22, the satellites will be tested to validate if they can make it through the rigors of a launch to space.

In 2021–22, the CSA's stratospheric balloon program, STRATOS,[xxv] will provide Canadian academia and industry with the opportunity to test and validate new technologies and perform scientific experiments in a near-space environment, while inspiring and training the next generation of experts. A large stratospheric balloon launch campaign will be held in Sweden and small expandable balloon flights will be conducted in Canada. At the same time, as part of the STRATOS program, the CSA-CNES (Centre national d'études spatiales) collaboration agreement will be negotiated and renewed.

Through the Science, Technology and Expertise Development in Academia[xxvi] (STEDiA), the CSA will continue to support academic research projects that advance scientific knowledge in the space field and develop innovative space technologies while contributing to the training of the new generation of scientists and engineers. The next wave of investments will be launched in the second half of 2021–22. As part of its commitment to support the development of the next generation of space professionals in Canada and to foster future international collaboration with other countries, the CSA will continue to support internships and conferences dedicated to students and young professionals.

The CSA uses social media engagements as an indicator of interest in Canada's Space Program. It is expected that the CSA's social media platforms will generate approximately 2 million engagements on social media in 2020–21. It is also expected that 1,090 new people and organizations will enter space-related fields as a result of CSA funding.

Result 3—Space information and technologies improve the lives of Canadians

Access to space data and technology is a game changer for many domains here on Earth. Every day, Canadian and international satellites provide information and services to support maritime

surveillance, space surveillance, ecosystems monitoring, environmental monitoring, natural disaster management, security and defence, as well as health. The CSA supports other government departments and agencies in the delivery of their mandates by providing access to space data, information, and services and encourages the development of space technologies that have the potential for use on Earth or re-use in space.

In 2021–22, of the CSA will continue to operate the RADARSAT Constellation Mission[xxvii] (RCM) in order to meet the mission requirements for Government of Canada users, industry, academia and foreign partners. The CSA will also continue to work with government departments, regulatory organizations, and the user communities to increase RCM[xxvii] data access and to augment RCM data services to Canadians through the vetting process. Greater access to this data will allow more value-added companies to develop applications and services for Canadians, fostering research and discoveries from academic institutions and strengthening international collaboration. With this in mind, and in line with the Open Government Directive,[xxviii] the CSA plans to progressively increase the RADARSAT-1[xxix] data archives with the repatriation of International archives and data processing over the next few years. Also, in order to complement RCM data, the CSA will continue to support government departments by providing RADARSAT-2[xxx] (R2) data and processing services, taking full advantage of the 12 years of R2 archived data, and providing data from both R2 and RCM for the International Charter on Space and Major Disasters.

In addition to this, the CSA will continue to work with partners on WildFireSat[ix], an innovative type of infrared sensor to monitor active wildfires. The CSA will also initiate early research and development on key Earth observation (EO) technologies on successor solutions to the RCM.

In 2021–22 the CSA will continue to support innovative solutions derived from satellite data through smartEarth[x], its application development funding initiative. Building on a series of investments, the smartEarth initiative will foster an intelligent use of satellite data to develop solutions to key challenges on Earth and in our everyday lives. One activity of particular interest over the next three years is a collaboration with Fisheries and Oceans Canada and Transport Canada to explore and develop innovative solutions in which satellite data can be used to contribute to the protection and environmental management of North Atlantic Right Whales[xxxi] in Canadian waters. At the same time, as part of its response to the growing crisis of climate change, smartEarth extended its support to 10 projects led by the Canadian EO Industry, in close partnership with federal departments and agencies as well as academia, under the theme Climate Change Impacts and Ecosystem Resilience, and the results will be delivered in Q3 of 2021–22. New smartEarth investments, with the objective of developing innovative solutions using space-based data to address challenges outlined in the SBEO Engagement paper as well as the 17 sustainable development goals in Canada’s national strategy to respond to the 2030 Agenda for Sustainable Development, are also planned to begin in 2021–22.

Now that Canada has completed and delivered its contribution to the Surface Water Ocean Topography[xxxii] (SWOT) hydrological science satellite, the CSA is focusing on the use of the data to be generated once it is launched in February 2022. The data, in combination with oceanographic and hydrological models, should lead to improvements in coastal and water-related services in Canada, such as forecasts of currents, storm surges, and floods. This preparatory work is being performed by scientists at Fisheries and Oceans Canada, ECCC, and several Canadian universities, with science partners in the United States of America and in France. The research is being done for multiple sites across Canada including: Atlantic waters off the coast of Newfoundland; the St. Lawrence River; lakes and rivers in Quebec, Ontario, Saskatchewan, Alberta and the Northwest Territories; and Pacific waters off the coast of British Columbia.

With the objective of contributing to the safety and security of Canadians, the CSA plans to support new Sun-Earth system science activities to analyze data from space platforms in order to develop new knowledge and improve predictive models of the Earth System and of the Earth's geospace, the region of near-Earth space comprised of the thermosphere, ionosphere, and magnetosphere. In 2021–22, the CSA will also continue to maintain space situational awareness in support of satellite operations and contribute to the sustainability of the space environment. To this end, the CSA will continue to operate and maintain its space debris Conjunction Risk Assessment and Mitigation System[xxxiii] (CRAMS), providing advanced analyses and collision avoidance strategies for close approaches with Canadian satellites, as well as international and national missions, for which the CSA has established partnerships. In addition, the CSA will continue to operate the Near-Earth Orbit Surveillance Satellite[xxxiv] (NEOSSat), providing Canada with a dual-use orbiting platform for advanced research, tracking, and characterization of objects orbiting earth, including satellites, space debris and asteroids, and will provide Canadian astronomers with observation time on this unique platform in 2021–22 through the NEOSSat Guest Observer program[xxxv], enabling scientific research in areas such as near-Earth asteroids, comets, and exoplanets.

In 2021–22, it is expected that 100 services dependent on CSA information will be offered to Canadians by the various federal departments and agencies using space data to deliver on their mandates. The services are varied and touch many different fields, such as agriculture, land use, climate, atmosphere and oceans and inland waters, amongst others. Some examples of these services include forecasting crop yields and assessing agricultural growth conditions, algae bloom detection, monitoring forest resources and assessing forest types, mapping and monitoring permafrost and assessing climate change risks for Canadians.

Canada is committed to remaining a leading space-faring nation, as noted in the Canadian Space Strategy. As a result, the CSA continues to meet its obligations to operate Canadian robotics and to support science on the ISS aimed at reducing health risks for astronauts during long-term missions. A number of scientific experiments will be conducted on the ISS in 2021–22 including: Vection,[xxxvi] Wayfinding[xxxvii] and Vascular Aging,[xxxviii] which will study neurological, ocular and cardiovascular risks. Furthermore, science opportunities will be offered to perform research on

space health risks, through data and sample mining, research models in laboratory, and spaceflight analogue environments, in order to complement studies performed on ISS.

The CSA will also complete the definition phases for a new astronaut health protocol aimed at mitigating the effects of spaceflight on the human body, which could translate into guidelines for analogous sedentary conditions for people on Earth. The CSA will work with partners to launch collaborative research and development initiatives with the health and biomedical sector, and to undertake the planning of a demonstration site in a remote Northern and Indigenous community, where early proof-of-concepts of health care solutions could be conducted, both for human spaceflight and isolated communities. The CSA will also launch, in collaboration with NASA and the Privy Council Office, a Deep Space Food Challenge[xxxix] designed to help bring innovative food production technologies to space and here on Earth.

In 2021–22, it is expected that 20 technological spin-offs resulting from the CSA's past investments will benefit Canadians.

Result 4—Canada's investments in space benefit the Canadian economy

In line with the Innovation and Skills Plan,[xl] in 2021–22, the CSA will continue to foster innovation in the space sector and enable Canadian innovators and entrepreneurs to take advantage of growth opportunities that create well-paying jobs and strengthen the Canadian economy.

Through the STDP[xvii] funding initiative, the CSA will launch other waves of investments to support the development of space exploration and EO-related technologies needed for future space missions and improve the commercial potential of innovative ones. Through LEAP,[v] the CSA will help small and medium-sized enterprises (SME) develop new technologies to be used and tested in lunar orbit and on the Moon's surface in fields such as artificial intelligence, robotics, and health. This will help Canadian enterprises, including SMEs, to capture their market share of the developing lunar economy.

In 2021–22, the CSA will start the definition phase for the first Canadian rover to ever drive on the surface of the Moon as a part of LEAP[v] and will award grants to universities to foster excellence in lunar science and to form networks. The CSA will also continue supporting industry through contributions to help them insert themselves in the supply chain of lunar spacecraft providers and to enable first-time demonstrations of Canadian technologies on or around the Moon.

The CSA will also support phase 2 of its first Innovative Solutions Canada (ISC)'s challenge (i.e., development of prototypes) which focused on applying artificial intelligence and big-data analytics to space-related technologies and applications. The second ISC challenge, which will focus on space exploration-related technologies, will also be launched.

Through the smartEarth[x] initiative's Enabler track, two funding activities are in place to increase the commercial and export potential for Canadian space-based applications. The first activity is Bridging the Information Gap with Space-Based Analytics[xli], which will lead to the funding of up to 16 Canadian companies to develop new disruptive applications with EO data. The second activity is the Canadian Downstream Space Sector Delivering on Canada's Better Future[xlii], which will provide contributions for the development of innovative space-based solutions by Canada's downstream industrial sector (data exploitation and application products, systems and services) to address complex global transformations, such as technological revolutions, climate change, and environmental degradation. Due to the COVID-19 crisis, a significant number of downstream organizations are struggling, particularly SMEs that constitute the bulk of commercial actors in the space industry. One of these activities is aimed at helping the sector capitalize on the data revolution, developing the necessary capabilities to better adapt to the current transformations in the digital marketplace, while the other aims to stimulate capacity development, answering national sustainable development challenges and priorities. These activities will ensure Canadian downstream sector growth, positioning, and competitiveness, which will help to secure and maintain highly qualified personnel in the space sector.

The CSA will continue to support the competitiveness and capacity of the Canadian space sector on the international market through the long-standing Cooperation Agreement between Canada and the European Space Agency (ESA). Investments in selected ESA programs will allow Canadian industry to participate in world-class missions in Earth observation, satellite communications, exploration, and technology development areas. The David Florida Laboratory's (DFL) world-class testing facilities and services will also support the Canadian space sector for Assembly, Integration, and Testing.

The CSA's investments seek to ensure that the Canadian space sector develops value-added services and ensures that the value of Canada's space sector exports is maintained. As such, in 2021–22, it is expected that the CSA investments will contribute to the Canadian space sector's $2.1B in exports and maintain 4,250 highly qualified jobs in Canada.

Gender-based analysis plus

The majority of employees working in STEM fields are men, making them more likely to directly benefit from the positive impact of the CSA's investments. In order to encourage more diversity and inclusion, the CSA investments will be accompanied by specific provisions in contracts and/or contribution agreements, to encourage companies to consider more women and other underrepresented groups in STEM in their hiring plan. Through this action, the CSA is aiming to contribute to the diversification of the Canadian space sector, to the prosperity and economic participation of all Canadians, as well as to participate in the establishment and maintenance of a diverse and highly skilled Canadian workforce.

The CSA will continue to seek to reduce systemic barriers to participation by specifically targeting underrepresented groups in its STEM outreach and education initiatives. The CSA plans to use space to inspire youth through astronaut, scientist and engineering role models who are representative of the Canadian population as well as demonstrating how space can benefit their lives in a tangible manner.

United Nations' 2030 Agenda for Sustainable Development and the UN Sustainable Development Goals (SDGs)

The CSA's scientific and satellite missions contribute to the achievement of the UN SDGs in multiple ways. On the space-based earth observation perspectives, missions such as SCISAT[xxii], SWOT[xxxii], WildFireSat[ix], and projects under the smartEarth[x] initiative will contribute to strengthening the resiliency and adaptive capacity to climate-related hazards and natural disasters (SDG 13.1[xliii]). While RCM's earth observation data will help to ensure sustainable food production systems and strengthen capacity for adapting to climate change, extreme weather, drought, flooding, and other disasters (SDG 2.4[xliv]). Furthermore, through it's Open Data strategy and engagement in bilateral and multilateral agreements, the CSA's enhances international cooperation and knowledge sharing in science, technology, and innovation domains (SDG 17.6[xlv]).

Scientific missions and activities such as space-based health experiments conducted on the ISS will contribute to universal health coverage by advancing technologies that will increase the access to quality essential health-care services in remote communities (SDG 3.8[xlvi]).

The CSA's initiatives such as LEAP[v] and STDP[xvii] aim to contribute to the reduction of Canadians living in poverty (SDG 1.2[xlvii]) by contributing to higher levels of economic productivity through diversification, technological upgrading, and innovation (SDG 8.2[xlviii]), and by supporting job creation, entrepreneurship, and innovation (SDG 8.3[xlviii]).

Through the Junior Astronauts[vii] campaign and the Canadian CubeSat[xxiv] project, the CSA contributes to increasing the number of youth and adults who pursue education and skills development (SDG 4.4[xlix]). Both projects are designed to empower and promote the social, economic, and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion, or economic or other status (SDG 10.2[l]).

Finally, the CSA helps to ensure women's full and effective participation and equal opportunities for leadership (SDG 5.5[li]) by having an executive committee composed of 65% women.

Experimentation

In 2021–22, following the creation of a new group dedicated to the management of services and experimentation, the CSA will integrate a framework for managing innovation ideas throughout the organization. Through the project *From Ideas to Results*, a defined process will allow CSA employees to bring innovative solutions to the different aspects of their work, to test them, and to

share the knowledge learned with other employees. In addition, experimentation will be incorporated into activities aimed at reviewing our services to ensure that they are client-centered.

Key risks

The *Canada in Space* core responsibility will be subject to risks from COVID-19 in 2021–22. The CSA is in regular communication with the space sector: thus ensuring a full comprehension of the impact of the COVID-19 pandemic on the space sector. Key concerns raised by firms include:

1) a reduction in the ability to seek, develop, and close new business opportunities;
2) the drying up of investment opportunities (specifically raised by start-ups); and
3) supply chain delays and disruptions.

Going forward, the CSA will maintain engagement with the sector to monitor impacts through the end of the pandemic and the economic recovery period so that space sector firms can maintain their capabilities.

Planned results for Canada in space

Departmental result	Departmental result indicator	Target	Date to achieve target	2017–18 actual result	2018–19 actual result	2019–20 actual result
1: Space research and development advances science and technology	I1: Business Expenditures in Research and Development (BERD) in the space sector	$324M	March 31, 2022	$254M (2016)	$363M (2017)	$356M (2018)
	I2: Canada's rank among OECD nations on the citation score of space-related publications	13	March 31, 2022	11 (2016)	11 (2017)	16 (2018)
2: Canadians engage with space	13: Number of new people and organizations entering space-related fields as a result of CSA funding	1090	March 31, 2022	N/A New indicator	206 (2017)	1041 (2018)
	I4: Number of engagements on social media related to the CSA	2,000,000[1]	March 31, 2022	2,591,031 (2017)	3,884,506 (2018)	3,592,089 (2019)

[1] In 2021–22, it is expected that the Canadian Space Agency's social media platforms will continue to support government-wide efforts to provide Canadians with crucial information related to the COVID-19 pandemic. Consequently, the CSA predicts that its engagements will plateau at 2 million engagements during the course of the year.

Departmental result	Departmental result indicator	Target	Date to achieve target	2017–18 actual result	2018–19 actual result	2019–20 actual result
3: Space information and technologies improve the lives of Canadians	I5: Number of services offered to Canadians dependent on CSA information (such as remote sensing data, including satellite imagery and science observations)	100	March 31, 2022	83 (2017)	96 (2018)	109 (2019)
	I6: Number of Canadian space technologies adapted for use on Earth or re-use in space	20[2]	March 31, 2022	13 (2016)	16 (2017)	22 (2018)
4 Canada's investments in space benefit the Canadian economy	I7: Number of highly qualified people in the Canadian space sector	4,250	March 31, 2022	4,085 (2016)	4,302 (2017)	4,120 (2018)
	I8: Value of exports of the Canadian space sector	$2.1B	March 31, 2022	$2B (2016)	$2.1B (2017)	$2.3B (2018)

Financial, human resources and performance information for the Canadian Space Agency's program inventory is available in the GC InfoBase.[lii]

[2] The CSA uses a three-year rolling average for this measure and given that multiple years had fewer technology transfers, the target is lower compared with last year's result.

Planned budgetary financial resources for Canada in space

2021–22 budgetary spending (as indicated in Main Estimates) (‘000)	2021–22 planned spending (‘000)	2022–23 planned spending (‘000)	2023–24 planned spending (‘000)
346,068	346,068	327,832	309,251

Financial, human resources and performance information for the Canadian Space Agency’s program inventory is available in the GC InfoBase.[lii]

Planned human resources for Canada in space

2021–22 planned full-time equivalents	2022–23 planned full-time equivalents	2023–24 planned full-time equivalents
430.0	424.5	424.1

Financial, human resources and performance information for the Canadian Space Agency’s program inventory is available in the GC InfoBase.[lii]

Internal Services: planned results

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 services that support Program delivery in the organization, regardless of the Internal Services delivery model in a department. These services are:

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

Planning highlights

To ensure the modern, efficient and relevant delivery of internal services, in 2021–22 the CSA will continue to improve its internal services processes and its business model, in order to align itself, strategically and operationally, with its international partners, stakeholders, academia, and other government departments and agencies.

In 2021–22, the CSA will streamline requirements for investments thus ensuring more timely and effective input to governance bodies, with the aim to improve decision-making. The CSA will also implement new product assurance requirements for small and microsatellites.

In 2021-22, the CSA will continue to roll out its three-year departmental security plan, with the objective of mitigating the main organizational risks to departmental security. The CSA will also continue its real property asset maintenance strategy to ensure and prolong optimal operations of its facilities in support of the agency’s mandate and its long-term greening government action plan, so that its activities have a low carbon footprint, increased climate resiliency, and meet government targets. In addition, the CSA will begin the implementation and testing phases of a pilot project at its headquarters in collaboration with NRCan to optimize building operations, generate energy savings, and reduce GHG emissions.

To ensure that it is an employer of choice and offers a diverse, inclusive, and anti-racist workplace, the CSA will begin the implementation of a new 3-year Strategic Plan for Diversity and Inclusion

that will pay particular attention to identifying and challenging practices that contribute to racism, bias, and systemic discrimination with a view to eliminating them, especially in the areas of recruitment, assessment, hiring, and talent management. In addition, it will provide support and tools to ensure a healthy and safe work environment oriented towards the future of work in the new social context. The CSA will continue to explore technological options for better integration of human resources and financial data and will establish a strategy to ensure the creation and maintenance of pools of qualified candidates to support the organization in the delivery of its mandate and to prepare for succession.

The CSA will also continue its digital transformation efforts by modernizing its infrastructure and tools, so as to optimize the work environment and promote employee mobility. Adopting cloud solutions will, for example, make information technologies more agile in responding to employees' needs. Moreover, by updating its digital operations and developing its digital strategy, the CSA will provide greater flexibility, openness, accessibility, and user-friendliness. The objectives are to provide to the CSA workforce a suite of accessible, modern and secure cloud-based tools for enhanced productivity, collaboration, videoconferencing and email. The Data Expertise Centre will also enable the CSA to advance the activities needed to develop a new data-based governance and culture.

Planned budgetary financial resources for Internal Services

2021–22 budgetary spending (as indicated in Main Estimates) ('000)	2021–22 planned spending ('000)	2022–23 planned spending ('000)	2023–24 planned spending ('000)
57,562	57,562	58,701	55,178

Planned human resources for Internal Services

2021–22 planned full-time equivalents	2022–23 planned full-time equivalents	2023–24 planned full-time equivalents
357.4	328.2	328.3

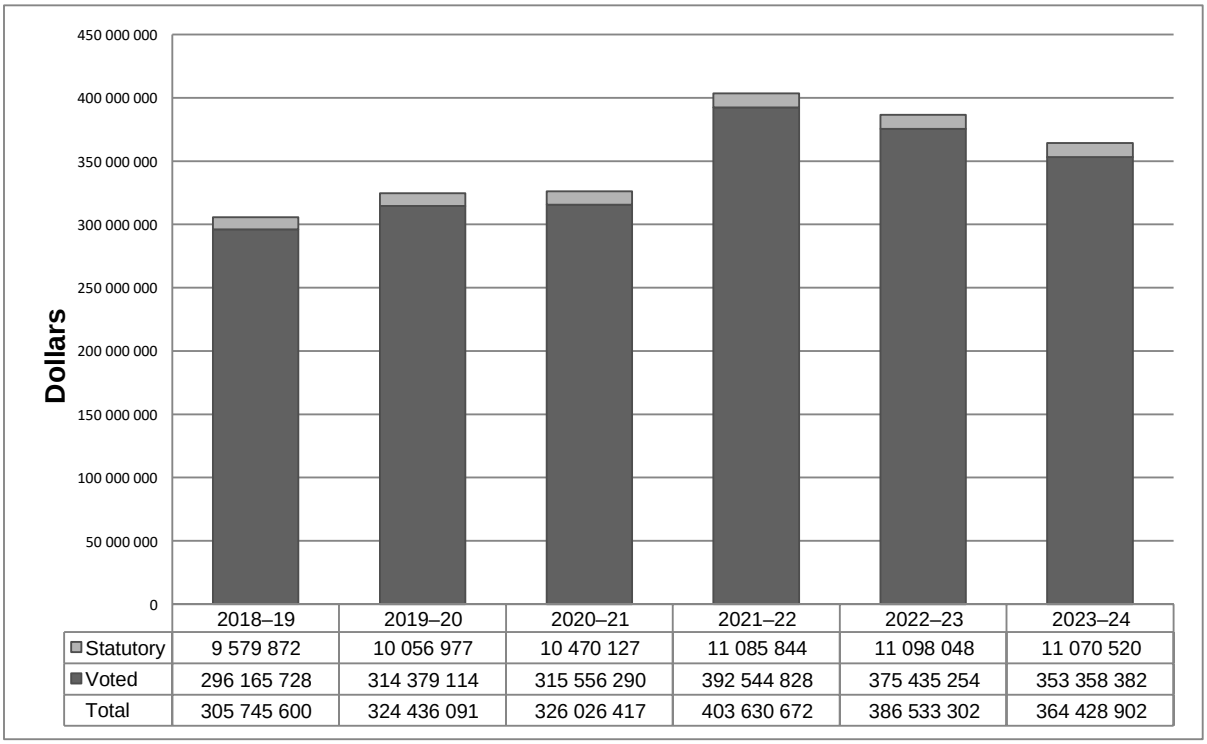
Spending and human resources

This section provides an overview of the department's planned spending and human resources for the next three consecutive fiscal years and compares planned spending for the upcoming year with the current and previous years' actual spending.

Planned spending

Departmental spending 2018–19 to 2023–24

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



	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24
Statutory	9 579 872	10 056 977	10 470 127	11 085 844	11 098 048	11 070 520
Voted	296 165 728	314 379 114	315 556 290	392 544 828	375 435 254	353 358 382
Total	305 745 600	324 436 091	326 026 417	403 630 672	386 533 302	364 428 902

Budgetary planning summary for core responsibilities and Internal Services (dollars)

The following table shows actual, forecast and planned spending for each of the Canadian Space Agency's core responsibilities and to Internal Services for the years relevant to the current planning year.

Core responsibilities and Internal Services	2018–19 expenditures	2019–20 expenditures	2020–21 forecast spending	2021–22 budgetary spending (as indicated in Main Estimates)	2021–22 planned spending	2022–23 planned spending	2023–24 planned spending
Canada in space	254,711,091	272,610,925	328,366,537	346,068,318	346,068,318	327,832,181	309,251,395
Subtotal	254,711,091	272,610,925	328,366,537	346,068,318	346,068,318	327,832,181	309,251,395
Internal Services	51,034,509	51,825,166	66,436,618	57,562,354	57,562,354	58,701,121	55,177,507
Total	305,745,600	324,436,091	394,803,155	403,630,672	403,630,672	386,533,302	364,428,902

The variance in CSA's past expenditures since 2018–19 is mainly attributable to investments in Canada's participation in the ISS until 2024, announced in Budget 2016, as well as to investments in the RCM, announced in Budget 2010.

The variance in the planned spending until 2023-24 is mainly attributable to investments in the Canada's participation in the ISS until 2024, which includes MSR, and investments in the LEAP, as well as the smart robotic system Canadarm3, which is the Canadian contribution to the NASA-led Lunar Gateway Program, announced in Budget 2019.It is noteworthy that the CSA's project and mission funding profile varies from year to year, depending on the status of each mission, which has an impact on expenditures, forecast spending, and planned spending.

Planned human resources

The following table shows actual, forecast and planned full-time equivalents (FTEs) for each core responsibility in the Canadian Space Agency's departmental results framework and to Internal Services for the years relevant to the current planning year.

Human resources planning summary for core responsibilities and Internal Services

Core responsibilities and Internal Services	2018–19 actual full-time equivalents	2019–20 actual full-time equivalents	2020–21 forecast full-time equivalents	2021–22 planned full-time equivalents	2022–23 planned full-time equivalents	2023–24 planned full-time equivalents
Canada in space	390.0	387.6	399.3	430.0	424.5	424.1
Subtotal	390.0	387.6	399.3	430.0	424.5	424.1
Internal Services	285.4	289.9	324.6	357.4	328.2	328.3
Total	**675.4**	**677.5**	**723.8**	**787.5**	**752.7**	**752.3**

The variance in the number of FTEs since 2018–19 is mainly attributable to the additional resources required to fill certain gaps and priorities, including:

- additional scientific and technical staff to support the activities of the ISS until 2024;
- additional changes as a result of the Canadarm3 mission, which includes new obligations such as those stemming from the new Policy on Service and Digital;
- increased investments to recruit the next generation of public servants, which includes the student programs; and
- new departmental requirements for internal services, such as managing Phoenix, setting up a data expertise centre, results-based accountability, and policy resets.

Estimates by vote

Information on the Canadian Space Agency's organizational appropriations is available in the 2021–22 Main Estimates.[liii]

Future-oriented condensed statement of operations

The future-oriented condensed statement of operations provides an overview of the Canadian Space Agency's operations for 2020–21 to 2021–22.

The amounts for forecast and planned results in this statement of operations were prepared on an accrual basis. The amounts for forecast and planned spending presented in other sections of the Departmental Plan were prepared on an expenditure basis. Amounts may therefore differ.

A more detailed future-oriented statement of operations and associated notes, including a reconciliation of the net cost of operations to the requested authorities, are available on the Canadian Space Agency's website.[liv]

Future-oriented Condensed statement of operations for the year ending March 31, 2022 (dollars)

Financial information	2020–21 forecast results	2021–22 planned results	Difference (2021–22 planned results minus 2020–21 forecast results)
Total expenses	363,907,270	567,586,030	203,678,760
Total revenues	17,771	17,771	-
Net cost of operations before government funding and transfers	363,889,499	567,568,259	203,678,760

Expenses

Total expenses, estimated on an accrual basis, are planned to be $567,586,030 in 2021-22 which is an expected increase of $203,678,760 (56%) from 2020-21 forecast results.

The increase is mainly due to:

- Increase of $179.6 million in amortization expenses, due to the depreciation of the RCM, which became operational at the end of 2020-21.
- Increase of $26.7 million in "Professional and Special Services" and "Travel and Communications" mainly due to the RCM operations.

Expenses are mainly related to professional and special services, amortization, salaries and benefits. and transfer payments. The expenses include planned spending presented in this Departmental Plan, as well as expenses not mentioned such as amortization, services provided without charge by other government departments, and severance benefits and vacation pay liability adjustments.

Revenues

Total revenues are projected to be $971,005 in 2021-22. Most of the revenues are generated from the sales of goods and services such as testing services provided at the DFL and are not respendable. The Agency's respendable revenues are projected to be $17,771 and represent revenues from Crown Asset Disposition.

Corporate information

Organizational profile

Appropriate minister(s):

The Honourable François-Philippe Champagne, P.C., M.P.

Minister of Innovation, Science and Industry:

Institutional head:

Lisa Campbell, President

Ministerial portfolio:

Innovation, Science and Economic Development

Enabling instrument(s):

Canadian Space Agency Act, S.C. 1990, c. 13[lv]

Year of incorporation / commencement:

Established in March 1989

Other:

The Canadian Space Agency was established in 1989. Approximately 84% of its employees work at the headquarters located at the John H. Chapman Space Centre, in St-Hubert, Quebec. The remaining personnel serve the CSA at the David Florida Laboratory in Ottawa, Ontario and its policy and planning offices in Gatineau, Quebec, with officials in Houston, Washington and Paris.

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 Canadian Space Agency’s website.[liv]

For more information on the department’s organizational mandate letter commitments, see the “Minister’s mandate letter.”[lvi]

Operating context

Information on the operating context is available on the CSA’s website.[liv]

Reporting framework

The Canadian Space Agency's approved departmental results framework and program inventory for 2021–22 are as follows.

Departmental Results Framework	**Core Responsibility: Canada in space**		**Internal Services**
	Departmental Result: Space research and development advances science and technology	Indicator: Business Expenditures in Research and Development in the space sector	
		Indicator: Canada's rank among OECD nations on the citation score of space-related publications	
	Departmental Result: Canadians engage with space	Indicator: Number of new people and organizations entering space related fields as a result of CSA funding	
		Indicator: Number of engagements on social media related to the CSA	
	Departmental Result: Space information and technologies improve the lives of Canadians	Indicator: Number of services offered to Canadians dependent on CSA information	
		Indicator: Number of Canadian space technologies adapted for use on earth or re-use in space	
	Departmental Result: Canada's investments in space benefit the Canadian economy	Indicator: Number of highly qualified people in the Canadian space sector	
		Indicator: Value of export of the Canadian space sector	
Program Inventory	Program: Space Capacity Development		
	Program: Space Exploration		
	Program: Space Utilization		

Supporting information on the program inventory

Supporting information on planned expenditures, human resources, and results related to the Canadian Space Agency's program inventory is available in the GC Infobase.[lii]

Supplementary information tables

The following supplementary information tables are available on the Canadian Space Agency's website.[liv]

- Departmental Sustainable Development Strategy
- Details on transfer payment programs
- Gender-based analysis plus

Federal tax expenditures

The Canadian Space Agency's Departmental Plan does not include information on tax expenditures that relate to its planned results for 2021–22.

Tax expenditures are the responsibility of the Minister of Finance, and the Department of Finance Canada publishes cost estimates and projections for government-wide tax expenditures each year in the Report on Federal Tax Expenditures.[lvii] This report provides detailed information on tax expenditures, including objectives, historical background and references to related federal spending programs, as well as evaluations, research papers and gender-based analysis. The tax measures presented in this report are solely the responsibility of the Minister of Finance.

Organizational contact information

Mailing address

6767 Route de l'Aéroport
Saint-Hubert, QC
J3Y 8Y9

Telephone: 450-926-4800

Fax: 450-926-4352

Email: asc.info.csa@canada.ca

Website: http://www.asc-csa.gc.ca

Appendix: definitions

appropriation (crédit)

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

budgetary expenditures (dépenses budgétaires)

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

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 a department over a 3-year period. Departmental Plans are tabled in Parliament each spring.

departmental priority (priorité ministérielle)

A plan or project that a department has chosen to focus and report on during the planning period. Departmental 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 factor or variable that provides a valid and reliable means to measure or describe progress on a departmental result.

departmental results framework (cadre ministériel des résultats)

A framework that consists of the department's core responsibilities, 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 and what doesn't. 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. Full-time equivalents are calculated as a ratio of assigned hours of work to scheduled hours of work. Scheduled hours of work are set out in collective agreements.

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

An analytical 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 2021–22 Departmental Plan, government-wide priorities refers to those high-level themes outlining the government's agenda in the 2020 Speech from the Throne, namely: Protecting Canadians from COVID-19, Helping Canadians through the pandemic, Building back better – a resiliency agenda for the middle class, The Canada we're fighting for.

horizontal initiative (initiative horizontale)

An initiative in which 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 up to the expected result.

planned spending (dépenses prévues)

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

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

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 of the department’s programs and describes how resources are organized to contribute to the department’s core responsibilities and results.

result (résultat)

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

statutory expenditures (dépenses législatives)

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

strategic outcome (résultat stratégique)

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

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

[i] Canadian Space Strategy, https://www.asc-csa.gc.ca/eng/publications/space-strategy-for-canada/default.asp
[ii] Canadarm3, https://asc-csa.gc.ca/eng/canadarm3/about.asp
[iii] Lunar Gateway, https://asc-csa.gc.ca/eng/astronomy/moon-exploration/lunar-gateway.asp
[iv] The Artemis missions, https://asc-csa.gc.ca/eng/astronomy/moon-exploration/artemis-missions.asp
[v] LEAP, https://asc-csa.gc.ca/eng/funding-programs/programs/leap/about.asp
[vi] International Space Exploration Coordination Group, https://www.globalspaceexploration.org/
[vii] Junior Astronauts, https://asc-csa.gc.ca/eng/resources-young/junior-astronauts/default.asp
[viii] A-CCP, https://science.nasa.gov/earth-science/decadal-accp
[ix] WildFireSat, https://asc-csa.gc.ca/eng/satellites/wildfiresat/default.asp
[x] smartEarth, https://asc-csa.gc.ca/eng/funding-programs/programs/smartearth/default.asp
[xi] ISS, https://asc-csa.gc.ca/eng/iss/default.asp
[xii] Canadarm2, https://asc-csa.gc.ca/eng/iss/canadarm2/default.asp
[xiii] Dextre, https://asc-csa.gc.ca/eng/iss/dextre/default.asp
[xiv] Industrial and Technological Benefits Policy, https://www.canada.ca/en/innovation-science-economic-development/news/2017/04/the_industrial_andtechnologicalbenefitspolicy.html
[xv] Beyond the ISS, https://asc-csa.gc.ca/eng/astronomy/moon-exploration/the-future-of-space-exploration-beyond-the-international-space-station.asp
[xvi] QEYSSat, https://asc-csa.gc.ca/eng/sciences/qeyssat.asp
[xvii] STDP, https://asc-csa.gc.ca/eng/funding-programs/programs/stdp/default.asp
[xviii] James Webb Space Telescope, https://www.asc-csa.gc.ca/eng/satellites/jwst/default.asp
[xix] XRISM, https://asc-csa.gc.ca/eng/satellites/xrism/default.asp
[xx] ORSIRIS-Rex, https://www.asc-csa.gc.ca/eng/satellites/osiris-rex/default.asp
[xxi] Curiosity, https://www.asc-csa.gc.ca/eng/astronomy/mars/missions/curiosity.asp
[xxii] SCISAT, https://asc-csa.gc.ca/eng/satellites/scisat/about.asp
[xxiii] UN Montreal Protocole, https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-2-a&chapter=27&clang=_en
[xxiv] Canadian CubeSat Project, https://asc-csa.gc.ca/eng/satellites/cubesat/what-is-the-canadian-cubesat-project.asp
[xxv] STRATOS, https://asc-csa.gc.ca/eng/sciences/balloons/about-stratospheric-balloons.asp
[xxvi] STEDiA, https://asc-csa.gc.ca/eng/funding-programs/programs/default.asp
[xxvii] RCM, https://asc-csa.gc.ca/eng/satellites/radarsat/default.asp
[xxviii] Open Government, https://open.canada.ca/en
[xxix] RADARSAT-1, https://asc-csa.gc.ca/eng/satellites/radarsat1/default.asp
[xxx] RADARSAT2, https://asc-csa.gc.ca/eng/satellites/radarsat2/default.asp
[xxxi] North Atlantic Right Whales, https://species-registry.canada.ca/index-en.html#/species/780-298
[xxxii] SWOT, https://asc-csa.gc.ca/eng/satellites/swot.asp
[xxxiii] CRAMS, https://conference.sdo.esoc.esa.int/proceedings/sdc7/paper/1006/SDC7-paper1006.pdf
[xxxiv] NEOSSat, https://www.asc-csa.gc.ca/eng/satellites/neossat/default.asp
[xxxv] NEOSSat Guest Obeservation Program, https://www.asc-csa.gc.ca/eng/funding-programs/funding-opportunities/ao/2020-neossat-science-guest-observation-cycle-2.asp
[xxxvi] Vection, https://www.asc-csa.gc.ca/eng/sciences/vection.asp
[xxxvii] Wayfinding, https://www.asc-csa.gc.ca/eng/sciences/wayfinding.asp
[xxxviii] Vascular Series, https://www.asc-csa.gc.ca/eng/sciences/vascular.asp
[xxxix] Deep Space Food Challenge, https://www.asc-csa.gc.ca/eng/sciences/food-production/deep-space-food-challenge.asp
[xl] Innovation and Skills Plan, https://www.ic.gc.ca/eic/site/062.nsf/eng/home
[xli] Bridging the information gap with space-based analytics, https://www.asc-csa.gc.ca/eng/funding-programs/programs/smartearth/contributions-grants-contracts-awarded.asp
[xlii] Canadian Downstream Space Sector, https://www.asc-csa.gc.ca/eng/funding-programs/funding-opportunities/ao/2021-space-sector-delivering-canada-better-future.asp
[xliii] SDG 13, https://sdgs.un.org/goals/goal13
[xliv] SDG 2, https://sdgs.un.org/goals/goal2
[xlv] SDG 17, https://sdgs.un.org/goals/goal17

[xlvi] SDG 3, https://sdgs.un.org/goals/goal3
[xlvii] SDG 1, https://sdgs.un.org/goals/goal1
[xlviii] SDG 8, https://sdgs.un.org/goals/goal8
[xlix] SDG 4, https://sdgs.un.org/goals/goal4
[l] SDG 10, https://sdgs.un.org/goals/goal10
[li] SDG 5, https://sdgs.un.org/goals/goal5
[lii] GC InfoBase, https://www.tbs-sct.gc.ca/ems-sgd/edb-bdd/index-eng.html
[liii] Main Estimates, https://www.canada.ca/en/treasury-board-secretariat/services/planned-government-spending/government-expenditure-plan-main-estimates.html
[liv] Reports to Parliament, https://asc-csa.gc.ca/eng/publications/rp.asp
[lv] Canadian Space Agency Act, https://laws.justice.gc.ca/eng/acts/C-23.2/page-1.html
[lvi] Minister letter, https://pm.gc.ca/en/mandate-letters/2021/01/15/minister-innovation-science-and-industry-supplementary-mandate-letter
[lvii] Report on Federal Tax Expenditures, https://www.canada.ca/en/department-finance/services/publications/federal-tax-expenditures.html